DETAILED PROJECT REPORT

Arambagh Municipality

October 2017

Preface

The urban solid waste problems are growing exponentially in the cities and urban centers of this country. Inadequate and inappropriate solid waste management policy is imposing threats on the environment, polluting the natural resources which in turn endangers the eco-system by large. It has reached disastrous proportions nowadays. The problem has become critical further for the reasons of lower socio-economic structures, inadequate resources, lack of techno management initiatives and community participation as a whole. Coupled with budgetary restrictions, poorly motivated staff, inadequate vehicles and implements the solid waste management has become one of the burning problems of the local bodies. The existing infrastructure is barely adequate to cope up with today's need.

This detailed project report, "**Proposed Solid Waste Management System**" for **Arambagh Municipality** has been prepared for improvement of the present solid waste management system of the town and also for proper surveillance and sustainability of the system. The report emphasizes upon the adequate steps for collection, transportation and processing through generation of bio-gas & disposal of solid waste generated by the community. **The total project cost is Rs. 933.69 lakh.** The most vital component of this project is the procurement of land in the near vicinity of the town and which has already been procured by the ULB. The project will be implemented and managed by Ranaghat Municipality with the technical assistance and guidance of M. E. Directorate.

Hope, this project will not only improve the environmental condition of the town and the health of the community, as a whole but will also fetch a good amount of revenue from the project.

*Thus **waste to wealth.***

Sub-Assistant Engineer
Arambagh Municipality

Chairman
Arambagh Municipality

CONTENT

16/10/17
Assistance of S. A. E
Arambagh Municipality

Sub-Assistant Engineer
Arambagh Municipality

Chairman
Arambagh Municipality

ARAMBAGH MUNICIPALITY

PROJECT SUMMARY

POPULATION	:		66175	
AREA	:		23.28	SQ.KM
NO. OF HOLDINGS	:		13547	Nos.
NO. OF WARDS	:		19	Nos.
NO. OF DAILY MARKETS	:		12	Nos.
NO. OF COMMERCIAL CENTRES	:		2	Nos.
NO. OF HOTELS	:		32	Nos.
NO. OF HOSPITALS	:		1	Nos.
QUANTITY OF WASTE				
A) DOMESTIC WASTE	:		18.20	MT
B) MARKET WASTE	:		6.00	MT
C) HOTEL WASTE	:		0.17	MT
GARDEN/AGRICURTURAL WASTE	:		0.50	MT
D) TRADE WASTE	:		1.00	MT
E) OTHERS WASTE	:		2.00	MT
F) CLINICAL WASTE	:		0.38	MT
TOTAL QUANTITY OF WASTE	:		28.24	MT
PROJECT COST				
A) PLANT, MACHINERY, EQUIPMENTS FOR COLLECTION, TRANSPORTATIONS AND DISPOSAL	:	Rs.	290.12	LAKH
B) DEVELOPMENT OF LANDFILL SITE	:	Rs.	84.02	LAKH
C) CONSTRUCTION OF BIO-GAS PLANT	:	Rs.	532.35	LAKH
D) CONTINGENCIES		Rs.	27.19	LAKH
TOTAL PROJECT COST	:	Rs.	933.69	LAKH
PROJECT PERIOD	:		2	YEARS
O & M COST PER YEAR	:		111.18	LAKH
REVENUE			PER YEAR	
TOTAL REVENUE GENARATION	:	Rs.	187.34	LAKH
O & M COST	:	Rs.	111.18	LAKH
SURPLUS (AFTER RE-PAYMENT OF LOAN, IF ANY)	:	Rs.	76.15	LAKH
LAND REQUIRED				
A) FOR SANITARY LANDFILL	:		0.9	ACRES
B) FOR BIOGAS PLANT AND OTHERS	:		0.6	ACRES
TOTAL LAND REQUIERD	:		1.5	ACRES
TOTAL LAND AVAILABLE	:		9.0	ACRES

Sub-Assistant Engineer
Arambagh Municipality

Chairman
Arambagh Municipality

INTRODUCTION

Solid Waste Management system involves activities associated with generation, collection, transfer & transport and processing and disposal of solid wastes generated by the community. It involves planning, organization, administration, finance, legal and engineering aspects involving interdisciplinary co-ordination. This aspect received scanty attention in most of the municipal towns resulting in insanitary conditions. An effective solid waste management scheme can be drawn by means of a harmonic integration between the available in house resources and the latest technologies.

Solid Waste Management is an obligatory function of Urban Local Bodies (ULBs) in India. However, this service is poorly performed resulting in problems of health, sanitation and environmental degradation. With over 3.6% annual growth in urban population and the rapid pace of urbanization, the situation is becoming more and more critical with the passage of time. Infrastructure development is not in a position to keep pace with population growth owing to the poor financial health of most of the urban local bodies. Solid Waste Management is one among the essential services, which suffers the most in such a situation. Lack of political will, inadequate financial resources, institutional weakness, improper choice of technology and public apathy towards Solid Waste Management has made this service far from satisfactory.

India has 4378 cities and towns as per 2001 census which comprises as under.

Type of cities/towns	Population range
Above 1 million	35
Above 1 lakh	358
Above 50000	401
Below 50000	3584
Total	4378

Waste generation ranges from 200 gms. to 600 gms per capita per day in cities ranging from I Lac to over 50 Lakh population. The larger the city, the higher is the per-capita waste generation rate. The total waste generation in urban areas in the country is estimated to exceed 100000 tons a day.

Indian mixed waste has a large proportion of compost able material and inerts. As per recent studies compost able matters are approximate 55% and inert materials 30 %. The component of recyclable material is between 15%.

A study of Indian cities has shown the Chemical Composition as under:

Chemical Characteristics of Municipal Solid Waste in Indian Cities

Population Range (in millions) ⟶	0.1 to 0.5	0.5 to 1.0	1.0 to 2.0	2.0 to 5.0	> 5
Physical Characteristics					
Paper (as %)	2.91	2.95	4.71	3.18	6.43
Rubber Leather And Synthetics (as %)	0.78	0.73	0.71	0.48	0.28
Glass (as %)	0.56	0.35	0.46	0.48	0.94
Metals (as %)	0.33	0.32	0.49	0.59	0.8
Total compostable matter (as %)	44.57	40.04	38.95	56.67	30.84
Inert (as %)	43.59	48.38	44.73	49.07	53.9
Chemical Characteristics					
Moisture (as %)	25.81	19.52	26.98	21.03	38.72
Organic matter (as %)	37.09	25.14	26.89	25.6	39.07
Nitrogen as Total Nitrogen (as %)	0.71	0.66	0.64	0.56	0.56
Phosphorous as P2O5(as %)	0.63	0.56	0.82	0.69	0.52
Potassium as K2O(as %)	0.83	0.69	0.72	0.78	0.52
C/N Ration	30.94	21.13	23.68	22.45	30.11
Calorific value* in Kcal/kg	1009.89	900.61	980.05	907.18	800.7

Source: Manual on Municipal Solid Waste Management 2000- CPHEEO
**Calorific Value on dry weight basis*

The prevalent SWM practices in the country are highly deficient. Generally no storage of waste is being done at source and instead, domestic, trade and institutional wastes, including bio-medical and industrial waste, are thrown on the streets, footpaths, drains and water bodies treating them as receptacle of waste. Recyclable waste material is also not segregated at source and is disposed of on the streets, along with domestic, trade and other wastes. Construction and demolition wastes also pose a serious problem as these wastes are also deposited on the roadside or open spaces, obstructing traffic and causing nuisance.

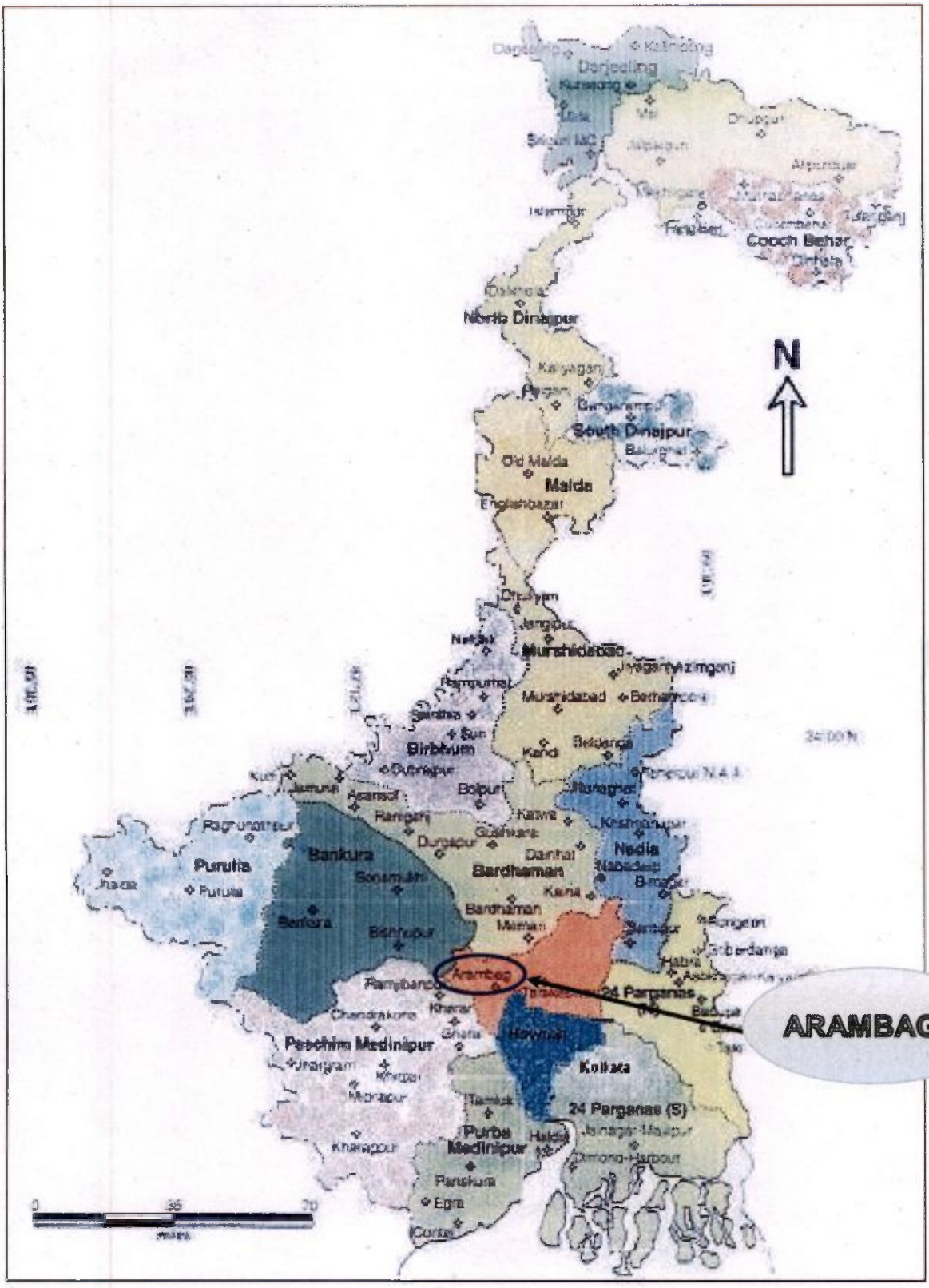
Generally no processing of waste is done in the country except in a few cities where decentralized or centralized composting is done on a limited scale. Here, the marketing of compost is posing a problem due to ineffective marketing mechanism. A few cities have recently attempted to set up waste to energy plant; their success is yet to be evaluated. Disposal of waste is done in a most unscientific manner. Generally crude open dumping is adopted for disposal of waste in low-lying areas. Most local bodies' deposits waste at the dump-yards without ascertaining the suitability of the land for waste disposal and do not bother to spread or cover the waste with inert material. These sites emanate foul smell, become breeding grounds for flies, rodent and pests, and pose a serious threat to underground water resources and overall environment. System of waste management in the country is thus out-dated, unscientific and highly inefficient.

The laws governing the urban local bodies do not have adequate provisions to deal with the situation effectively officials dealing with SWM service do not have the necessary powers to punish defaulters. Filling of cases in the court for sanitation offences is cumbersome, takes a lot of time and energy of the staff and does not give the desired results as the punishment imposed at the end of long drawn proceedings is too small to have any salutary effect on the offender.

Looking to the deplorable situation of solid waste management in the country, public interest litigation was filed in the Supreme Court of India seeking direction to central government, state governments and city governments to manage the waste scientifically in an environmentally acceptable manner. Having realized the gravity of the situation, the Hon'ble Supreme Court constituted an expert committee to look into all aspects of solid waste management and make recommendation to improve the situation in class-1 cities.

The Committee so formed considered various options to improve solid waste management practices in these cities and, looking to the present state of SWM practices in urban areas in the country, the institutional capabilities of local bodies, their financial health and other priorities, recommended a minimum level of services that each local body must provide and gave technological options which the local bodies may consider while choosing the technology suitable for their cities, etc.

Map of West Bengal showing Non-KMA ULBs :



TOWN PROFILE

1.0 SALIENT FEATURES OF ARAMBAGH MUNICIPAL TOWN

1.1 Location

Arambag is one of the four Sub – Divisional towns of the district Hooghly in the state of West Bengal. The town is situated at 22°39' N and 8°°31' E. It is situated in the north western part of the district, the towns is connected by state highways and is the gate way to Midnapur, Bankura, Burdwan, Purulia districts. The town is 42 k.m. from Burdwan, the nearest district town.

1.2 Area

At present the area of the town is 34.75 Sq. km. The Municipal area is divided in to 18 nos Wards for administrative purposes. At the time of establishment of Municipality in 1886, the area was 4.8 Sq. km.

Ward-wise Area is as follows:

Sl. No.	Ward No.	Area in Sq. km.
1	1	3.41
2	2	1.47
3	3	0.37
4	4	0.43
5	5	0.66
6	6	0.71
7	7	1.85
8	8	1.35
9	9	3.76
10	10	3.38

Sl. No.	Ward No.	Area in Sq. km.
11	11	4.78
12	12	1.62
13	13	1.165
14	14	0.58
15	15	2.63
16	16	2.96
17	17	0.8
18	18	2.26
19	19	0.565
Total		**34.75**

1.3 Historical Background

Arambagh is situated to the east of Kamarpukur by 14 km. and Joyrambati by 19 km. Both the place are international places of interest, being the birth place of Sri Sri Ramkrishna Paramhansa Dev and Mata Saradamoni respectively. These places have gained international pilgrimage and are spots for tourist attraction.

Arambagh is diagonally situated to the North Western corner of Radhanagar by 27 km. Radhanagar is the birth place of great social reformer, Raja Rammohan Roy and a place of tourist attraction.

Great novelist, Bankim Chandra Chatterjee wrote his famous novel "Durgesh Nandini" on Garh Mandaron, a historical place, while he was S.D.O. of Arambag.

1.4 Population

Population as per 2001 census is 56140. Male population is 28729, Female population is 27411. The sex ratio i.e. number of female per 1000 males is 954. The gross density of population is 1615 person per Sq. km.

Growth of population since 1951 may be seen from the Table below :

Year	Population
1941	8992
1951	11460
1961	16501
1971	25592
1981	34205
1991	45211
2001	56140
2011	66175

It may be observed that there is steady growth of population in the town - no sudden influx of population has been there at any point of time.

The population of 66175 (2011 Census) is distributed in 19 Wards as under:

Sl. No.	Ward No.	Ward Population as per Census 2011
1	1	3461
2	2	6974
3	3	4656
4	4	2633
5	5	3124

Sl. No.	Ward No.	Ward Population as per Census 2011
11	11	2507
12	12	2322
13	13	3654
14	14	2974
15	15	4979

6	6	4283
7	7	3005
8	8	2573
9	9	3400
10	10	3430

16	16	4065
17	17	2513
18	18	1858
19	19	3764
Total		**66175**

It may be seen from the Table that a few wards are thinly populated whereas some wards located at central portion of the town are thickly populated.

1.5 Topographical and Geological Features

The soil is reach fertile forms of new alluvial on clay subsoil with clay surface at some places. The town belongs to the gangetic plains of West Bengal. The topography is flat and at plains low with cobweb formation by main rivers and their branches.

The water table below ground level is fluctuating with the variation of the season. In the rainy season water table rises up to 8'-0" below G.L. and drops down to 30'-0" below G.L. during the summer season.

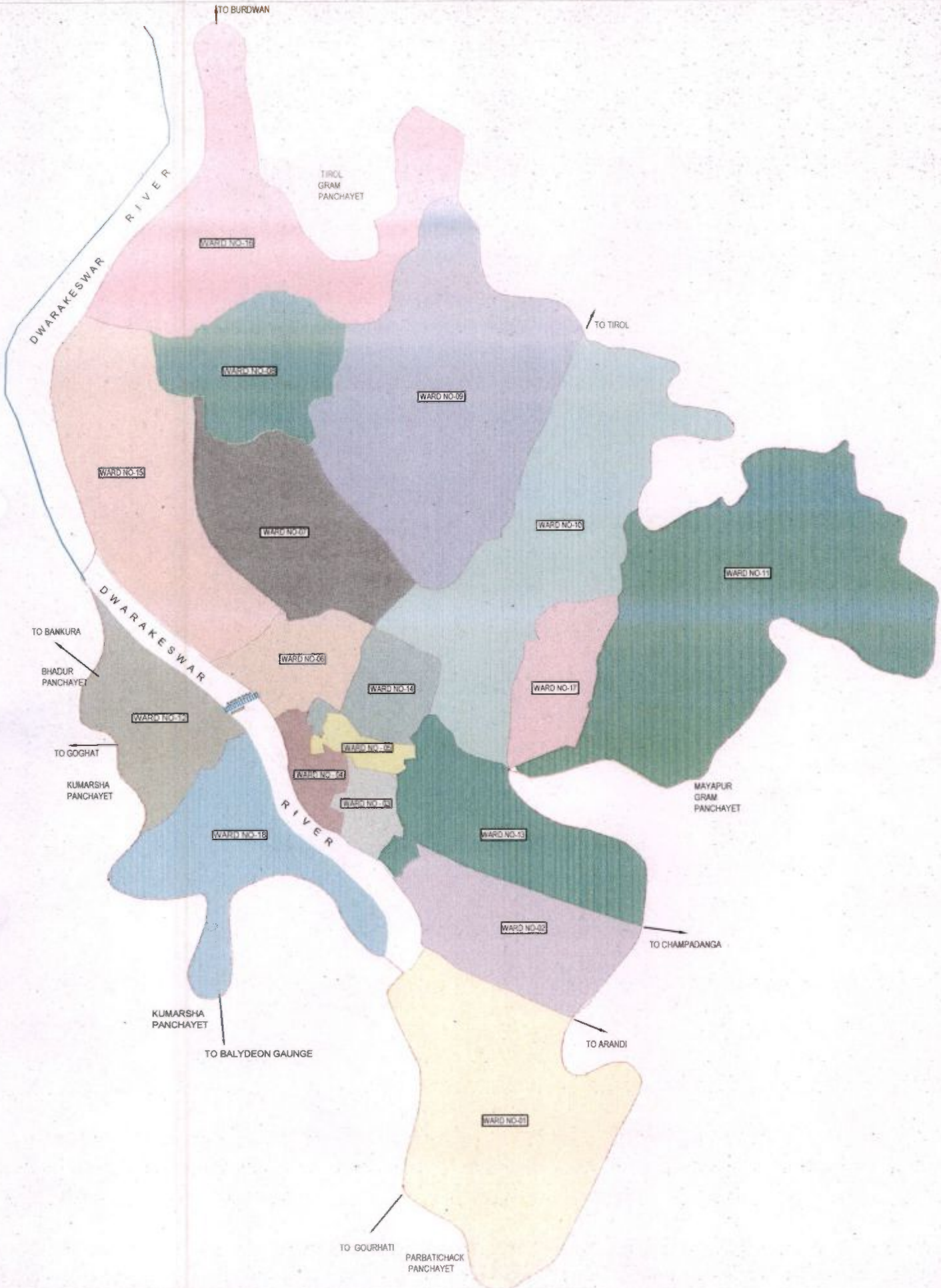
1.6 Climate and Rainfall

The climate is hot and humidity is high. In winter the temperature often fall below 10^0C in the month of November and last till the end of February. In summer the temperature crosses 40^0C. The average temperature ranges between 22^0C and 35^0C. The general wind direction is from south, south-west.

The rainy season is between June to September and the average rainfall is 1800 mm.

1.7 Agriculture

Arambagh Sub-Division is the highly agricultural advance area of West Bengal. Main products are Paddy, Potato, and Vegetables of every descriptions of highest quality. There is ample scope & opportunity for establishing rice brain oil Mills, Potato based



ARAMBAGH MUNICIPALITY | DRAFT DEVELOPMENT PLAN 2008-09 TO 2012-13

LEGEND

MUNICIPAL BOUNDARY
WARD BOUNDARY
WARD NO.- 1
WARD NO.- 2
WARD NO.- 3
WARD NO.- 4
WARD NO.- 5
WARD NO.- 6
WARD NO.- 7
WARD NO.- 8
WARD NO.- 9
WARD NO.- 10
WARD NO.- 11
WARD NO.- 12
WARD NO.- 13
WARD NO.- 14
WARD NO.- 15
WARD NO.- 16
WARD NO.- 17
WARD NO.- 18

MAP No. - 03 WARD MAP

SCALE- 10 0 10 20 30 (Mtr.)

alcohol factories; Potato based other consumer products and fast food preparation industries.

1.8 Industry

Economy of the town is based on mainly on agriculture and trading. There are 2 nos. Cold Storage, 14 nos. Rice mill and few nos. Oil mill in the town.

Arambag town is the main production centers of Arambag hatcheries, which is one the leading hatcheries of India today. Agricultural based industry such as solvent oil extraction plant from paddy brans and husks has also been setup in this Municipality.

A list of Industrial Units /Workshop in the town is given below:

1. Wood Craft / Bam - 55 nos.
2. Gold - 38 nos.
3. Bakery - 8 nos.
4. Hotel - 12 nos.
5. Pottery & Clay modeling - 18 nos.
6. Auto Mobile - 18 nos.
7. Spices - 8 nos.
8. Cold Storage - 2 nos.
9. Rice Mill - 14 nos.
10. Paper Mill - 1 no.
11. Oil Mill - 2 nos.
12. Poultry - 14 nos.
13. Snacks - 8 nos.
14. Brick Field - 9 nos.

1.9 Trade and Commerce

It has been stated that economy of the town is based on agriculture and trading, so main occupation of the town is trade, commerce and agriculture.

There are two Municipal Markets & three shopping centers. Road side shopping is cropping up indiscriminately causing congestion for traffic.

There is a high demand of commercial shops and organized shopping will help to create additional activities of the town. Two nos. shopping complex and one Super Market are owned by Municipality. There are a few nos. of oil mills, soap making

industries and 2 nos. cold storage in the town. There are the largest Hatcheries in this town.

1.10 Banking Facilities

Banking facilities are adequate for the town.

Available banks are:

1. State Bank of India
2. United Commercial Bank
3. United Bank of India
4. Oriental Bank of Commerce
5. Arambagh Co-operative Agriculture and Rural Development Bank Ltd.
6. Hooghly District Central Co-operative Bank Ltd.

1.11 Health

There is one Sub-Divisional Hospital with 250 bed capacity, Student Health Home, Hospital under Lions Club and 14 nos. Private Nursing Home, with specialized Doctor's in the town. These render health services to entire Arambag Sub-Division, Major part of Ghatal, Part of Burdwan. Different national health programme such as Pulse Polio, AIDS, TB etc. is also carried out in assistance with Municipality.

1.12 Education

There are two degree colleges out of which one is exclusively for women, 3 nos. of Madhyamik Schools out of which 1 no school is exclusively for girls, 4 nos of H.S. Schools out of which one is exclusively for girls, 24 nos of Primary Schools, which have strengthened educational facility to the dwellers of Arambag Municipality and its suburb areas.

1.13 Recreation and Cultural Facilities

There are 3 nos. Cinema Halls, Four small community Hall, 4 nos. Football ground.

1.14 Drainage

Like all flat terrains the town has some localized drainage problems. Since the town is in the making, there is dearth of proper drainage facility which needs to be attended. There are 8.50 km. of pucca drains and 5.00 km of Kancha drains.

1.15 Transport

The town has got about 74.13 km. road out of which 39.00 km. is metalled (Bituminus & concrete) road, 35.13 km. is Brick pavement & bats morrum road.

The life line of the town is Champadanga - Pursurah - Arambag Road through which is connected to Kolkata and Tarakeshwar in the east and Bishnupur, Bankura, in the North West Burdwan in the north and Midnapore, in the east. At present the main mode of travel with in the town is cycle, rickshaws. Buses are not allowed to run in side the town.

1.16 Housing

The type and pattern of housing facilities in the town presents more or less the similar picture as could be observed in the other district and sub-divisional towns of the state.

Most of the houses are old single stories and double storied.

1.17 Sanitation

There is no underground Sewerage System in this Town. The garbage of the towns is collected by the Municipal Authority and dumped for filling up of low lands.

1.18 Drinking Water Supply

It has been well-appreciated by the Municipal Authority that potable water supply is one of the most important civic services that the Municipal Authority is under legal obligation to care to.

Ever since the Municipality was established in 1886, there was a provision of water supply for the inhabitants of the Municipal town. The only sources of drinking water were Earthen Well / Masonry Well. Some section of the private individuals provided Masonry well in their own premises and the Municipal Authority provided a few number of Earthen Well for drinking water. Now, the Earthen wells are no more in existence.

Between 1960 and 1970, a good number of hand pump fitted shallow tube wells were installed. The Municipal Authority finally decided to replace shallow tube wells by Deep Tube wells and drinking water would be distributed to the consumers through pipe distribution systems. In pursuance of this, by 1975, a piped water supply scheme based on extraction of ground water by deep tube wells were prepared and executed by the Public Health Engineering Department, Govt. of West Bengal. Ground water thus extracted was stored in a one lakh gallon capacity overhead reservoir and supply was made to the Public Stand Posts through distribution pipe network.

Between 1975 and 1985, the existing water supply systems were being operated and maintained by PHED (West Bengal). The length of total distribution pipe line was about 24 km. There was no house connection, water was only available through 86 nos. of Public Stand Posts.

In the year 1985, the Municipality has taken over the above water supply systems from the Public Health Engineering Department, Govt. of West Bengal. Afterwards, old deep tube wells were replaced by new one to cater the emerging demands and small part of distribution system was also extended time to time. Presently 13 (thirteen) tube wells, 12 (twelve) in the east bank (5 running + 7 stand by due to aging & also low yield) and the other in the west bank (no stand by) are in operation. TW - 1 to TW - 3 are connected with existing OHR and the remaining tube wells are used for direct supply to the distribution grid. The existing scheme as on to-day was supplying water through about 600 stand posts available only on road side and 3228 house-service connection four times in a day (morning, noon, afternoon & night total 7 hours).

About 52% of the total population is served through this system. The remaining population still depends on shallow hand pumps tube wells. There are 600 nos. Hand operated tube-wells for them.

1.19 Existing Land Use

The town is connected with four Districts i.e. Burdwan, Bankura, East Midnapur and Howrah. Naturally, people of all classes visit here. It is the main trading center for

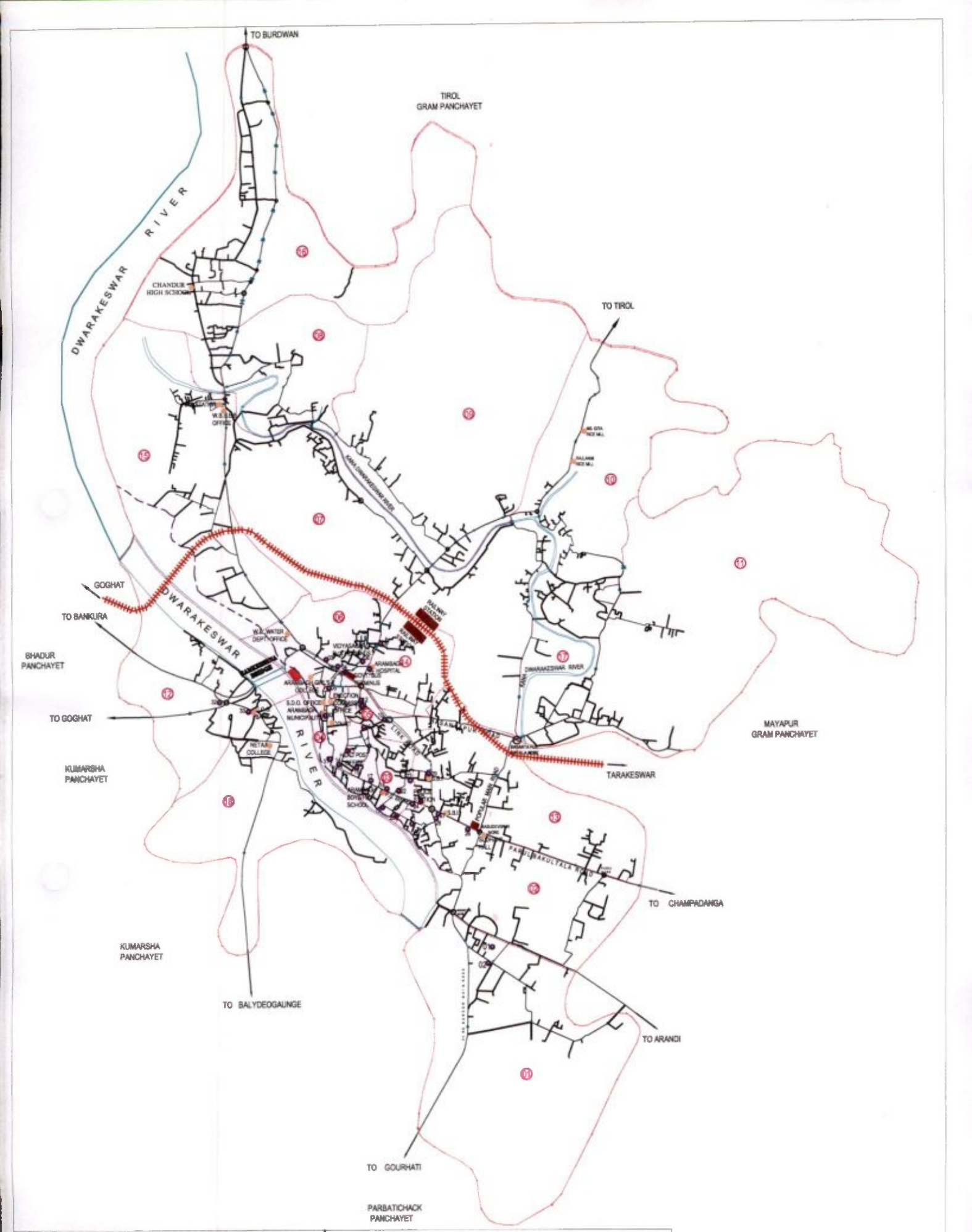
vast hinter land. Outskirts of the towns are agricultural based. Rapid growth of population is not worthy to mention here.

1.20 Electrical Power Supply

Electrical Power is required for Industrial as well as for Domestic use such as Street Lighting, Public Buildings and Individual Houses Lighting, etc. The entire Electrical Power Supply to the Municipal Town of Arambagh is controlled by West Bengal State Electricity Board (W.B.S.E.B). It is gathered that adequate Electric Power is available for operation of the Pumping Station, lighting and other purposes of the proposed Water Supply Scheme at Arambagh Municipal Town.

1.21 Administrative Set Up

The Arambag is the Sub-Divisional Town in the District of Hooghly. It is also under the Arambag Police Station and Arambag Block. The town earned the status of Municipality on 1886. The Municipality divided in to 18 nos. of Wards. The town accommodates Block Development Office and Police Station and other various offices of different departments of the Govt. and Semi Govt.



ARAMBAGH MUNICIPALITY

DRAFT DEVELOPMENT PLAN 2008-09 TO 2012-13

MAP No. - 11

SOLID WASTE MANGEMENT

SCALE-

LEGEND

MUNICIPAL BOUNDARY	IMPORTANT LAND MARK
WARD BOUNDARY	TRANSPORTATION
ROADS	RAILWAY TRACK
BRIDGE/CULVERT	VATS
RIVER / CANAL	DOUMPING GROUND
RIVER BANDH	

1.0 PRESENT SCENARIO OF SOLID WASTE MANAGEMENT SYSTEM IN WEST BENGAL

1.1 SOLID WASTE MANAGEMENT SYSTEM

The state of West Bengal witnessed significantly high level of Urbanization during the decades of seventies and eighties. The urban population in West Bengal was estimated as 27.39% of the total population in the 1991 census report as against 25.70% for the entire country. In terms of density of urban population, West Bengal is much ahead of other states. The over all density of urban population in West Bengal in 1990-91 was estimated as 6207 individuals per square kilometer against the national average of 4098.

While the urban towns in West Bengal have rapidly increased in terms of activities and population, the municipal services available at these urban centers are yet to reach the adequate level. Solid wastes in the urban areas are generated from a multitude of sources out of domestic, commercial, institutional & industrial activities. If these wastes are not stored, collected, hauled and disposed off safely and timely, the same cause aesthetic problems and severe impact upon the public health, by means of pollution of air, soil and natural water sources. Therefore Solid Waste Management (SWM) is one of the crucial civic services, without which no pollution abatement measure can be full proof and sufficient. Although SWM is the single largest item of expenditure in the municipal budge, this service suffers from critical deficiencies.

In the wake of fast growing environmental consciousness and increasing public health problems, the concern in respect of inefficient SWM has metamorphosed into an alarming situation, which has inspired the urban local bodies to look for appropriate cost effective technology along with fiscal support.

The different components of the SWM for a particular town can be designed in a no. of ways depending on local conditions e.g. climate, waste characteristics, urban structure, transport economics and desired level of services.

1.2 EXISTING INFRASTRUCTURE & DEFICIENCIES

At present there is no National or State Plan for an integrated approach to deal with the Solid Waste Management System. In the matter of financial resources, the small and medium municipalities are much weaker / compared to the bigger municipalities. The bigger municipalities employ 5 staff per 1000 population, whereas the small and medium municipalities can hereby employ 2 to 3 staff per 1000 population.

1.3 SOLID WASTE CHARACTERISTICS

Community produces variety of wastes ranging from metal to textile produces and from ash to vegetable produces which have different physical and chemical composition. Apart from that, industrial and medical wastes used to get mixed up with municipal wastes frequently, which are usually disposed off indiscriminately without any special treatments.

The average properties of solid waste based upon past studies may be predicted as per following :

Table-1

Character	Contents		Percentage
Physical :			
(i)	Earth & Ash Content	:	48%
(ii)	Fermentable	:	37%
(iii)	Stones & non-degradables	:	12%
(iv)	Density	:	560 to 600 kg/cu.m.
(v)	Calorific value	:	800 to 980 kcal/kg.
Chemical :			
(i)	Moisture	:	45%
(ii)	P^H value	:	6.80
(iii)	Nitrogen	:	0.5%
(iv)	Phosphorus	:	0.52%
(v)	Potassium	:	0.50%
(vi)	Organic matters	:	38%
(vii)	Carbon	:	20%
(viii)	C / N ratio	:	40

1.4 QUANTUM OF SOLID WASTE

The quantum of Waste generation depends upon the size of the town as well as its, socio-economic conditions. However, it was estimated that the generation of solid waste range from 200 to 600 gms. per capita per day depending upon the category, size and nature of activities in the town.

1.5 STORAGE AND COLLECTION

1.5.1 Existing Solid Waste Management

At present the refuse in municipal areas is disposed by uncontrolled dumping at places wherever low land is available. Landfill sites do not conform to any long term regional land use planning. Garbage removal is done only on intervals and there are always some accumulation of garbage on road side. Operational control for environmental protection and control of fly breeding is inadequate. Covering and compaction are not practiced.

1.5.2 Primary Collection

Primary collection starts at the household or at the community facilities. In all the municipal towns under consideration, house collection is almost non-existent and community facilities are scarcely provided. Practically none of the municipal bodies collects solid waste regularly from all areas except from market areas. The existing methods of garbage collection consists of following operation: i) Street sweeping, ii) Collection of road side garbage heaps and sweeping into box type hand carts or wheel barrows, iii) unloading the hand carts into bigger garbage vats or into bigger heap sites on main road.

1.5.3 Secondary Collection & Transfer

This particular activity in solid waste handling in municipal bodies involve picking up manually from the dumps of solid waste and loading into conservancy trucks / trailers. This results in wastage of labour and time for vehicles apart from the health risks of the workers and public at large, which are also exposed to

danger of contamination of ground water, which is the main source of drinking water in most of the municipal bodies. In some small and medium towns, tractor-trailer system is being used extensively for transportation and in some small towns animal carts are also employed.

In most cases, the design of transportation vehicle is not appropriate and also not conducive to labour and vehicle productivity. The trucks which are used for transportation of the garbage to the dumping ground are found to be very inconvenient because (i) Excessive loading height of the trucks making manual loading difficult, (ii) they can not carry more than 3-4 tons of garbage due to its low density and high bulkage (iii) Excessive wear and tear of the body due to corrosive nature of the garbage (iv) Idle time lost in loading of the trucks.

1.6 DISPOSAL

More than 90% collected solid wastes in most of the municipal towns are disposed by filling up low lands scattered within the municipal areas in an uncontrolled, haphazard and insanitary manner which is a potential health risk for the community. Orthodox type composting in few towns is also practiced.

1.7 DEFICIENCIES AND SHORT COMINGS IN THE PRESENT SYSTEM

The overall picture of solid waste management in the municipal towns is not quite satisfactory and needs to be improved in order to achieve proper environmental sanitation. The basic short-comings and problems associated with solid waste management in municipal towns are as follow :

1. Population explosion, uncontrolled urbanization, slum area proliferation.
2. Socio-economic crisis (huge external debt, economic austerities, prolonged recession, high rate of inflation, high rate unemployment, social disorder, etc.)
3. Accelerated and uncontrolled generation of municipal wastes and industrial hazardous wastes.
4. Negligence and lack of interest for an effective solid waste management plan.
5. Insufficient public education and limited community participation.
6. In appropriate design of primary handcarts and collection vehicles causing multiple handling of waste and environmental problems.
7. The small and medium municipalities are lacking considerably in the servicing and workshop facilities for the mechanical transport fleet.
8. The location of disposal grounds and their sizes are not decided on the basis of optimum haulage and rotational transportation routing.
9. Disposal of solid waste by land filling method is not generally carried out in a proper sanitary method.
10. Regular analysis and monitoring of solid waste characteristics are not done and presence of toxic and hazardous materials cannot be ruled out.

2.0 RECOMMENDATIONS OF THE SUPREME COURT APPOINTED COMMITTEE FOR MODERNIZATION OF SOLID WASTE MANAGEMENT PRACTICES ARE BRIEFLY AS UNDER

☆ Ban on Throwing of Wastes on the Streets

No waste shall be thrown on the streets, footpaths, open spaces, open drains or water bodies.

☆ Storage of waste at source

Waste shall be stored at source of generation in 2 bins/bags, one for food/bio-degradable wastes and another for recyclable waste. Domestic hazardous waste, as and when produced, shall be kept separately from the above two streams.

Multi storied buildings, commercial complexes and group housing shall additionally provide community bins for storage of waste generated by their members. Community bins shall also be provided in slums by the local body for the community storage of waste by slum dwellers.

☆ Doorstep Collection of Waste

Both the streams of waste, organic/ bio-degradable waste as well as recyclable waste shall be collected from the doorstep. Containerized handcarts or containerized tri-wheel cart or small-motorized vehicles shall be used for daily collection of food/ bio-degradable waste from the doorstep through public participation using a bell, whistle or horn as a means of announcing the arrival of the collection staff.

For collection of recyclable waste from the doorstep NGOs may be encouraged to organize the rag pickers. They may allot them the work of collection of recyclable material from the doorsteps instead of picking it up from the streets, bins or dump-yard, thereby upgrading their status. This waste can be collected once or twice a week according to the convenience of the households, shops or establishments.

Hazardous toxic waste material, which is occasionally generated, shall however be disposed of by the citizens in special bins to be provided in the city at suitable locations by the urban local bodies.

☆ Sweeping of Streets on All Days of the Year

Sweeping of streets and public places having habitation or commercial activities on one or both sides shall be done on all days of the year irrespective of Sundays and public holidays. Arrangements for rotating weekly rest-days are to be made by the local bodies.

☆ Work Norms for Sweeping of Streets

Work norms ranging from 250 to 750 running meters of road length have been recommended, depending on the density of the area and local conditions. Giving a demarcated "pin point" area for street sweeping and waste collection is also recommended for optimum utilization of manpower.

☆ Provision of Litterbins at Public Places

Provision of litterbins at railway stations, bus stations, market places, parks, gardens and important commercial streets may be made, to prevent littering of streets.

☆ **Abolition of Open Waste Storage Sites and other Un-hygienic Street Bins**

The pathetic condition of street bins must be corrected by the provision of neat mobile closed body containers into which waste can be directly transferred from the containerized hand carts or tri-wheel cart and all open waste-storage sites as well as cement concrete or masonry bins must be abolished in a phased manner.

☆ **Transportation of Waste to Synchronize with Waste Storage Facility - Dispense with Manual Loading of Waste**

For the transportation of waste, a system which synchronizes with both primary collection and bulk waste storage facilities may be introduced. Manual loading and multiple handling of waste may be dispensed with and instead, hydraulic vehicles for lifting the containers may be used in larger cities and tractor trolleys or a tractor container combination may be used in smaller cities.

Transportation of waste shall be done on a regular basis before the temporary waste-storage containers start over-flowing. For economy in expenditure, the vehicle fleet should be used in at least two shifts. Workshop facilities may be optimized to keep at least 80% of the vehicle fleet on road. Transfer stations may be set up in cities where the distance to waste-disposal sites is more than 10 Kms.

☆ **Processing And Disposal Of Waste:**

Conversion of Organic Waste / Bio-degradable Waste into Bio-organic Fertilizer (Compost)

With the availability of land for processing and disposal of waste becoming scarce and the food and bio-degradable component useful to agriculture going waste, measures for conservation of land and organic waste resource shall be taken and Organics shall be returned to the soil. To meet these objectives, all food waste and bio degradable waste shall be composted, recyclable waste shall be passed on to the recycling industry and only rejects shall be land filled in a scientific manner. Decentralized composting with public and NGOs/CBO participation, may be encouraged wherever possible, and centralized composting of the rest of the waste may be done. Microbial or vermi composting processes may be adopted. A variety of composting options has been given in the report and their processes are explained.

☆ **Caution Against Using Unproven Technologies**

Local bodies are cautioned not to adopt expensive technologies of power generation, fuel polarization, incineration etc. until they are proven under Indian conditions and the Government of India or expert agencies nominated by the Government of India advises cities that such technology can be adopted.

☆ **Land To Be Made Available On Priority For Processing And Disposal Of Waste**

Availability of land for setting up processing plants and for disposal of waste is a major problem faced by urban local bodies. Government wasteland must therefore be given on top priority for this purpose free or at nominal cost, and if such land is not available or not found suitable, private land should be acquired or

purchased through negotiated settlement. A Committee at the district level should identify suitable land and State Governments should form Empowered Committees to give speedy final clearance and prompt possession of suitable land to the ULB.

☆ Criteria for Site Selection, Site Development and Landfill Operations

Criteria for site selection, development of land fill sites and scientific landfill operations may be adopted. Remediation of old abandoned landfill sites should also be done as suggested in the detailed report. Bio-medical waste, industrial waste and slaughterhouse waste may be managed as per the relevant Rules and guidelines of the Government of India and/or Central Pollution Control Board.

☆ Institutional Strengthening and Capacity Building

Institutional strengthening is the key to success of the SWM system. Professionalism in administration, decentralization of administration, delegation of financial and administrative powers, induction of environmental/public health engineers in the solid waste management services and fixation of work norms and proper supervisory levels are recommended. Human resource development through training at various levels needs to be taken up.

☆ NGO/Private sector Participation in SWM Services

There is a need to improve accountability and the level of services through NGO/Private sector participation in SWM services to improve overall performance without harming the interests of the existing staff.

☆ Enforcement

A system of levy of administrative charges or special cleaning charges from those who litter the streets or cause nuisance on the streets may be introduced and powers to punish offenders may be given to the local bodies through suitable additions to the Municipal acts & rules.

☆ Management Information System

MIS is the key to monitoring the performance of manpower and machinery and to help in planning for the future. Detailed management information systems should be introduced.

☆ Financial Aspects

The poor financial health of ULBs is major constraint in improving SWM systems. The financial condition of local bodies may first be improved by setting the house in order and a series of measures towards financial discipline, avoidance of wasteful expenditure, prioritizing the expenditure on essential services, as recommended in the report may be taken. Taxes, user charges and fees should be raised and linked to the cost-of-living index. Area-based property-tax reforms may be taken up to improve the finances of the ULBs.

☆ Health Aspects

Improper SWM practices give rise to problems of health and sanitation. Twenty-two types of diseases are associated with improper SWM practices. Proper management of processing and disposal sites, special attention to cleaning of slums, provision of low cost sanitation facilities to prevent open defecation, prevention of cattle nuisance, proper training to the workforce and use of protective clothing are some of the measures the local body should take immediately to protect the health of the citizens and the work force.

☆ Legal Aspects

Citizens' active participation may be ensured through massive public awareness campaigns. Simultaneously, adequate provisions may be made in local State laws governing the local bodies to ensure public participation and action against defaulters. Legislative provisions to be made by each State have been suggested in the report.

☆ Public Awareness Strategy

Public awareness campaign using information, education and communication (I-E-C) techniques may be used. Waste Reduction, Reuse, Recycling (R-R-R) may be advocated to reduce the burden on the local body and citizens may be motivated to store waste at source in a two-bin system, co-operate with the doorstep primary collection system and keep the city litter-free. Hygienic Solid Waste Management needs to find a place in the National Agenda.

☆ NGO, Public and Private Sector Participation.

Supreme court committee has laid emphasize on active involvement of non-governmental organizations (NGOs) in creating awareness among the people, in organizing the rag pickers for collection of recyclable material and in organizing door step collection from households, shops and establishments.

A lot of emphasizes is to be given on public participation, without which no system would ever succeed. Public participation in the area of storage of waste at source, & at the community level and in the primary collection of waste is highly advocated and insisted upon. Legal provisions are also suggested to take action against the citizens if they fail to comply in spite of repeated instructions through awareness campaign to cooperate in the system.

Private sector participation is the key to success in the areas where higher technologies are involved and where personalized services are proposed to be given. With ever increasing cost of manpower and relatively lower efficiencies of public sector undertakings, it has been strongly recommended that private sector should be involved in the area of door step collection of waste ***from hospitals, nursing homes, hotels, restaurants, commercial complexes, households, etc. as well as in the area of transportation of waste and setting up solid waste treatment and disposal facilities in the urban areas.***

2.1 ISSUES TO BE ADDRESSED

The following issues need to be addressed during policy formulations.

i) **Effective public participation in segregation of recyclable waste and storage of waste at source.**
ii) Public participation in primary collection of waste
iii) Sweeping of streets and primary collection of waste on all the days of the year irrespective of Sundays and public holidays.
iv) Provision of closed body mobile waste storage depots and abolition of open waste storage sites.
v) Safe and separate storage as well as doorstep collection of biomedical waste, hotel and restaurant waste, yard waste, etc., on full cost recovery basis.
vi) Avoid the need of multiple handling of waste through the adoption of principal of "handle waste once only" in the matter of collection, transportation and disposal of waste.
vii) Transportation of waste on day to day basis in closed body vehicles.
viii) Processing of waste for generating biogas, power and other useful products.
ix) Disposal of waste in an environmentally acceptable manner through establishment of sanitary landfill sites.
x) Grant of land for processing and disposal of waste.
xi) Institutional strengthening and human resources development.
xii) Institutional strengthening and human resources development.
xiii) Introducing element of cost recovery.
xiv) Encouraging private sector participation in waste management
xv) Welfare of the staff engaged in solid waste management services.
xvi) Creation of public grievances redressal mechanism.
xvii) Provision for enforcement of sanitation laws and rules.

2.2 SCOPE OF THIS REPORT

This report will deal with Solid Waste Management System of the town **Arambagh** in the district of Hooghly of West Bengal. The objective of this report is to analyze the present situation and recommend for **"Planning and Development of Modernized Practices for Sustainable Solid Waste Management System in the Arambagh Municipality of West Bengal"**

The following chapters will discuss about the appropriate technology and methodology for handling, collection, transportation, processing & final disposal of municipal solid waste and also design a comprehensive Solid Waste Management System for Arambagh Municipality. The necessary recommendations and directions are also furnished below.

This project report is prepared by Municipal Engineering Directorate, Govt. of W.B., as per the request of Municipal Authority for compliance of Govt. order.

3.0 COLLECTION OF WASTE

3.1 DEVELOPMENT OF POLICIES AND CHOICE OF APPROPRIATE TECHNOLOGY AND METHODOLOGY

The success of any solid waste management system largely depends upon the three factors (i) Collection, (ii) Transportation & iii) Disposal. So, to make success clear assessment on the quantity of solid waste to be handled is very much essential. In respect of Arambagh town a figure of 275 gm/cap/day is fairly reasonable for consideration. The verity of solid waste generally generate in a Municipal town are domestic, market, trade, Hospital / Clinical Waste in nature. Waste from street sweepings, sewer line cleanings and construction debris etc. also get into the access with the main waste.

With a view to improve upon the present collection, transport and disposal methods in the municipality, future solid waste management works are to be carried out on the basis of the principles stated below.

Cost of transportation is one of the major components of solid waste management system. Routing and scheduling of vehicles are of prime important from economic point of view. For convenience and economic consideration of as collection and transportation of solid waste the whole Arambagh municipal area may be divided in three zones as given in the following table.

Table No. - 2

ZONES	WARD NOS.
Zone A	1, 2, 3, 4, 5, 6, 13, 14
Zone B	7, 8, 9, 10, 11, 15,16,17,19
Zone C	12, 18

3.1.1 Collection

The local body shall be the responsible for the arrangement for the collection of waste stored at various sources of waste generation on a daily basis. This shall be done by any of the following methods or combination of more than one method:

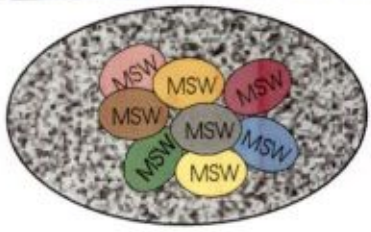
i) The garbage is to be suggested to be separated in accordance with their classes at the point of generation. This practice will help to dispose off the garbage effectively at the dumping ground, as well as reduction of massive handling activities of the cumulated garbage mass at a centralized point.

ii) The garbage is suggested to be containerized at the point of generation. This will not only help to reduce the collection time but will also reduce the health hazards. Therefore the service level will be better.

iii) Door-step collection of domestic waste through handcarts or similar other devices with active community participation.

iv) Collection through community bins from private societies multi storied buildings, markets, commercial and Office complexes etc.

FLOW CHART FOR SWM SYSTEM



Collection from point of generation

DOMESTIC WASTE

To be collected from house to house by wheel barrow and Transferred either to community bins or directly to container (HLDC) kept at Transfer Stations. Waste from community bins shall be collected by Hook Lift dumper carrier.

HOTEL

Waste stored by the Hotels in their containers is to be collected directly by HLD.

MARKET WASTE

To be collected at a particular time of a day in HLDC kept at a particular place and the containers are to be transported to Disposal site .

WASTE FROM TRADE & COMMERCE

To be collected either by wheel barrow or directly at Community Bins / Dumper Containers at a particular place and the containers are to be transported to Disposal site.

WASTE FROM ROAD SIDE LITTRE BINS

To be cleaned daily and the waste to be transferred to Wheel Barrows and from it to nearby HLDC.

TRANSPORTATION

To Processing and Disposal / Site(s)

Recovery of Recyclable materials

Degradable waste to be processed

Non-Degradable waste to be disposed off by sanitary landfill

Value addition and realization of economic value by proper placement and marketing of the product

Volume reduction through Compactor

Monitoring and Evaluation of the total systems & adoption of necessary modification required

v) Door-step collection of waste from authorized / unauthorized slums or collection from the community bins to be provided in the slums by the local bodies.

vi) Door-step collection of waste from posh residential areas on full-cost-recovery basis.

3.1.2 People's Participation in Collection:

Success of the effective solid waste management particularly primary collection system largely depends on the proper co-ordination between people who are the generator and the staff who are the collector.

The average municipal solid waste characteristics depict high moisture content, with a relatively high density. Conventional metal bins and dumpers are found to be deteriorating within a short period due to the corrosive action of the waste mass. Hence, an appropriate design of the primary collection bins, with the help of modern technology is of prime necessity in order to reduce the recurring capital as well as maintenance costs.

3.2 MODUS OPERANDI

3.2.1 Door-step collection through containerized handcarts with bells / whistles

For domestic waste collection each collector may be given a tyre-mounted wheel barrow having eight detachable 20 litres containers and provided with a bell or whistle. Each collector shall be given a fixed area or beat for sweeping plus a fixed number or stretch of houses from which to collect the domestic waste. In congested or thickly populated areas, 300 running meters of road length and the adjoining houses may be given to each sweeper, whereas in less congested areas 500 running meters of the road length with adjoining houses may be allotted to a sweeper depending upon the density of population in the given area and local conditions. In low density areas even 500 running meters of road length can be given. Normally 50 to75 houses coupled with the above road length may be taken as a yard stick for allotment of work to an individual sweeper.

3.2.2 Role of the Collector

The collector should ring the bell or blow the whistle announcing his arrival at the place of his work and start sweeping the street. The people may be directed that on hearing the bell or whistle they should put their domestic biodegradable waste into the handcart of the sweeper.

No collector may be expected or directed to do house to house collection by asking waste from the doorsteps to save his time energy and productivity.

3.2.3 Collection of waste from Societies / Complexes

In the private societies / complexes / multi stories buildings normally no collectors are provided by the local bodies and private collectors are generally engaged. It may be therefore be made compulsory for the management of the Societies / Complexes etc. to keep the bins in which waste has been stored at the easily approachable location to facilitate easy collection by the municipal staff. The local body shall arrange to collect waste from these community bins through handcarts, tricycles of pick up vans etc. as may be convenient on day to day basis.

This method will have to be followed for the greater mass of waste with a proper sanitation approach, in place of the present process of indiscriminate dumping. Adequate precaution against leachate pollution, fly, insect, odor and other unsightly problems, will have to be ensured for proper environmental protection. The fuel gas generated at landfill site can be salvaged and put into proper use for energy recycling. Assistance from developed countries to achieve this object will be of high necessity. A conceptual arrangement for sanitary landfill system has been given below.

5.2.1 Identification of Suitable Lands for Disposal of Waste Site selection :

Local bodies must identify suitable landfill sites 1) for the disposal of rejects from the compost plants and 2) for making a secured landfill for the disposal of non-biodegradable items following the directions of central or state pollution control boards. Such sites should be large enough to meet their requirement of waste disposal for 15 to 20 years and capital investments could be made for making the site fit for disposal of wastes.

a) The landfill site should be at least 0.5 km. away from the habitation so that it does not cause nuisance to the people on account of emission of foul smell etc.

b) It should have relatively impervious soil strata.

c) It should have good approach roads.

d) It should large in size.

e) Landfill site should be very near to compost area to minimize transport cost.

f) Landfill site should not be very near to water bodies like lake, cannel, river etc.

5.2.2 Development of Site

a) If the soil has some porosity, it should be made impervious before being used for land filling, by liners of compacted clay, plastic of concrete.

b) Approach roads may be made to connect the landfill site to the main road.

c) Internal approach roads are made to facilitate easy movements of vehicles and tipping of wastes at the landfill site during the monsoon months.

d) The local bodies should set up monitoring stations near the major landfill sites to ensure that quality of subsoil water does not get affected on account of leachate emerging from the landfills. A leachate pit is required at the lowest point for pumping leachate.

e) A small store room may be constructed at the landfill site to store the tools and equipment required.

f) A compound wall or fencing by barbed wire may be done to prevent blowing of waste due to air, controlling the entry of unauthorized persons and conceal the unsightly appearance of the of the landfills. The site should be surrounded be adequate no. of trees.

g) In large cities having population above 5 lakh a mechanical or computerized weighbridge may be installed for monitoring the quantities of wastes being carried by the vehicles to the landfill.

3.2.4 Collection of Wastes from Slums

The local body shall collect waste from slums on bell system along their main access-lanes, with residents bringing their wastes to the handcart from their houses and / or from the community bins by using the pick-up vans or containerized handcarts or other means which may be convenient transferring the waste to the municipal waste storage sites for daily clearance. The local body may, if so desire engage a private contractor for daily collection of this waste. Performance certification by "Maholla / Bastee Committee" may be insisted in such cases.

3.2.5 Collection from the door-steps in posh residential areas

In the posh residential areas where the residents might not be willing for community participation and bring their waste to the municipal hand cart, door-step collection of wastes may be introduced for picking up domestic waste from households on day to day basis. Such service may be provided on full cost recovery basis and contractor may be engaged to provide such service if so desired to ensure that the waste generated from posh area is collected regularly and taken to the waste storage sites.

3.2.6 Collection of Duly Segregated Recyclable / Non-degradable Waste from Households

NGOs may be activated to organize the rag-pickers in the city and the rag-pickers may be allotted lanes and bye lanes comprising of 150 to 250 houses for door-step collection of recyclables. The rag-pickers may be given identity cards by the NGOs for increasing their acceptability in the society. NGOs and / or the corporation may support the rag-pickers by giving them nylon bags for collection of recyclable waste from the door-steps.

3.2.7 Collection of Waste from the Shops and Establishments

The shops and establishments normally open after 9 a.m. These timings do not synchronize with the work schedule of the sweepers. Under this situation one of these three alternatives may be adopted.

1. Sweepers may first carry out the work of street sweeping in the morning hours as usual and soon thereafter take up the work of door-step collection of wastes, after most of the shops open.
2. Rag pickers may be organized to collect the recyclable waste from the shops and establishments as soon as the shops get opened as most of such waste is recyclable. Working arrangement may be made with the shops and establishments accordingly. The shops & establishments may be asked to store waste in two bins if they produce waste other than recyclable waste also. The rag pickers may be organized to collect recyclable waste from such establishments on a daily basis. This arrangement may be made on 'No payment' basis on either side.

   The recyclable material received by the rag-pickers directly from the shops and establishments would give them a better return. The waste would be dry and not soiled and would fetch a good price in the market. This will work as an incentive for them to continue door to door collection. The

associations of markets, shops and establishments may be persuaded to make an endeavor in organizing this service with the help of NGOs and rag-pickers in their market.

3. Door-stop collection service from the shops and establishments may be contracted out on 'full cost-recovery' basis.

3.2.8 Collection of Hotel and Restaurant Waste

The hotels and restaurants may make their own arrangements of collection or be given door step collection service for their food wastes by the urban local body on full cost recovery and pro-rate basis. This door step service may be contracted out by the local body if so desired.

Charges for the collection of hotel waste may depend upon the quantity of waste to be picked up from the hotels and restaurants.

The cost recovery may be planned according to the classification of hotel / restaurant made on the above basis and decided in consultation with them.

A survey of the Waste Generation of the hotel / restaurants may be made before the collection rates are introduced and notified.

3.2.9 Meat And Fish Waste

Meat and fish waste from the meat / fish markets should be removed on a daily basis departmentally or through contractor on full cost recovery basis.

3.2.10 Sweeping Of Streets & Public Spaces

Sweeping of all the public roads, streets, lanes, by-lanes should be done daily if there is habitation or commercial activities on both the sides or on either side of the street. A list of such roads and streets together with their length and width should be prepared and a programme of their daily cleaning should be worked out by the local body keeping in views the norms of work (yardstick) prescribed. However, the roads and streets, where there is no habitation around and they do not require daily cleaning, may be put in a separate group and may be taken up for cleaning periodically depending upon the need of cleaning those roads or streets. Cleaning of such roads, streets etc. may be included in the list of periodical cleaning of such spaces to ensure that they do not become the dump yards and remain clean. A programme should be worked out for cleaning such roads, streets and open spaces according to the periodicity of cleaning decided upon and may be adhered to.

3.2.11 Transfer Of Waste

Collectors shall transfer the waste collected from Door to door to a container kept at transfer station of their respective zones from where the container would be transported to dumping site by prime movers.

The waste collected in community bins / litter bins shall be directly transported to dumping site by prime movers.

Details of the transportation system and nature of vehicles have been given in Chapter 4 below.

3.3 Tools to be given to Sweepers

With a view to ensure that the sweepers, more particularly female workers can work conveniently, appropriate types of tools and equipment should be given to them.

3.3.1 Brooms

The brooms should have a long handle to facilitate cleaning of the street without bending the body. In the cities where the broom allowance is being given or only broom sticks are provided to the sweepers, it should be ensured that long handle brooms are used or made by them for street sweeping. While making such brooms, a metal blade which can scrape the material sticking on the street should be fixed on the top of the broom or a separate metal scraper may be given to the sweepers to remove the sticking material from street while sweeping.

There is no yardstick about the number of brooms to be given to the sweepers per month. In some cities three brooms are given per month whereas in some cities only one broom is given per quarter of a year. One long handle broom per month considered being adequate for street sweeping. The bamboo (long handle) to which the broom is attached need not be given once a month as it has a long life. The same bamboo should be reused while making the broom. The bamboo may be replaced as and when required. It could be once in six months or once a year depending upon the local conditions of the city.

3.3.2 Metal Tray and Metal Plate

Each sweeper engaged in the street sweeping should be given a metal tray and a metal plate in for facilitating easy transfer of street sweeping from the streets into the handcart.

3.3.3 Hand-Carts / Wheel Barrows

Each sweeper engaged in street sweeping should be given a handcart having 8 containers of 20 liters capacity each. These containers should be detachable to facilitate the direct transfer of street sweeping from the container into the communal waste storage bins. Such containers should be lockable with a chain arrangement. The handcart should have sealed ball bearing and at least 3 wheels so that it can be used efficiently. Containerized tricycles can be used in lieu of the handcarts.

3.3.4 Norms Of Work For Street Sweepers

The sweepers may be assigned "Pin point" work according to the density of the area to be swept. The following yardstick can be adopted :

1. In high density area 300 RMT of road length covering about 200 to 175 houses
2. In medium density area 500 RMT of road length covering about 150 to 125 houses
3. In low density area 750 RMT of road length covering about 125 to 100 houses

The sweepers may be directed to sweep the roads and footpaths in the area allotted to them as well as to collect the domestic, trade and institutional wastes in their handcart from the households, shops and establishments situated on the road / street allotted them.

3.3.5 Cleaning of Surface Drains

Arambagh Municipality has separate sewer line system. The sewer lines should be clean and regular intervals by using **Sewer Line Suction cum Jetting Machine (SLSJM)**. The waste from the suction operation should be directly transported to dumping site.

In some areas of Arambagh Municipality there are open surface drains. In these drains quite often the sweepers and the people dispose of the waste un-authorized. These drains are required to be cleaned on regular basis to permit free flow of waste-water. Action should be taken to ensure that the sweepers and the citizens do not dispose of their waste into the drains.

Drain cleaning should be done regularly at least twice in a weak and the cleaner should be given suitable handcarts and shovels for transferring the waste to the site identified for depositing such waste. The periodicity of cleaning such drains should be worked out looking to the conditions of clogging of drains.

3.3.6 Provision of Litter Bins

For the facility of the citizens to dispose of their waste in hand such as used cans of soft drinks, used bus tickets, wrapper of chocolate or empty cigarette cases etc. litter bins should be provided in all the market places, office complex areas, places of public gathering and on the important roads at reasonable distance ranging from 25 meters to 250 meters depending on the density of the road or market place. The removal of waste from these litter bins should be done by the sweepers during their street cleaning operations. The waste from the litter bin should be directly transferred into the handcart of the sweeper.

Such facility may be created at no cost to the local body by involving the private sector and giving them advertisement rights on the bins for a specified period or by allowing them to put their name on the bins as sponsor. Litter bins should be put in posh as well as poor areas and the sponsor should put such bins in both the areas in the proportion decided by the local body.

3.3.7 Temporary Waste Storage Depot for Bulk Community Waste

The Bulk community waste storage has to be properly linked with Collection System adopted by the city / town where house to house collection.

The local body may depend upon the system of Collection adopted in the town, identify the locations where community waste storage facilities shall be created.

3.3.8 Segregation Of Recyclable / Non-Degradable Waste

The local body shall make serious endeavor to motivate households, shops and establishments to segregate recyclable / non-degradable wastes at the source of waste generation and hand over such waste to the rag-pickers. The arrangement may be made on 'no payment on either side basis' for collecting the recyclable / non-degradable wastes by the rag-pickers and simultaneously mobilize NGOs to take up the work of organizing rag-pickers and motivating them to collect recyclable wastes from the doorstep instead of picking up solid waste from the streets, bins or disposal sites. This step may create some earnings to some BPL persons.

The Local Bodies may actively associate resident associations, trade & street associations & NGOs in the awareness campaign to motivate people for segregation of such waste at source.

Priority must be given for the source segregation of recyclable wastes by shops and establishments. Efforts may be made to introduce segregation of recyclable waste at source and its collection from the doorstep by the rag-pickers. In case of households such an arrangement may be made within one year.

The rag-pickers may be given an identity card by the NGOs organizing them so that they may have acceptability in the society. The Local body may notify such an arrangement made by the NGOs and advise the people to cooperate.

As soon as this arrangement is made and a reasonable awareness campaign is carried out it shall be made compulsory to do source-segregation from the date that may be notified by the local body.

4.0 TRANSPORTATION OF WASTE

Transportation of waste is very important aspect so far cost is concerned. Proper planning and management of man machine and vehicle is of utmost important to minimize the cost.

a) The waste collected from door-to-door shall be transferred to transportation containers viz. **Hook Lift Dumper Containers 5 to 7.5 cu.m. capacity (HLDC), Hydraulic Dumper Container (HDC),** etc. kept at transfer station located at various zones.

b) The transportation of waste from the bulk community waste storage sites or transfer stations may be planned in accordance with the frequency of containers becoming full. The locations where the containers are placed may be grouped into four categories is given below. These containers should be of about 1000 ltr. capacity still bins with **Swivel Castor Wheel Automatic Lifting** arrangement and are to be transported directly to dumping site by prime movers .

a) The containers which are required to be cleared more than once a day.

b) The containers which are required to be cleared once a day.

c) The containers to be cleared on alternate days or twice a week.

d) The containers which take longer time to fill to be cleared once a week.

The various types of transportation vehicles which may be used for transportation of waste from Arambagh Municipal area to dumping site are **Hook Lift Dumper Carrier (Hydraulic), Hydraulic Dumper Carrier, Tractor-Trailer, Ordinary Truck.**

4.1 Transportation Of Waste From Hotels & Restaurants

The hotels and restaurants waste shall be collected on day to day basis either departmentally or through a contract. Door-step collection system may be introduced for the collection of this waste. Eight refuse collectors with back loading facility or motor vehicle with close body may be used. This entire collection and transport system could be privatized and rates may be prescribed by the local body. 33% spare vehicles may be kept to ensure reliable service.

4.2 Transportation of Construction Waste

Removal of construction waste is the liability of waste producer. If he does not remove the construction waste, it may be removed by the local body on full cost recovery basis. One of the following methods may be adopted for transportation construction waste:

i) Here skip renting system may be introduced; the skips shall be transported by hydraulic system at the time mutually agreed between the parties i.e. local body and waste producer.

ii) The local bodies may also use front-end loaders and trucks, hydraulic dumper truck for transportation construction waste.

4.3 Transportation of Waste from Narrow Lanes

Quite often small quantity of waste is disposed of in the narrow lanes which cannot be removed by sending out usual transport vehicle. Wheel barrows may be used for removal of such waste.

Small vehicles may be used for the collection of waste from narrow lanes and transfer the same to containers kept at nearby transfer station for transportation of waste to dumping site. The transfer stations itself should be transported to the dumping ground by the Prime Movers. Facility of ramp may be provided for transferring the waste from the collecting vehicles to the transportation vehicles. The requirements of such large container are worked out on the basis of total quantity of waste expected to be brought to the transfer station.

4.4 Type of Vehicles to be Used

The vehicle which synchronizes well with the community waste storage system shall be utilized to prevent multiple handling of waste which may be done as under.

i) Wheel Barrows with 8 containers of 20 lts. Capacity; 4 for Bio-degradable and 4 for non-degradable for house to house collection for solid waste.

ii) The box type or wheel borrows are suggested to be replaced preferably with containers / bins in narrow lanes.

iii) The filled up containers are proposed to be hauled away by prime movers and in doing so the filled up skips / containers / trailers being replaced by empty one. The transfer station needs to be designed in a proper manner by constructing suitable ramps and vehicles bays for transferring waste from the primary collection fleet to transportation vehicles / containers.

iv) The container lifting devises such as Dumper placers / skip lifters/ Hook Lift Dumper Carrier may be utilized for transportation of large size containers to the transfer station of the disposal site.

4.5 Routing of vehicle

Routing and scheduling of vehicles are of prime important for management of waste transportation system. Depending on the containers to be cleared each day, the route for lifting the container may be worked out avoiding zigzag movement of the vehicle to the extent possible.

4.6 Workshop Facility for Repairing and Maintenance of the Vehicles

Arambagh Municipality must have adequate workshop facility for the regular maintenance to the various types of accessories and fleet of vehicles. Such facility may be created by the local body departmentally or through a contractual arrangement. The workshop should have adequate technical staff and spares to ensure that at least 80% of the vehicles remain on the road each day and the down time of repair / maintenance is minimized to the extent possible. Spare assemblies should be kept available which could give as replacement till such time necessary repairs are carried out. The workshop should be preferably headed by an automobile or mechanical expert.

Team incentives should be introduced in workshop for ensuring more than 80% of vehicles on the road throughout the month.

The workshop should be run in more than one shift. Technical staff as per the requirement may be kept in the second or third shifts to ensure that more than 80% of vehicles remain on the road for optimum utilization of the fleet of vehicles of the local body.

5.0 DISPOSAL OF WASTE

The disposal of waste, processing of degradable waste and disposal of non-degradable waste, is one of the most important aspects of integrated waste management as unscientific disposal of waste can cause irreparable damage to the environment and subsoil strata and human health and life. No local body should therefore allow any dumping of waste at unauthorized sites. Suitable landfill sites must therefore be urgently identified and designated as Landfill Sites for the disposal of rejects from the Compost Plant and for non-biodegradable waste. Municipality should arrange required land for disposal of waste keeping in view the requirements of the city for at least the next 15 – 20 years. Depending upon the quantity of waste to be disposed of annually, the requirement of land has been worked out below and the land may be acquired accordingly.

Composting is the process of waste disposal which our predominantly agricultural country must follow. It can be done by aerobic and anaerobic processes. The aerobic process is a biological oxidation process where the organic portion of the waste is decomposed and a material useful to agriculture having N: P: K values is produced. This process can be completed in 45 to 50 days.

An aerobic process of composting is very slow. It takes about 180 days to make compost. It is therefore not desirable to go for anaerobic composting. Besides it does not kill pathogens.

The aerobic composting is suitable under Indian conditions. Indian waste generally contains 30% to 50% of organic wastes. It also has the required moisture content, C/N ration etc. It is a low cost option and does not require high skills. It has a market potential and land requirement for disposal of waste gets reduced.

Disposal of SW involves processing of bio-degradable portion of the waste into manure and generation of bio gas and disposal of the remaining after recovery of recycleable materials of the total solid waste.

DISPOSAL TECHNOLOGIES

Technology Comparison

The following technology options were considered as a solution for the solid waste management facility:

1. Scientific landfill for handling the entire solid waste generated.
2. Windrow and or Vermi Composting
3. Waste to Energy via Incineration
4. Waste to Energy via Syngas (Gasifier or Plasma Arc) process
5. Sorting followed by bio-gasification

The following table provides the summary of the comparison :

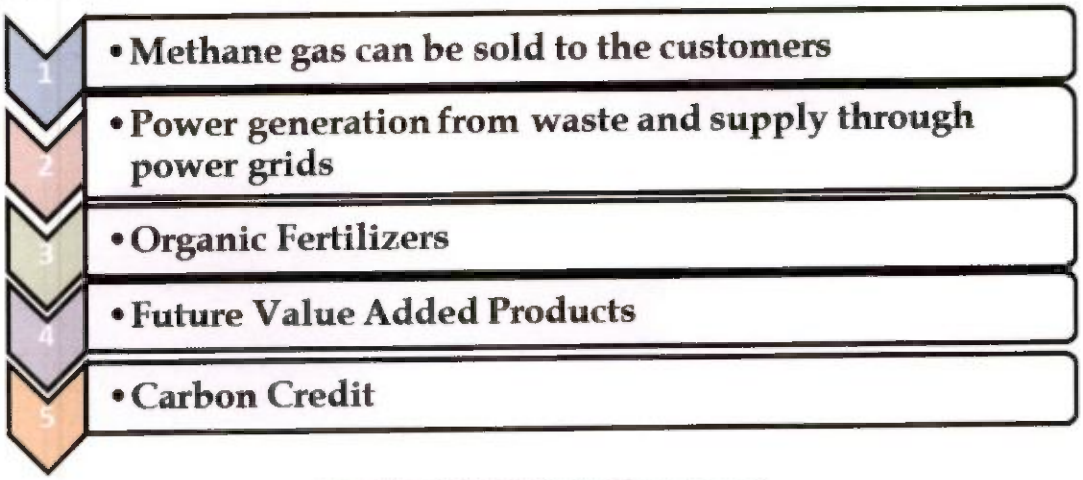
Technology	Land Requirement	End Product	Viability
Scientific Landfill	High. Does not need sorting to function	Landfill gas at low rate for several years.	Will need substantial land and high capital cost to construct. The gas generation is gradual. Not viable primarily due to land constraints
Windrow or Vermi Compost	Moderate. Needs sorting to operate	Compost	Difficult to have all the compost consumed by the customers. A few days of lack of collection will lead to accumulation at the site. Uncertainty of feed quality will also cause reluctance among farmers to accept the final product. Limited viability.
Waste to Energy: Incineration	Moderate. But needs land for ash/residue disposal	Electricity	High moisture and low carbon in the waste makes the process very inefficient leading to very low electricity generation. Air pollution is also a major concern. The land requirement goes up due to the Requirement of ash dispoal within the premises. The capital cost is also very high. Not viable
Waste to Energy: Syn Gas	Moderate. Needs land for ash disposal	Electricity	High moisture and low carbon in the waste makes the process very inefficient leading to very low electricity generation. The land requirement goes up due to the Requirement of ash dispoal within the premises. The capital cost is also very high. Not viable
Bio-methanation after sorting	Relatively low. But needs sorting for functioning.	Biogas/Electricity and Organic Fertilizer	If sorting is done properly, the gas (and if converted to electricity) is viable end product. No end residue of the process other than the products. The cost is reasonable. Viable for these applications.

Based on above criteria Bio-methanation after sorting is hereby proposed for Biodegradables and Sanitary land fill for the inert.

5.1 Generation of BIO-GAS

According to the Arambagh Municipality estimation, approximately 28 MT of waste is generated daily basis in the Arambagh Town. It was seen that for the Arambagh Municipality the amount of the Biodegradable Waste generated (16 MT) was considerably higher in comparison to the Non Biodegradable waste. Thus, a Bio gas Plant layout is ideal for the Project Area and will be designed for the Arambagh Municipality. Primarily, three 5 MT Bio gas Plants are proposed for Arambagh Municipal Area.

At a glance, the benefits which can be drawn out of Solid Waste Management are as follows:



Benefits of Solid Waste Management

Waste Generation Trend

Arambagh is a municipality well known for its tourism and horticultural importance in West Bengal. Following are the major sources for generation of Solid Waste:

Domestic;

Commercial Areas and Vegetable Markets;

Household and other factories;

Hotels and Restaurants;

Health Care Facilities

Slaughter House;

Street Sweeping and Construction Activities

Horticultural Waste

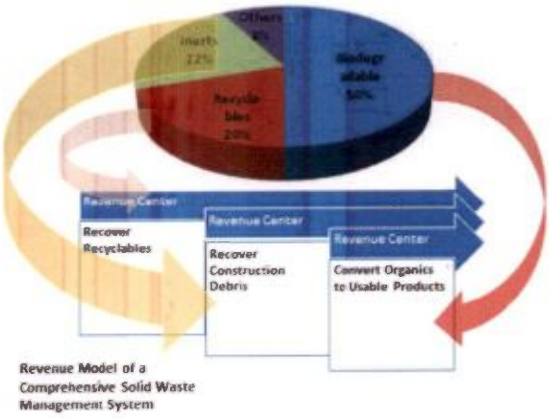
The following diagram shows the proposed approach for a comprehensive solid waste management system. The overall solution should be a combination of the following:

Sorting and segregation

Recovery of Recyclables

Recovery of inerts

Conversion of biodegradables to valuable products like biogas and fertilizers



Revenue Model of a Comprehensive Solid Waste Management System

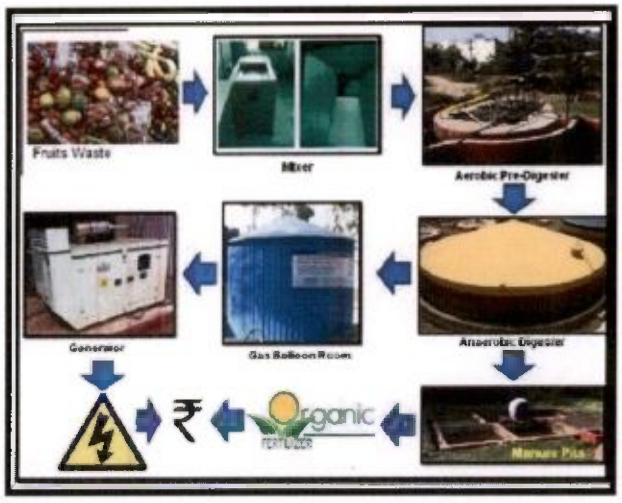
Solid Waste Sorting Operation

The collected solid waste will be segregated into biodegradable and non biodegradable components. The non-biodegradable components will be sorted into paper, plastic, glass, metals and inerts. There is a ready market for all of these sorted materials in Siliguri and other urban centers for these recyclable markets. It is recommended that Arambagh assigns one of the companies operating in the region for sorting the waste so that the biodegradable component can be fed into the biogas generating facility.

Solid Waste Handling Technique

Approximately 28 MT of solid waste is generated on a daily basis. Thus the expected Biodegradable Waste to be generated daily is approximately 17 MT. It is recommended that biogas plant should be setup for optimal utilization of the processed waste.

Science of the Process



Waste Processing Flow Diagram

The principle as explained in the figure above produces organic manure (soil conditioner) and biogas based on the process of Bio-Methanation. The organically rich biodegradable portion of solid waste is mixed with recycled water to form slurry. The slurry is then aerobically digested in Pre-digester, where organic matter is converted to organic acids. Prior to Pre-digestion, final digestion is required. The Pre-digestion is accentuated by addition of hot water and intermittent aeration. Pre-digestion reactions are

exothermic and temperature rises to 40 ºC by itself. Hot water obtained using solar heater is added to raise the temperature to 50 ºC.. Their main role is to digest proteins and low molecular weight carbohydrates to produce volatile fatty acids.

The smaller molecules like proteins and simple carbohydrates are degraded during Pre-Digestion. The pH of the feed slurry to Pre-digester is around 7-8. The retention time (Hydraulic time) of 4 days is maintained in the Pre-digester. After the Pre-digestion the pH reduces to 4-5 pH units. The predigested slurry is further digested under anaerobic conditions for about 15 days. The process of methanogenesis takes place in this digester. Methane and carbon dioxide are the terminal products of this process. Methane is produced from two primary substrates viz. Acetate and Hydrogen/ Carbon dioxide (Formate). At this stage the organic acids are converted by consortium of methane bacteria to methane and carbon dioxide. The undigested lignocelluloses and hemi celluloses then flow out as high quality organic manure slurry. The pH of this slurry ranges from 7.5-8. Since the waste is processed at higher temperature, weed seeds are killed completely and the manure becomes weed free.

The three steps of Biogas production are as follows; 1) Hydrolysis 2) Acidification and 3) Methanogenesis. Various bacteria are involved in these processes.

Hydrolysis

In the first step (hydrolysis), the organic matter is analyzed externally by extra cellular enzymes (cellulose, amylase, protease and lipase) of microorganisms in the pre-digester tank. Converting solid waste into liquid form in the mixer stimulates this step. Bacteria start decomposing the long chains of the complex carbohydrates, proteins and lipids into shorter parts. Proteins are split into peptides and amino acids. Simple carbohydrates and proteins are degraded completely.

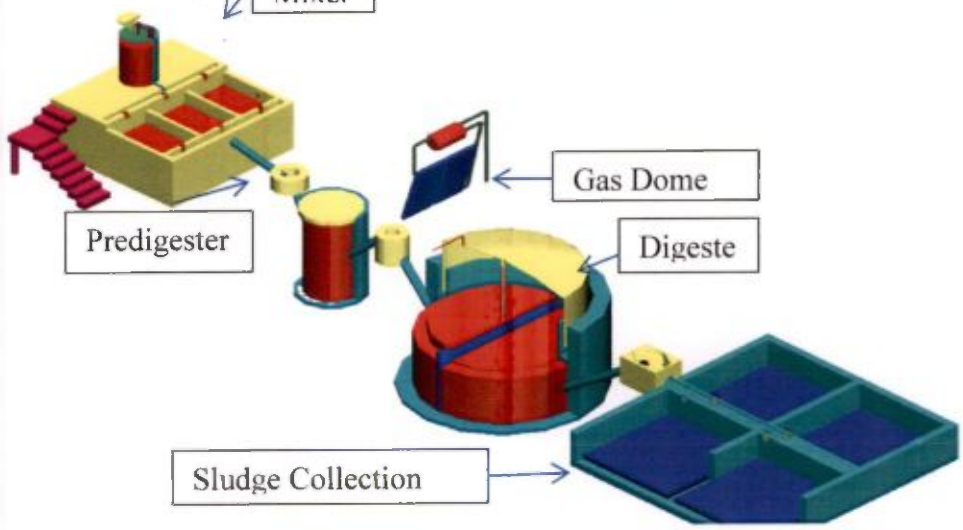
Acidification

Acid-producing bacteria involved in the second step convert the intermediates of fermenting bacteria into acetic acid (CH3COOH), hydrogen (H2) and carbon dioxide (CO2) in the Pre-digester. These bacteria of the genus bacillus, are aerobic and facultative anaerobic, and can grow under acidic conditions. The aerobic conditions in the pre-digester will be maintained by an air compressor..The bacteria use the oxygen dissolved in the solution producing acetic acid, thereby reducing the compounds with a low molecular weight into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane. The pH of the raw slurry falls from 7.5 to about 4.5 to 5.5 in the pre-digester. , Various zones are formed in the pre-digester and different bacteria dominate these zones. Addition of hot water helps in eliminating the mesophilic bacteria and selection of thermophilic bacteria. But these thermophilic bacteria can operate at lower temperatures also. Hence hot water added even once a day should be sufficient for maintaining the pure consortium in the pre-digester. However if it is possible to maintain the temperature of pre-digester in the range of 50-55oC throughout the day, the performance of pre-digester will be enhanced and the holding time may be further reduced, by maintaining temperature in the range of

50-55.C, throughout the day.. The hot water helps in hygienization of the slurry by killing the enteric bacteria that may be present in the waste. Some Gram negative Enterobacteria and Coliform bacteria have been isolated in the rawslurry. However in the second zone these bacteria are totally eliminated. From the pre-digester tank, the slurry enters the main tank where it undergoes anaerobic degradation by a consortium of archaebactereacea belonging to Methanococcus group.

Methane Formation

Methane-producing bacteria, in the third step, decompose compounds with a low molecular weight. . In contrast to acidogenic and acetogenic bacteria, methanogenic bacteria belong to the archaebacteria group, a group of bacteria with a very heterogeneous morphology and a number of common biochemical and molecular-biological properties that distinguish them from all other bacterial genera. It is advisable to circulate the generated biogas back into the system using a small compressor. This would enhance the reduction of Carbon dioxide to methane and enrichment of methane fraction in the biogas. The separation of two stages in methane production helps in improving the purity of methane gas, thereby increasing its fuel efficiency. However, the average composition round the year would depend on how effectively pre-digester temperatures can be maintained. It is taken through a GI pipeline to utility points. Drains for condensed water vapor are provided online. The biogas burns with a blue flame and is ideal for cooking. Alternately, it can be used to prod city in a dual fuel biogas-diesel engine.



Process Schematic of the Waste to Biogas-Organic Fertilizer System

5.2 SANITARY LANDFILLING

This is presently the commonest method of waste disposal. But it has associated problems of land and sub soil water contamination besides availability of land is becoming scares from year to year for filing of waste. Efforts have therefore to be made to minimize the wastes going to the landfill by resorting to composing of organic waste and only rejects should be land filled from the dates that may be notified by the local bodies after setting up of the Compost Plant.

This method will have to be followed for the greater mass of waste with a proper sanitation approach, in place of the present process of indiscriminate dumping. Adequate precaution against leachate pollution, fly, insect, odor and other unsightly problems, will have to be ensured for proper environmental protection. The fuel gas generated at landfill site can be salvaged and put into proper use for energy recycling. Assistance from developed countries to achieve this object will be of high necessity. A conceptual arrangement for sanitary landfill system has been given below.

5.2.1 Identification of Suitable Lands for Disposal of Waste Site selection :

Local bodies must identify suitable landfill sites 1) for the disposal of rejects from the compost plants and 2) for making a secured landfill for the disposal of non-biodegradable items following the directions of central or state pollution control boards. Such sites should be large enough to meet their requirement of waste disposal for 15 to 20 years and capital investments could be made for making the site fit for disposal of wastes.

a) The landfill site should be at least 0.5 km. away from the habitation so that it does not cause nuisance to the people on account of emission of foul smell etc.

b) It should have relatively impervious soil strata.

c) It should have good approach roads.

d) It should large in size.

e) Landfill site should be very near to compost area to minimize transport cost.

f) Landfill site should not be very near to water bodies like lake, cannel, river etc.

5.2.2 Development of Site

a) If the soil has some porosity, it should be made impervious before being used for land filling, by liners of compacted clay, plastic of concrete.

b) Approach roads may be made to connect the landfill site to the main road.

c) Internal approach roads are made to facilitate easy movements of vehicles and tipping of wastes at the landfill site during the monsoon months.

d) The local bodies should set up monitoring stations near the major landfill sites to ensure that quality of subsoil water does not get affected on account of leachate emerging from the landfills. A leachate pit is required at the lowest point for pumping leachate.

e) A small store room may be constructed at the landfill site to store the tools and equipment required.

f) A compound wall or fencing by barbed wire may be done to prevent blowing of waste due to air, controlling the entry of unauthorized persons and conceal the unsightly appearance of the of the landfills. The site should be surrounded be adequate no. of trees.

g) In large cities having population above 5 lakh a mechanical or computerized weighbridge may be installed for monitoring the quantities of wastes being carried by the vehicles to the landfill.

h) Trees may be grown around to create a green belt to improve the environmental conditions and screen the site from the people vies.

5.2.3 Landfill Operation

i) Compost-yard rejects and non-degradable may be brought to the landfill site for disposal.

j) Bulldozers may be used on a daily basis for spreading and compacting of such waste and covering it with inert material.

k) The waste may be covered with 7 to 10 cm. thick layer of inert materials such as construction wastes to avoid any foul smell and breeding of rodents and insects.

l) The landfills may be carefully monitored against subsoil contamination through leachate.

m) Gardens or playgrounds may be developed on the landfill and they may be made useful to the society or put to a profitable use.

n) On-site construction is not recommended for ten years after closure of the site (or 25 years in temperate regions).

o) Waste should not be allowed to be burnt at the landfill to avoid air-pollution.

p) Toilets should be constructed to prevent open defecation and make arrangements for extinguishing accidental fires.

q) Records may be maintained of the wastes received at the landfill and the number of trips made by each transport vehicle on day to day basis.

Landfill Section

Landfill may have different types of sections depending on the topography of the area. The Landfill may take the following forms: (a) above ground landfills (area landfills), (b) below ground landfills (trench landfills), (c) slope landfills, (d) valley landfills (canyon landfills) and (e) a combination of the above.

In case of Arambagh Town a combination of above ground landfills (area landfills) may be adopted.

Phasing of Landfills Operation

Landfill is to be operated in phases because it allows the progressive use of the landfill area, such that at any given time a part of the site may have a final cover, a part being actively filled, a part being prepared to receive waste, and a part undisturbed;

The term 'phase' describes a sub-area of the landfill. A 'phase' consists of cells, lifts, daily cover, intermediate cover, liner and leachate collection facility, gas control facility and final cover over the sub-area.

Each phase is to be typically designed for a period of 12 months. Phases are generally filled from the base to the final/intermediate cover and capped within this period leaving a temporary un -restored sloping face.

It is recommended that a 'phase plan' may be drawn as soon as the landfill layout and section are finalized. It must be ensured that each phase reached the final cover level at the end of its construction period and that is capped before the onset of monsoons. For very deep or high landfills, successive phases should move from base to the top (rather than horizontally) to ensure early capping and less exposed plan area of 'active' landfills.

The term cell is used to describe the volume of material placed in a landfill during one operating period, usually one day. A cell included the solid waste deposited and the daily cover material surrounding it. Daily cover usually consists of 15 to 30 cm of native soil that is applied to the working faces of the landfill at the end of each operating period. The purposes of daily cover are to control the blowing of waste materials; to prevent rate, flies and other disease vectors from entering or exiting the landfill; and to control the entry of water into the landfill during operation.

A lift is a complete layer of cells over the active area of the landfill. Typically, each landfill phase is comprised of a series of lifts. Intermediate covers are placed at the end of each phase; these are thicker than daily covers, bench (or terrace) is commonly used where the height of the landfill will exceed 5 m. The final lift includes the cover layer. The final cover layer is applied to the entire landfill surface of the phase after all landfilling operations are complete. The final cover usually consists of multiple layers designed to enhance surface drainage, intercept percolating water and support surface vegetation.

5.2.4 Liner System for Control of Leachate

Leachate control within a landfill involves the following steps: (a) prevention of migration of leachate from landfill sides and landfill base to the subsoil by a suitable liner system: and (b) drainage of leachate collected at the base of a landfill to the sides of the landfill and removal of the leachate from with the landfill.

Liner systems comprise of a combination of leachate drainage and collection layer(s) and barrier layer(s). A competent liner system should have low permeability, should be robust and durable and should be resistant to chemical attack, puncture and rupture. A liner system may comprise of a combination of barrier materials such as natural clays, amended soils and flexible geo-membranes. Three types of liner systems viz. **Single Liner System, Single Composite Liner System and Double Liner System** are usually adopted.

a) **Single Liner System** : Such a system comprises of a single primary barrier overlain by a leachate collection system with an appropriate separation/protection layer. A system of this type is used for a low vulnerability landfill.

b) **Single Composite Liner System** : A composite liner comprises of two barriers, made of different materials, placed in intimate contact with each other to provide a beneficial combined effect of both the barriers. Usually a flexible geomembrane is placed over a clay or amended soil barrier.

A leachate collection system is placed over the composite barrier. Single composite liner system are often the minimum specified liner system for non-hazardous wastes such as MSW.

c) **Double Liner System** : In a double liner system a single liner system is placed twice, one beneath the other. The top barrier (called the primary barrier) is overlaid by a leachate collection system. Beneath the primary barrier, another leachate collection system (often called the leak detection layer) is placed followed by a second barrier (the secondary barrier). This type of system offers double safety and is often used beneath industrial waste landfills. It allows the monitoring of any seepage which may escape the primary barrier layer.

Considering the advantages of composting liner system, in Indian conditions it is recommended that for all MSW landfills the following single composite liner system be adopted as the minimum requirement.

a) A leachate drain layer 30 mm thick made of granular soil having permeability (K) greater than 10^{-2} cm. /sec.

b) A protection layer of silty soil of 20 – 30 cm thick.

c) A geomembrane of thickness of 1.5 mm.

d) A compacted lay barrier and amended soil barrier of 1 mm thick having permeability (K) 10^{-7} cm. /sec.

To achieve good composite action the geomembrane must be placed against the clay with good hydraulic contact. To achieve intimate contact the surface of a compacted soil liner on which the geomembrane is placed should be smooth-rolled with a steel dump roller. All oversized stones in the soil should be removed prior to rolling. Also the geomembrane should be placed and back fill in a way that minimizes wrinkles.

Cut-Off Walls : When a landfill is underlain, at shallow depths, by an impervious layer, vertical cutoff walls may be constructed around a landfill to intercept off-site migration. Cut-off walls are physical barriers (typical made of bentonite or bentonite-soil mix) and such barriers are aided by active pumping used to remove leachates from within the perimeter of the cutoff wall.

Leachate Drainage, Collection and Removal

A leachate collection system comprises of a drainage layer, a perforated pipe collector system, sump collection area, and a removal system.

The leachate drainage layer is usually 30 cm thick, has a slope of 2% or higher and a permeability of greater than 0.01 cm/sec. A system of perforated pipes and sumps are provided within the drainage layer. The pipe spacing is governed by the requirement that the leachate head should not be greater than the drainage layer thickness. Pipe material selection is based on design requirements: HDPE pipes are most commonly used; other materials can also be examined for feasibility.

Leachate is removed from the landfill by (a) pumping in vertical wells or chimneys, (b) pumping in side slop risers, or (c) by gravity drains rough the base of a landfill in above-ground and sloped landfills. Side slope risers are preferred to vertical wells to avoid any down drag problems.

Submersible pumps have been used for pumping for several years; educator pumps are also being increasingly used. In some landfills, the leachate is stored in a holding tank (for a few days) before being sent for treatment.

The possibility of fall in efficiency of the drainage system due to clogging associated with solid deposits and microbial growth can be controlled by a number of options, including back-flushing or breakthrough water after leachate head build-up.

Treatment of Leachate:

Control / Management of leachate is very complicated. The five/ alternative methods viz. **a) discharge to lined drains; b) discharged to waste water treatment system; c) re-circulation; d) evaporation of leachate; e) treatment of leachate** may be considered in this regard.

Out of the above five the Recirculation Method may be considered suitable for small to medium landfill site. This method of treatment of leachate is to re-circulate it through the landfill. This has two beneficial effects : i) the process of landfill stabilization is accelerated and ii) the constituents of the leachate are attenuated by the biological, chemical and physical changes occurring with the landfill. Recirculation of leachate requires the design of a distribution system to ensured that the leachate passes uniformly throughout the entire waste. This method also accelerates the process of gas generation.

Final Cover System

A landfill cover is usually composed of several layers, each with a specific function. The final cover system must enhance surface drainage, minimize infiltration, vegetation and control the release the landfill gases. The landfill cover system to be adopted will depend on the gas management plan by (a) controlled passive venting; (b) uncontrolled release; or (c) controlled collection and treatment/reuse.

For all landfill sites where controlled gas venting is planned, the cover system is recommended. Gas vents will be placed at a spacing of 30 m to 75 m on the landfill cover and the level of methane will be monitored regularly. If methane concentration exceeds permissible limit a gas collection and treatment system will be installed with flaring facility.

For sites where landfill gas recovery is to be undertaken, the placement of passive and/or active gas venting systems will be governed by the energy recovery system. In such case a cover of granular soil of 45 cm thick over the waste followed by barrier layer of compacted clay of 60 cm deep followed by a protection layer of 2 cm is to be given. Over the protection layer one layer of granular soil of 30 cm followed by a top layer of thickness 45 cm with soil suitable for vegetation growth will improve the efficiency of gas recovery system by minimizing the loss of gas to the environment.

For uncontrolled release of gas (in small, shallow and remote sites) a cover of 60 cm depth is recommended.

The cover system adopted at any landfill must satisfy the minimum requirements published by regulatory agencies CPCB.

Slope Stability Aspects and Seismic Aspects

The stability of a landfill should be checked for the following cases.

1. Stability of excavated slopes.
2. Stability of liner system along excavated slopes.
3. Stability of temporary waste slopes constructed to their full height (usually at the end of a phase).
4. Stability of slopes of above-ground portion of completed landfills.
5. Stability of cover systems in above-ground landfills.

Closure and Post Closure Maintenance of Landfill Site

Determination of the end-use of a landfill site is an essential part of the plan for landfill closure and post-closure maintenance. Some possible uses of closed landfill sites near urban centers include parks, recreational areas, golf courses, vehicle parking areas and sometimes even commercial development.

A closure and post-closure plan for landfills involves the following components:

- Plan for vegetative stabilization of the final landfill cover.
- Plan for management of surface water run-off with an effective drainage system.
- Plan for periodical inspection and maintenance of landfill cover and facilities.

5.3 Introduction of Recycling System

In view of the fact that municipal wastes constitute variety of materials which have a good salvage value. Prospect of alternative disposal system based on the traditional practice can be explored in the non formal sector. We may also develop some resource recovery approach which propose to include :

i) Improved sorting technique and reduction of occupation hazards of pickers.

ii) Measures to reduce the health risk of workers.

iii) To develop a comprehensive plan of the existing agro pisi-culture system to improve utilization of garbage to increase productivity of vegetables and fish.

5.4 Disposal of slaughter-house waste and carcasses of dead animals etc.

The disposal of slaughter house waste and carcasses of dead animals should be done scientifically following the directions / guidelines of the Ministry of Environment, Govt. of India. This waste should not be mixed with municipal waste.

This waste could be converted into a useful product by installing a carcass-utilization plant with financial support Govt. of India's Ministry of Agriculture and Animal Husbandry.

Municipal authority should take appropriate steps for lifting, transportation and disposal of Carcass. Suitable mechanism is required to be developed for reporting of the dead animals found with in the municipal area. On receiving the information the "Dead Animal Carrier Van" should reach the spot as soon as possible but not later than one hour to lift the Carcass and to transport the same to dumping ground.

The "Dead Animal Carrier Van" should be a covered one having chain-pulley system for lifting and placing the dead animals into the van. There are number of options for disposal of carcass.

The best method is to keep the dead animal in open air on an impervious platform at the remotest corner of the dumping ground so that it can be used as food for vultures. This is the most economic and easy method of disposal of carcass. Survival of vultures has become very important now a days for maintaining the ecological balance and this method of disposal of carcass will be very much effective in this regard.

The other options are :

i) Secured burial of carcass in impervious burial pits. This method is to be adopted where the dumping ground is located very near to the locality.

ii) A raised platform may be constructed to keep the dead animal in open air for feeding the same as food for vultures. This method may be adopted where the dumping ground is located far away from the locality.

iii) Shred the carcass into small pieces and mixed it in windrow where Windrow Composting facility exists. This will not only increase the process of decomposition but also will enhance the nutritious value of the compost manure.

The skin of the animal, if valuable, can be extracted before it is disposed off. After the carcass is feed by the vultures, the bones can be collected for use in bio-fertilizer.

In slaughter house liquid waste should be carried separately to the septic tank where anaerobic decomposition will take place and the effluent from the tank may be discharged to the normal drain after chlorination. Carcass of the slaughter house may be mixed with the vermi compost after initial decomposition of the same in solar light.

Private parties / NGOs may be engaged for collections and transportation of carcass on service charge basis. They may be allowed to extract the valuables from the carcass to minimize the cost of operation.

5.5 Disposal of Industrial Waste

Industrial waste is required to be stored, transported and disposed of by industries as per the guidelines of the respective State Pollution Control Boards. However, the local bodies may extend help to the industries in the transportation and disposal of non-hazardous industrial waste on full cost-recovery basis. This work can be contracted out by the local bodies in consultation with the industries associations etc. and strictly monitored by both the local body and the State Pollution Control Board.

6.0 DESIGN OF THE SYSTEM

6.1 Quantum of Solid Waste

The success of any solid waste management system largely depends upon the three factors (i) Collection, (ii) Transportation & iii) Disposal. So, to make success clear assessment on the quantity of solid waste to be handled is very much essential. In respect of Arambagh Municipality that solid waste generation is @ 275 gm/cap/day is fairly reasonable for consideration.

Total quantity of waste generated per day from various sources in Arambagh Municipality is given below :

Generation Points	Total (in kg.)	Quantity of Waste (in Kg.)	
		Waste Type	
		Bio-degradable	Non-degradable
Domestic	18198	10919	7279
Daily & Wholesale Market	6000	4800	1200
Hotels	165	66	99
Agricultural/ Garden	500	500	0
Sub-total	24863	16285	8578
Commercial Centres	1000		1000
Railway Station	500		500
Bus Stand	100		100
Sub-total	1600		1600
Street Sweepings	500		500
Drain Cleanings	300		300
Sub-total	800		800
Cess pool	600	600	
Clinical	375		375
Total	28238	16885	11353

Data Validation by Solid Waste Sampling

A detailed sampling exercise was performed at the Arambagh solid waste dumping ground to estimate the quality of the solid waste reaching the site. The assumption was that through the quantity of the waste will vary with seasons, the overall sorting practices and the solid waste generation points will remain the same during all the seasons.

The following Table shows the result of the sampling exercise.

Tare Weight (Kg)	Full Weight (Kg)	Waste Total (Kg)	Plastic (Kg)	Metal (Kg)	Glass (Kg)	Paper (Kg)	Biodegradable (Kg)	Biodegradable (%)
54350	84600	30250	9075	0	0	302	18150	60%

The following conclusions can be drawn from the sampling exercise:

Nearly all the glass, paper and metals are sorted out of the solid waste even before it can reach the solid waste facility. One aspect that is a good practice as the recyclables are definitely gets recycled under this procedure.

The pre-sorting would reduce the revenue that the solid waste facility could have earned by selling the recyclables to the scrap market

The remaining plastic was mostly of low grade thin sheet. The only applicable process for conversion this plastic is to breakdown the plastic into dirty fuel through Pyrolysis so that it can be subsequently sold as furnace oil to factories.

The final solution will not require any process for recycling glass, metal and paper as these components can be expected to be drawn back into the economy.

The main revenue sources from the process will be from

- Gas and or electricity generated from the biogas
- Organic fertilizer
- Fuel oil from the plastic pyrolysis
- Selling any other recyclables recovered will be sold in the market through solid waste

Biodegradable materials will account for 85-90% of the waste finally reaching the solid waste facility. It is projected that as the waste reaching the solid waste site is after the sorting done by rag pickers and the residents, the biodegradable part as a percentage of the whole waste generated is expected to be close.

Therefore, the plant should be designed on the basis of the overall waste tonnage expectation while using the solid waste quality observed during the sampling process.

BASIC CONSIDERATIONS

1. Per capita waste generated @ 275 gm/day and average family size is 5 persons.
2. Domestic Waste shall be segregated (bio-degradable and non-degradable) at generating points House to House in separate containers.
3. Each family would preserve the degradable waste in green container & non-degradable waste in yellow container.
4. House to House collection shall be done by Wheel Barrows having eight containers; four for bio-degradable and another four non-degradable waste.
5. There will be number of Transfer Stations in each zone .
6. At Transfer Stations waste from Wheel Barrow shall be transferred to Community Bins / Dumper / Refuse Trailer from a ramp.
7. Market Waste should be collected through Community Bin(s) to be placed at suitable points.
8. Trade Waste should be collected by Wheel Barrows or through Community Bin(s) to be placed at suitable points
9. Waste from Market shall have to be dumped in Transfer Stations. Each Market\Commercial Centre should have one Transfer Station in the form of containers. No road side open vat should be allowed. All road side bins must have cover and with necessary arrangement for tilting directly on to the transportation vehicles.
10. From Transfer Stations waste shall be transported to disposal site by prime movers.
11. Penalty may be imposed for haphazard throwing of waste.
12. Variety of non-degradable waste can be recycled after processing.
13. NGOs may be encouraged for employing daily wage earners to collect the non-degradable waste and to sale them.
14. One Wheel Barrow will cover about 50 to 75 holdings in a day and will make three trips to Transfer Stations.

15. Each and every hotels should keep two containers one yellow another green for storing their non-degradable & degradable waste respectively which shall be collected by the transportation vehicles at the particular time on each day.

16. Capacity of Refuse Trailer is 1.0 – 1.5 MT.

17. Capacity of Dumper / Truck is 5 – 7.5 MT

18. In an average one Tractor will be able to make 4 - 5 trips per day.

19. Moisture content in organic waste is about 60%.

20. Domestic SW contains about 60% organic matter and remaining 40% is inert materials.

21. Hotels generate SW @ 750 gm/bed and contains about 50% organic matter and remaining 50% is inert materials.

22. Market SW contains about 80% bio-degradable matter and remaining 30% is inert materials.

23. Assumed that Trade Waste contains about 10% bio-degradable matter and remaining 90% is inert materials.

24. Assumed that Agricultural Waste contains about 100% bio-degradable matter neglecting the very few mixed inert materials.

25. Assumed that Clinical Waste generated @ 1500 gm per bed/day.

26. In Clinical Waste infectious material is 25%.

6.2 PROCESSING AND DISPOSAL OF WASTE

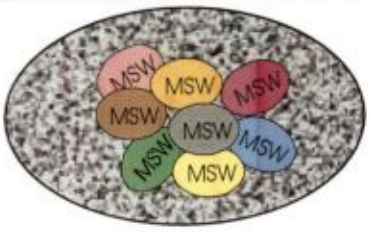
The solid waste of Arambagh Municipality is proposed to be disposed of partly by processing and partly by sanitary landfill method. Bio-degradable part will be processed bio gas will be generated.

Present land availability to Arambagh Municipality for disposal of SW is about 30958.48 SQM located at a distance of 3.5 Km from the central place of the town. The detailed design of the disposal system is given below.

6.3.1 Design Of Solid Waste Processing System

The Solid Waste Management Facility in Arambagh Municipal Area is shown in figure below. It is proposed to be a Biogas Plant, which will produce electricity in the long run.

FLOW CHART FOR SWM SYSTEM



Collection from point of generation

DOMESTIC WASTE

To be collected from house to house by wheel barrow and Transferred either to community bins or directly to container (HLDC) kept at Transfer Stations. Waste from community bins shall be collected by Hook Lift dumper carrier.

HOTEL

Waste stored by the Hotels in their containers is to be collected directly by HLD.

MARKET WASTE

To be collected at a particular time of a day in HLDC kept at a particular place and the containers are to be transported to Disposal site .

WASTE FROM TRADE & COMMERCE

To be collected either by wheel barrow or directly at Community Bins / Dumper Containers at a particular place and the containers are to be transported to Disposal site.

WASTE FROM ROAD SIDE LITTRE BINS

To be cleaned daily and the waste to be transferred to Wheel Barrows and from it to nearby HLDC.

TRANSPORTATION

To Processing and Disposal / Site(s)

Recovery of Recyclable materials

Degradable waste to be processed

Non-Degradable waste to be disposed off by sanitary landfill

Value addition and realization of economic value by proper placement and marketing of the product

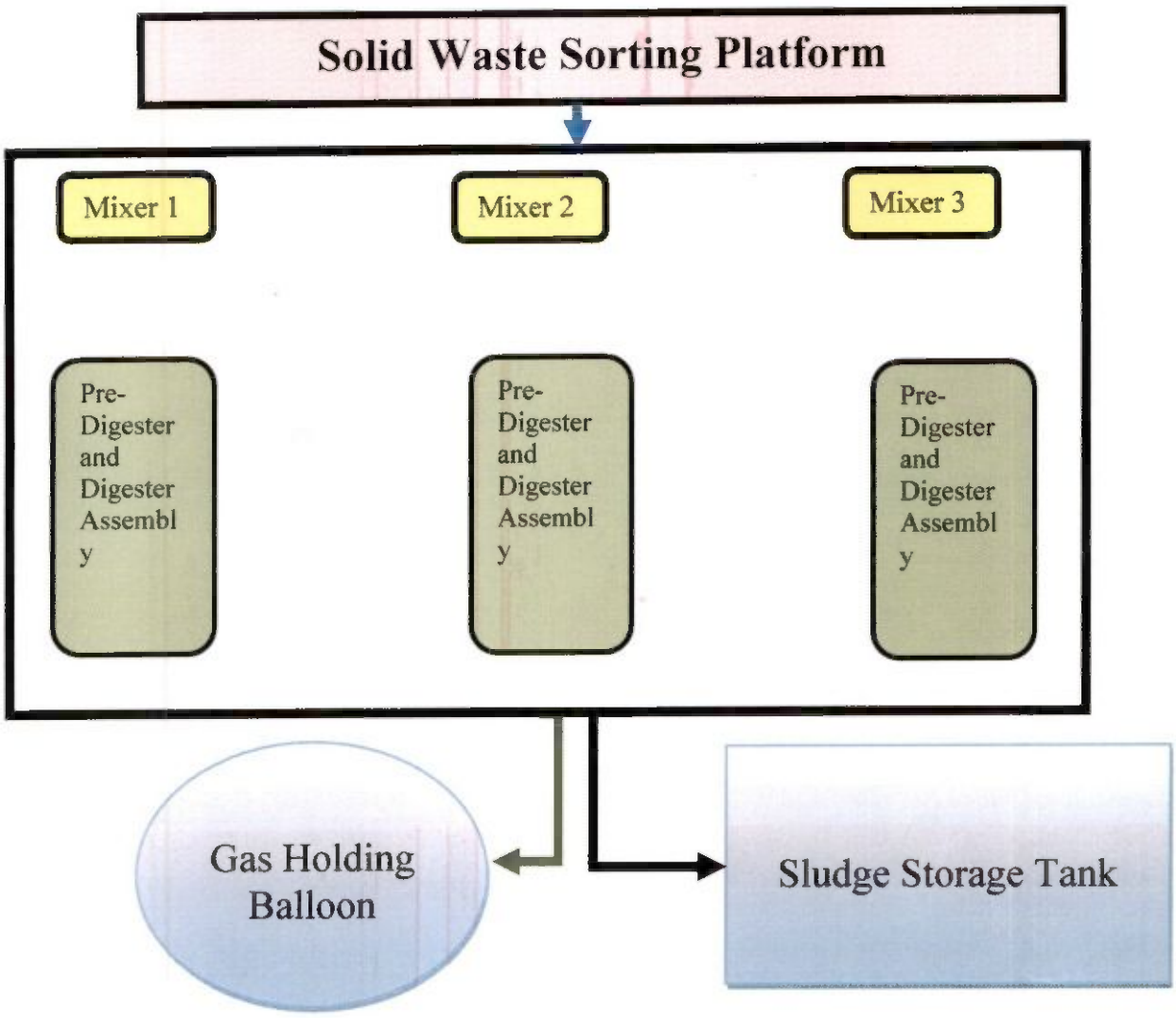
Volume reduction through Compactor

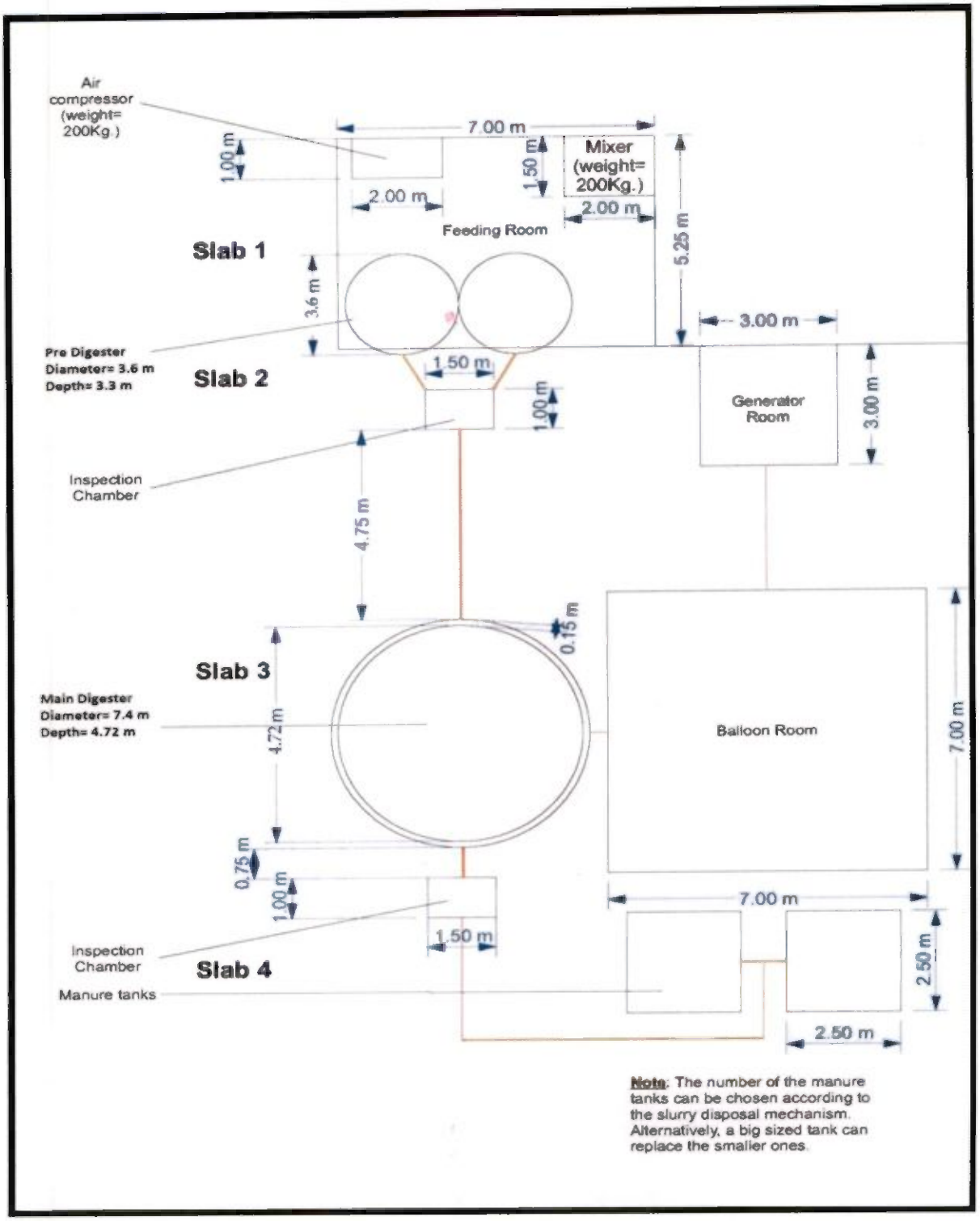
Monitoring and Evaluation of the total systems & adoption of necessary modification required

The Bio-Gas Plant at Arambagh Municipal Area

Total capacity to be provided at the site is 15 MT per day. This will be done by a combination of three 5 ton plants. This would provide a sufficient redundancy and flexibility to the operation with changing load with different seasons. The Bio-Gas Plant Facility at Arambagh will require an area availability of approximately 1800 sq.m, to handle a capacity of 15 MT of Biodegradable wastes, on daily basis as shown in figure below. Any additional available land can be used as a sorting facility.

Overall Arrangement of Three 5 MT Biogas Plants





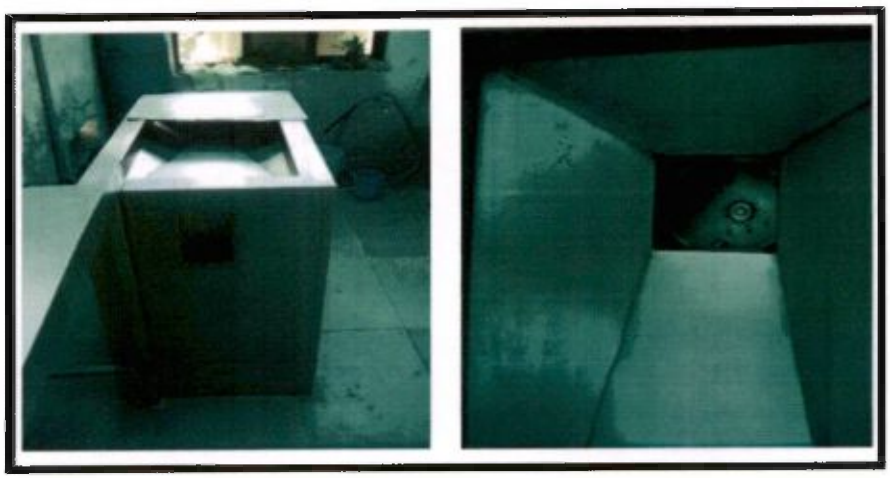
Proposed Biogas Plant Layout (each 5 MT Plant) for Arambagh Solid Waste Management

Components of Biogas Plant

Following are the major components will be installed at each of the SWM Facilities (Biogas Plants) in Arambagh, Nadia District as shown in the figures below.

- **A Mixer for crushing the solid waste**

Here the organically rich bio-degradable portion of solid waste is mixed with recycled (depending on availability) and/or fresh water to form a uniform slurry. The water ratio needed for this technology is 1:1 i.e., for 100 kg of waste, 100L of water will be needed. All of the required water need not necessarily be fresh water; Recycled water from the plant and from Sewage treatment plants can also be used. It is important to maintain the ratio, as addition of excess amount of water can lead to washing away of culture, thereby ceasing the process. The microbial quality of water needs to be checked regularly.



A Typical Mixer for crushing Biodegradable Waste

- **Thermophilic Aerobic Pre-Digester Tank**

Each 5 MT Bio-Gas Plant will have two Aerobic Pre-Digesters. Each Pre-Digester will be 2500 mm in diameter and 4000 mm deep. The Pre-Digesters will be aerobic in nature as name suggested. The Pre-Digester will receive flow of oxygen through air supplied by compressor housed in the Mixing and Feeding Room. The slurry will be aerobically digested in the pre-digester, where organic matter is converted to organic acids. The pre-digestion is accelerated by addition of hot water and intermittent aeration. Predigestion reactions are exothermic and the temperature rises up to 40oC by itself. The main role of the bacteria is to digest proteins and low molecular weight carbohydrates to produce volatile fatty acids. The retention time in the pre-digester is 4 days. Before introducing the slurry in the Main Digesters, it will pass through 1500 mm x 2500 mm inspection chambers. The aeration grid in the chamber will be as shown in figure below.

A Typical Pre-Digester

- **Air Compressor**

The air compressor will be placed in the Mixing and Feeding Room. The pre- digester requires aerobic condition. To maintain aerobic conditions in the pre-digester aeration is given at regular intervals using a compressor. Aeration not only supplies oxygen but also enhances the uniformity in the slurry and in-turn promotes proper digestion for further fermentation in the main digester.

Typical Air Compressor

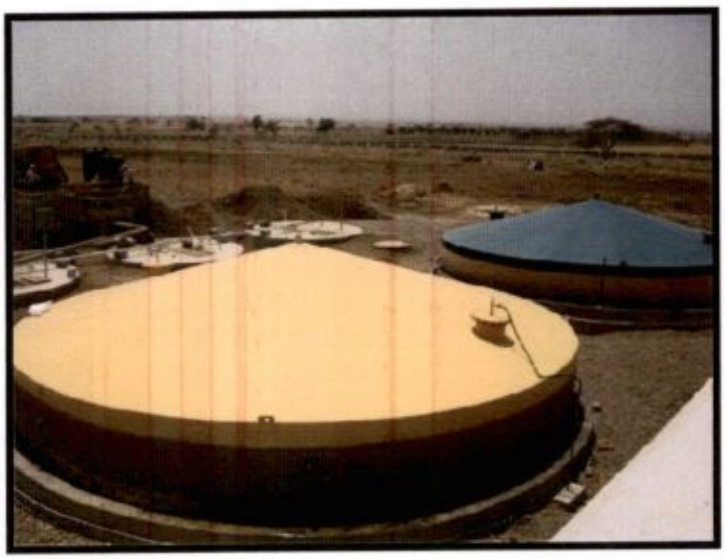
- **Solar Unit for Hot Water**

The Solar Power will be used for heating water which will be used for raising temperature in Aerobic Pre-Digester. Low temperatures arrest microbial growth and halt the process of bio-methanation.

- **Main Digester tank**

This is the heart of the Biogas Plant. There will be a main digester for each 5 MT Plant. The digester will be anaerobic in nature. The Main Digester will be 5400 mm in diameter and 6000 mm deep with floating

roof. The predigested slurry will be further digested under anaerobic conditions for about 15 days. The process of methanogenesis takes place in this digester. Methane and carbon dioxide are the terminal products of this process. At this stage the organic acids are converted by consortium of methanogenic bacteria to methane and carbon dioxide which get collected in the dome above the main digester. The excess gas will be stored in a gas balloon as shown in the figure below. The undigested slurry will be transported to Manure Pits as explained below.



Typical Anaerobic Digester

- **Gas Holder/Gas Balloons**

Balloons are required to store the gas produced, when the production is higher than the utilization, as this results in the gas escaping from the water seal.

A Typical Gas Balloon

- **Manure pits**

The undigested lignocelluloses and hemicelluloses that flow out of Main Digesters as high quality organic manure slurry. The pH of this slurry ranges from 7.5-8. Since the waste is processed at higher temperature, any weed seeds are killed completely and the manure becomes weed free. Depending upon the raw materials used and the conditions of digestion, this sludge contains many elements essential to plant life – Nitrogen, Phosphorous, Potassium plus small amount of salts (trace elements), indispensable for plant growth such as boron, calcium, copper, iron, magnesium, sulphur, zinc, etc. It is a good source of all the essential elements needed for restoring the fertility of the soil. The Manure Pits will be located on end of the 5 MT Biogas Plant as shown below.

A Typical Manure Pit

- **Effluent water collection and recirculation system**

The sludge flows out into the manure pits, the water separated here is recycled to the mixer for feeding. Hence brick/concrete tanks are used to store this water.

6.3.2 Technical Specifications of Bio-Gas Plant

Specifications of the Tanks & Pits

Table 3:

Specifications of the Tanks & Pits

S.No	Description	Nos	Dimensions	Volume of Each Tanks/Pits/ (cu.m.)	Total Volume of Tanks/Pits (cu.m.)
A	Primary Digester	2	3.6 m Dia x 3.3 m Deep	33.57	67.14
B	Main Digester	1	7.4 m Dia x 4.72 m Deep	202.90	202.90
C	Manure Pits	4 Cells	4.0 x 4.0 x 4.35	72	288
D	Outlet Chambers	2 Cells	2.050 x 8.0 x 1.65	12.38	24.79
E	Water Recycling Tank	1	: 5.95 x 2.7 x 1.75	28.11	28.11

Specifications of the Mechanical Equipment

Table 4:

Specifications of the Mechanical Equipment

S.No	Description	Specifications
A	Mechanical Mixer	7.5 HP/7 KW with double cutting arrangement
B	Compressor	3 HP/3 KW Phase 3 Fauji Make
C	Slurry Pump	3 HP/3 KW

As mentioned earlier, the following equipment will be installed at the plant:

Specifications of other Ancillary Items

Table 5:

Specifications of the Ancillary Items

S.No	Description	Specifications
A	Main Digester Gas Dome	4 mm M.S. Sheet with FRP coating
B	Gas Pipeline	GI pipe Class C
C	Air Compressor Grid in Pre-Digesters	GI Pipe Class C
D	Bio-gas Balloon/Bag for extra Gas Storage	Polyethylene Bags
E	Biogas Flame Arrestor	
F	Plumbing Accessories	Check Valves, Isolation Valves, Control Valves, etc
G	Shell & Tube Heat Exchangers	200 SS 304
H	Recycling Water Line	150 mm uPVC SH 40
I	Inspection Lids	Cast Iron
J	Burners	
K	Bucket Conveyor	
L	Solar Heater	
M	Small Incinerator for Non Recyclables	

6.3.3 Disposal by Modified Sanitary Landfill (MSLF)

Total wastes to be disposed of in MSLF = (Non-Degradable Waste part of A, B, C, D & E category waste per day	12.28 MT
30% of projected (final year) waste generation	15.00 MT
Maximum of above two	15.00 MT
Approximate Vol. of Solid Waste to be at Landfill site per day	30.00 CUM
Vol. of Solid Waste to be disposed off per year	10800.00 CUM
Assuming 52% compaction, compacted Vol. of Solid Waste	5184.00 CUM
It is recommended that the disposal will be done above ground level (area landfill) Let us consider that the total depth of MSLF is 25 M above GL. Earth cover 30 CM.	
So, Area required for yearly dumping	209.88 SQM
For 15 years required area will be	3148.18 SQM
Considering change in habits, increase land requirement by 10%	3463.00 SQM
Add service area @ 10%	3809.30 SQM
or Area in Acres	0.94 Acres
Land requirement for Bio-gas plant	0.6 Acres
So, total land required for bio gas plant and sanitary landfill	1.54 Acres

The landfill site is to be operated in phases because it allows the progressive use of landfill area, such that at any given time a part of the site will have final cover, a part being actively field, a part being prepared to receive waste and a part is undisturbed.

In this case Landfill site area required to be develop in 3 phases each phase will be used for 5 years period; so area required for 5 years	1049 SQM
Cell size to be provided Length :	50 Mtr
Width :	20 Mtr
Contact Surface Area :	3849 SQM
Adding 30% extra for 5 years dumping :	5003.7 SQM

Linear will be provided on the contact surface area of the cell of each phase before the commencement of landfill operation. The cost of construction of linear for each phase (for 5 years dumping) has therefore been considered in the project cost.

Economics of the Project

Economics Based on Revenue Generation from Sorting of Recyclables

The Operation and Maintenance Cost and the Revenue Generation associated with Sorting and Sale of

Recyclables are calculated and provided in the table below:

Table 6:

Economics for Sorting and Selling of Recyclables

Operation and Maintenance Cost per month		
Workers	20	Rs. 140,000
Supervisors	1	Rs. 14,000
Safety Equipments and Additional Accessories		Rs. 40,000
Total O&M Cost per month		Rs. 194,000
Revenue Generation per day		

Sale of Recyclables in MT	5	Rs. 40,000
Revenue generated per month		Rs. 1,200,000
Annual Revenue		Rs. 14,400,000

Economics Based on Revenue Generation from Sorted Waste

The plant can have potentially two end products besides the organic fertilizer. It can generate biogas or it can generate electricity (using this gas in a generator). The economic viability of both the options is listed separately.

Revenue generated using biogas as the final product

The table below shows the Revenue generated where Biogas is the final product

Table 7:

Revenue Generation when Biogas is end product

Case I: End Product: Biogas		
Biogas Produced on Daily Basis:	450	Kg
Revenue from Biogas sale	Rs. 30	per kg
Daily Revenue	Rs. 13,500	
Monthly Revenue	Rs. 4,05,000	
Annual Revenue	Rs. 48,60,000	

Revenue Generation when Electricity is end product

Case II: Electricity		
Plant Generator Rating	15	Kwh/T
Hours of Operation	10	hours per day
Energy Produced Daily	1500	KWH
Excess Electricity for Sell:	1350	KWH
Unit Price for Sell:	7.5	per KWH
Daily Revenue	Rs. 10,125	
Annual Revenue	Rs. 3,037,500	

** Besides the above revenue sources the city can gain some additional revenue from Organic Fertilizers. In several communities, with this type of systems, cities are selling this product to organic farmers and commercial crop growers. However, the proximity to tea plantations may prove to be a major factor for selling organic fertilizers. Based on experiences with the other system, if the city manages to identify appropriate customers it can generate revenue as shown below:

Table 8:

Waste generates around (8%) i.e.	1.2	MT Organic Fertilizer
Rate of Organic Fertilizer=	Rs. 3	/Kg
Revenue from Organic Manure=	Rs. 3,600	per day
Monthly Revenue =	Rs. 108,000	
Annual Revenue=	Rs. 1,296,000	
This additional revenue can be included to the above mentioned revenue alternatives, in case prospective buyers for organic manures are sourced.		

From the tables above, we can easily project the Case il to be a more viable option. The table below presents the viability analysis for both the options.

Total Revenue Generation per Year = 14400000 + 3037500 + 1296000 =

Rs. 18,733,500

Sustainability

The proposed biogas plant will generate Biogas and if needed electricity along with some organic fertilizer on a daily basis. Each of these components generate predictable revenue for the duration of the plant operation. The main product is biogas that can be easily used for cooking and other applications. That can generate a substantial revenue at the rate of Rs 30-60 per kg with a generation rate of 60 cubic meter of biogas per ton. In case the gas is converted to electricity, the state electricity board has to mandatorily purchase the electricity. The electricity generation rate is about 100 KWH per ton of solid waste. The organic waste also has a readily available market in the tea plantations or pineapple farms or other organic farming community. For every one ton of solid waste, about 60-80 kg of organic waste is generated and that can be sold for Rs 1 to 4 per kg. This revenue stream is reliable as the end product is easily transportable to the customers and has ready market. Therefore, once the plant is in operation, the plant can sustain its operation and maintenance cost purely based on the revenue. In reality, there will be some additional revenue also from recycle operation, but that is not being discussed in this section.

Viability analysis for both the options considered

Table 9:

Parameters	Case I: Biogas as the end product	Case II: Electricity as the End Product
Buyers	Hotels, Restaurants, Hospitals, etc	Buyers are easily available and Electricity can be sold to the SEBs or can be used by the Municipality.
Transport and Supply	Biogas needs to be transported in specialized storage trucks, from source to site.	Electricity can be directed to the customers through Transmission Line
Plant Machineries at Source	Biogas can be extracted directly from the Gas Balloons. The process will involve daily filling up of the trucks with biogas and delivery of the gases to the individual storage units with the customers. This has to be done daily while following all the appropriate risk management protocols associated with transportation and storage of explosive gases in pressure vessels in public areas.	On the other hand, for Electricity Generation, Generators, Gas Turbines and other accessories are required, along with transmission lines.
Operation and Maintenance	O &M Cost will involve maintenance of the vehicles and depreciation involved	The O&M will involve some maintenance of the generators and gas cleaning equipment along

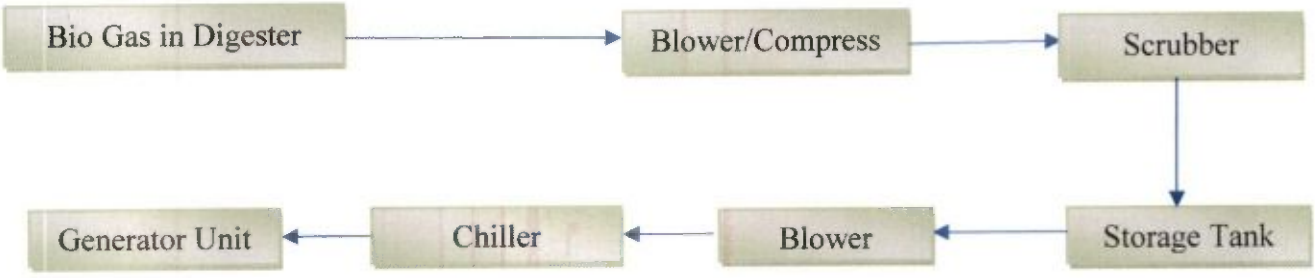
	along with the salary of the driver and maintenance crew.	with the depreciation of the equipment. The Generators depreciates with time. Thus more O & M Cost is involved
Economic Viability	It involves similar less Capital cost and yields slightly greater revenue	Capital cost is slightly higher, with similar revenue
Operational Risk	There is an inherent risk of an accident occurring during transportation and storage of the biogas in the pressure vessels either on the trucks or at the site of usage. That may happen with a road accident, or improper operation or any negligence. That may have some adverse impact on life and property over the long term. This will necessitate development and implementation of detailed risk management protocol by the Municipality	The entire system will be contained within the premises of the biogas plant and the electricity generated will be uploaded to the grid. Therefore there is no requirement of transportation of explosive gases on the public streets or storing gases in pressure vessels in public properties outside the site. Therefore, this alternative posses significantly less risk than the option of transportation of biogas as all risk is contained within the premises. Also, revenue collection is easier as revenue will be collected from a single source (Electric company)

Thus from the above table, generation and distribution of electricity is the safer alternative with an assured source of revenue. The daily operations is simple with minimum daily inputs.

Bio-gas to Electric Generating Unit for 15 MT MSW Process Capacity Plant

The bio-gas generated from the waste in the main-digester is stored in tank located at site. The gas transferred to storage tank by a blower/compressor unit pass thru' a Scrubber. The bio-gas produced is generally have 30 to 35% of Carbon-di-oxide & 5 to 6% of moisture and some Hydrogen Sulphide which requires to be eliminated. This Scrubber works on elimination of these components. So a dry & pure bio-gas is transferred to the storage tanks.
This stored dry & pure bio-gas then drawn by a blower to pass thru' a de-humidifier cum chiller unit compatible to the process for conversion to electricity in the generator unit. Generally, 80 kWh power is generated from each MT of MSW processed. For 100 MT MSW process plant, 4 x 250 KVA generating unit is required to be installed to take care of the energy produced.

The schematic below shows the process flow for conversion of bio-gas to electrical energy :



The Digesters, Blower/Compressors for transfer gas to storage tank & the storage tank is a part of main process plant. To convert the output usage to generate electricity, The Scrubber unit, The Blower, The Chiller and the Generator units are to be added in the plant system and are to be integrated in-line with the schematic shown above.

Brief Specification:

A. Generator Unit:

Capacity	: 125 kVA, 3-phase
Fuel	: Bio-Gas
Engine Type	: 4 stroke, self-start, 1500/3000 RPM, SI engine
Power Factor	: 0.8
Engine Make	: Ashok Leyland / Equivalent
Alternator	: 125 kVA, Three/single phase, 415/230 Volts
Protection	: IP23
Sound Pressure Level	: 90 dB(A)
Cooling System	: Water Cooled

B. Scrubber cum Dehumidifier unit:

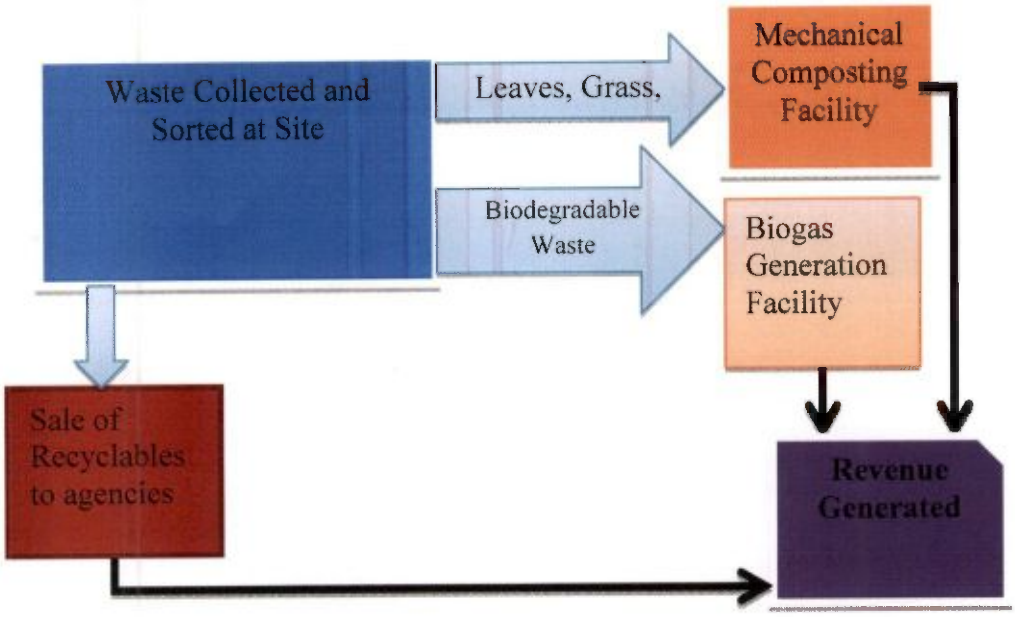
Capacity	: 65 m^3/hr
Pressure	: 50 – 100 mBar
Temperature	: Ambient
Gas-impurities to remove	: CO_2/CO, H_2S, SO_2, H_2O etc.
Scrubber type	: Chemical
Dehumidifier type	: Regenerative type bio-gas dehumidifier

C. Blower Unit:

Capacity	: 337 m3/hr , 4.98 psig
Type	: twin-lobe
Motor rating	: 7.5 HP

Conclusion

The proposal intends to offer an integrated solution for Solid waste management for the Arambagh Municipal Area. The suggested alternative will create a regular sustainable solution in concern with "Zero Discharge" of waste along with generating electricity or Biogas, thereby generating revenue on a regular basis.



Two revenue streams have been discussed; one with electricity and the other with biogas as the end product. The revenue with the biogas option is substantially better than the electricity. However, the ease of portability and readily available customers make the electricity alternative an easier alternative.

The organic waste being generated (approximately 1.5 tons per day) also can be sold to the plantations and other entities interested in organic farming. So, once started, the project will certainly generate additional revenue from the fertilizer sales.

The overall cost for setting up the system including the initial capital cost for the at source sorting operation is Rs. 532.35 Lakh and total project cost estimated to the tune of Rs. 933.69 Lakh and the City will gain revenue from the electricity sales, Organic fertilizers and some from the collection process.

Basic Ward wise Information : ARAMBAGH MUNICIPALITY

Table - 10

Ward No.	Area (sq. km.)	No.of Holdings	Population (2011)	Daily & Wholesale Market		Commercial centres		Hotels		Hospitals		Domestic Waste Collection System Followed	Market/ Commercial Waste Collection System Followed	Distance from the Dumping Ground (in Km.)
				No.	Appr. Quantity of Waste Generated (in mt)	No.	Appr. Quantity of Waste Generated (in mt)	No.	Total No.of Beds	No.	Total No.of Beds			
1	3.41	660	3461									Community Bin Collection	Vat Collection	3
2	1.47	1774	6974	1	0.34			3	20					4
3	0.37	972	4656	2	1.23			3	22					4
4	0.43	701	2633	2	0.65									3
5	0.66	694	3124	2	1.10									3
6	0.71	800	4283	2	1.17	2	1	3	21					3
7	1.85	478	3005					12	80					5
8	1.35	396	2573											5
9	3.76	626	3400											5
10	3.38	576	3430											5
11	4.78	397	2507											6
12	1.62	405	2322											2
13	1.17	1105	3654	1	0.11			8	62					4
14	0.58	710	2974	1	0.88			3	15	1	250			4
15	2.63	714	4979											3
16	2.96	625	4065											5
17	0.8	414	2513											5
18	2.26	345	1858											2
19	0.57	1155	3764	1	0.52									4
Total	**23.28**	**13547**	**66175**	**12**	**6.00**	**2**	**1.00**	**32**	**220**	**1**	**250**			**4**

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ARAMBAGH MUNICIPALITY

Table - 11

Ward Wise Population as per 2011 Census

Wardwise Population	Population
1	3461
2	6974
3	4656
4	2633
5	3124
6	4283
7	3005
8	2573
9	3400
10	3430
11	2507
12	2322
13	3654
14	2974
15	4979
16	4065
17	2513
18	1858
19	3764
Total	**66175**

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Table - 12

Zonewise Distribution of Population as per Census Year - 2011				
Wards No.	Population	Distributed population in		
		Zone - A	Zone - B	Zone - C
1	3461	3461	0	0
2	6974	6974	0	0
3	4656	4656	0	0
4	2633	2633	0	0
5	3124	3124	0	0
6	4283	4283	0	0
7	3005	0	3005	0
8	2573	0	2573	0
9	3400	0	3400	0
10	3430	0	3430	0
11	2507	0	2507	0
12	2322	0	0	2322
13	3654	3654	0	0
14	2974	2974	0	0
15	4979	0	4979	0
16	4065	0	4065	0
17	2513	0	2513	0
18	1858	0	0	1858
19	3764	0	3764	0
Total	**66175**	**31759**	**30236**	**4180**

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ARAMBAGH MUNICIPALITY

Table - 13

Zonewise Population as per Census Year - 2011		
Zone No.	Ward Nos.	2011
A	1, 2, 3, 4, 5, 6, 13, 14	31759
B	7, 8, 9, 10, 11, 15,16,17,19	30236
C	12, 18	4180
Total		**66175**

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Table - 14

Growth Trend

Growth trend of the town has been computed in three different methods which are given in the following below.

A. Arithmatic Increase Method

Sl. No.	Year	Population	Increase in Population
	(1)	(2)	(3)
1	1981	34205	
			11006
2	1991	45211	
			10929
3	2001	56140	
			10035
4	2011	66175	
	Total	201731	31970
Average per decade		**X = 50432.75**	**x_1 = 10657**

Therefore, average rate of increase per decade

x = 21.13 %

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ARAMBAGH MUNICIPALITY

Table - 15

B. Geometric Increase Method

Sl. No.	Year	Population	Increase in Population	Percentage increase in population i.e. growth rate (r)
	(1)	(2)	(3)	(4) = Col. (3)/ Col. (1) x 100
1	1981	34205	11006	11006/ 34205 x 100 = 32.18 %
2	1991	45211	10929	10929/ 45211 x 100 = 24.17 %
3	2001	56140	10035	10035/ 56140 x 100 = 17.87 %
4	2011	66175		

The geometric mean of the growth rate per decade (r) = $(n-1)^{th}$ root of the multiplication of all 'r's

= (32.18 x 24.17 x 17.87) ^ 1/3

= **24.04 %**

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Table - 16

C. Incremental Increase Method

Sl. No.	Year	Population	Increase in Population in each decade	Incremental Increase i.e. increment on the increase
	(1)	(2)	(3)	(4)
1	1981	34205		
			11006	
2	1991	45211		-77
			10929	
3	2001	56140		-894
			10035	
4	2011	66175		
	Total =		31970	-971

Average increase per decade (x_1) = 10657

and average of incremental increases (x_2) = -485.5

Therefore, average rate of increase per decade,

x = 16.10 %

and average rate of incremental increase per decade,

y = -0.73 %

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Table - 17

Computation of Design Population in different zones for different Design Years

Methods	Zone - A			Zone - B			Zone - C		
	Base Year	Intermediate Year	Final Year	Base Year	Intermediate Year	Final Year	Base Year	Intermediate Year	Final Year
	2019	2029	2039	2019	2029	2039	2019	2029	2039
Arithmetic Increase Method	34444	44510	54576	32792	42375	51959	4534	5859	7183
Geometric Mean Method	34618	47823	66066	32958	45530	62898	4557	6295	8696
Incremental Increase Method	33740	40833	47402	32122	38875	45128	4441	5375	6239
Average of the three Methods	**34268**	**44389**	**56015**	**32624**	**42260**	**53329**	**4511**	**5843**	**7373**

Total Design Population of the Town:

Base Year	71403
Intermediate Year	92492
Final Year	116717

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ARAMBAGH MUNICIPALITY

Table - 18

Computation of n values for different design years

Last known year	Future Year		Difference in years	Difference in decades (n)
(1)	(2)	(3)	(4)	(5) = Col. (4)/ 10
2011	Base year	2019	4	0.4
2011	Intermediate year	2029	19	1.9
2011	Final year	2039	34	3.4

Computation of zonewise Projected Population in different design years

Population in last known census year (P_0) (2011)			Arithmetic Increase Method				Geometric Mean Method				Incremental Increase Method			
			x(%)	$P_n = P_0(1+\frac{n.x}{100})$			r(%)	$P_n = P_0(1+\frac{r}{100})^n$			x(%)	$P_n = P_0\{1+\frac{nx}{100}+n(n+1).\frac{y}{100x2}\}$		
Zone No.	Year	P_0 (2011)		Base Year	Intermediate Year	Final Year		Base Year	Intermediate Year	Final Year		Base Year	Intermediate Year	Final Year
				2019	2029	2039		2019	2029	2039		2019	2029	2039
A	2011	31759	21.13	34444	44510	54576	24.04	34618	47823	66066	16.10	33740	40833	47402
B		30236		32792	42375	51959		32958	45530	62898		32122	38875	45128
C		4180		4534	5859	7183		4557	6295	8696	y(%) -0.73	4441	5375	6239
Total		66175		37326	48234	59142		37515	51825	71594		36563	44250	51367

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ARAMBAGH MUNICIPALITY

Table - 19

Projected waste generation				
Year		Projected Population	Projected waste generation as per Manual in MT	Projected waste generation considering present rate of the town in MT i.e. @0.43 kg/C/D
1		2	3	4
Base Year	2019	71403	15	31
Intermediate Year	2029	92492	19	40
Final Year	2039	116717	25	50

Conclusions:

1. As there are huge gap between manual provision and actual data collected from ULB(s) with respect to total generation of waste, the basic design is proposed considering present estimated genaration i.e.28 MT/Day except provision for sanitery land fill.

2. As the Bio gas plants are designed in modular manner hence another one or more module can be added as & when required. Provision of land for future expansion is earmarked.

3. Land for sanitery land fill is to be calculated on the basis of Final year generation of column 4 i.e. 30% of 50MT

Table 3.1 Quantity of Municipal Solid Waste in Indian Urban Centres

Population Range (in Millions)	Number of Urban Centres (sampled)	Total population (in Million)	Average per capita value (kg/capita/day)	quantity (tonnes/day)
< 0.1	328	68.3	0.21	14343.00
0.1 - 0.5	255	56.914	0.21	11952.00
0.5 - 2.0	31	21.729	0.25	5432.00
1.0 - 2.0	14	17.184	0.27	4640.00
2.0 - 5.0	6	20.597	0.35	7209.00
> 5. 0	3	26.306	0.50*	13153.00

* 0.6 kg/capita/day generation of MSW has been observed in metro cities

Source: Manual on MSW Management 2000

Domestic Waste : ARAMBAGH MUNICIPALITY

Table - 20

Ward No.	Distance from the Dumping site (in KM.)	No. of Holdings	Population	Domestic Waste generate (in Kg.)	No. of Container (20 lit.) required	No. of Tyre-Mounted Wheel Barrow Required	Remarks
1	3	660	3461	952	66	13	In areas where house to house collection by wheel barrow will not be possible, combination of collection in community bin system and house to house collection by Wheel Barrow shall have to be adopted. Capacity of Community Bins - 200 lit.
2	4	1774	6974	1918	177	35	
3	4	972	4656	1280	97	19	
4	3	701	2633	724	70	14	
5	3	694	3124	859	69	14	
6	3	800	4283	1178	80	16	
7	5	478	3005	826	48	10	
8	5	396	2573	708	40	8	
9	5	626	3400	935	63	13	
10	5	576	3430	943	58	12	
11	6	397	2507	689	40	8	
12	2	405	2322	639	41	8	
13	4	1105	3654	1005	111	22	
14	4	710	2974	818	71	14	
15	3	714	4979	1369	71	14	
16	5	625	4065	1118	63	13	
17	5	414	2513	691	41	8	
18	2	345	1858	511	35	7	
19	4	1155	3764	1035	116	23	
TOTAL		**13547**	**66175**	**18198**	**1357**	**271**	

1 wheel barrow will covered about 50 to 75 holdings

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Trade Waste : ARAMBAGH MUNICIPALITY

Table -21

Ward No.	Area (sq. km.)	No.of Holdings	Population	Daily & Wholesale Market		Commercial centres		Hotels			Total Quantity of Waste Generated (MT)	Distance from the Dumping Ground (in Km.)
				No.	Appr. Quantity of Waste Generated (MT)	No.	Appr. Quantity of Waste Generated (MT)	No.	Total No. of Beds	Total . Quantity of Waste Generated (MT)		
1	3.41	660	3461	0	0	0	0	0	0	0	0.00	3
2	1.47	1774	6974	1	0.34	0	0	3	20	0.015	0.36	4
3	0.37	972	4656	2	1.23	0	0	3	22	0.0165	1.25	4
4	0.43	701	2633	2	0.65	0	0	0	0	0	0.65	3
5	0.66	694	3124	2	1.1	0	0	0	0	0	1.10	3
6	0.71	800	4283	2	1.17	2	1	3	21	0.01575	2.19	3
7	1.85	478	3005	0	0	0	0	12	80	0.06	0.06	5
8	1.35	396	2573	0	0	0	0	0	0	0	0.00	5
9	3.76	626	3400	0	0	0	0	0	0	0	0.00	5
10	3.38	576	3430	0	0	0	0	0	0	0	0.00	5
11	4.78	397	2507	0	0	0	0	0	0	0	0.00	6
12	1.62	405	2322	0	0	0	0	0	0	0	0.00	2
13	1.165	1105	3654	1	0.11	0	0	8	62	0.0465	0.16	4
14	0.58	710	2974	1	0.88	0	0	3	15	0.01125	0.89	4
15	2.63	714	4979	0	0	0	0	0	0	0	0.00	3
16	2.96	625	4065	0	0	0	0	0	0	0	0.00	5
17	0.8	414	2513	0	0	0	0	0	0	0	0.00	5
18	2.26	345	1858	0	0	0	0	0	0	0	0.00	2
19	0.565	1155	3764	1	0.52	0	0	0	0	0	0.52	4
TOTAL	**23.28**	**13547**	**66175**	**12**	**6.0**	**2**	**1.0**	**32**	**220**	**0.165**	**7.165**	

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Clinical Waste : ARAMBAGH MUNICIPALITY

Table - 22

Ward No.	Area (sq. km.)	No.of Holdings	Population	Hospitals		Total Quantity of Clinic Waste Generated Daily (MT)	Total Quantity of infectious & hazardous Waste Generated Daily (MT)	Total Quantity of non-hazardous Waste Generated Daily (MT)	Total Quantity of hazardous & infectious Clinic Waste Generated in three days (MT)	Distance from the Dumping Ground (in Km.)
				No.	Total No. of Beds					
1	3.41	660	3461	0	0	0.00	0.00	0.00	0.00	3
2	1.47	1774	6974	0	0	0.00	0.00	0.00	0.00	4
3	0.37	972	4656	0	0	0.00	0.00	0.00	0.00	4
4	0.43	701	2633	0	0	0.00	0.00	0.00	0.00	3
5	0.66	694	3124	0	0	0.00	0.00	0.00	0.00	3
6	0.71	800	4283	0	0	0.00	0.00	0.00	0.00	3
7	1.85	478	3005	0	0	0.00	0.00	0.00	0.00	5
8	1.35	396	2573	0	0	0.00	0.00	0.00	0.00	5
9	3.76	626	3400	0	0	0.00	0.00	0.00	0.00	5
10	3.38	576	3430	0	0	0.00	0.00	0.00	0.00	5
11	4.78	397	2507	0	0	0.00	0.00	0.00	0.00	6
12	1.62	405	2322	0	0	0.00	0.00	0.00	0.00	2
13	1.165	1105	3654	0	0	0.00	0.00	0.00	0.00	4
14	0.58	710	2974	1	250	0.38	0.09	0.28	0.28	4
15	2.63	714	4979	0	0	0.00	0.00	0.00	0.00	3
16	2.96	625	4065	0	0	0.00	0.00	0.00	0.00	5
17	0.8	414	2513	0	0	0.00	0.00	0.00	0.00	5
18	2.26	345	1858	0	0	0.00	0.00	0.00	0.00	2
19	0.565	1155	3764	0	0	0.00	0.00	0.00	0.00	4
TOTAL	**23.28**	**13547**	**66175**	**1**	**250**	**0.38**	**0.09**	**0.28**	**0.28**	

There are 15 Nos. Private Clinic, 55 nos. Pathological Laboratories. Total quantity of waste generated from those establishment will be about 100 kg.

Note: i) Assumed that Clinical Waste generated @ 1500 gm per bed. ii) 25 % of the Clinical Waste generated is infectious in nature

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ARAMBAGH MUNICIPALITY

Estimation of Total Waste Generation Per Day in the Town

Table - 23

Category	Generation Points	Total (in kg.)	Quantity of Waste (in Kg.) Waste Type		Remarks
			Bio-degradable	Non-degradable	
A	Domestic	18198	10919	7279	To be transported to Bio Gas / Compost plant site except the non-degradable portion of domestic and hotel waste
	Daily & Wholesale Market	6000	4800	1200	
	Hotels	165	66	99	
	Agricultural/ Garden	500	500	0	
	Sub-total	24863	16285	8578	
B	Commercial Centres	1000		1000	To be transported to land fill Site
	Railway Station	500		500	
	Bus Stand	100		100	
	Sub-total	1600		1600	
C	Street Sweepings	500		500	do
	Drain Cleanings	300		300	
	Sub-total	800		800	
D	Cess pool	600	600		To be transported to trenching site
E	Clinical	375		375	To be transported to secured burial site
	Total	28238	16885	11353	

Note:

i) Domestic SW contains about 60% organic matter and remaining 40% is inert materials
ii) Moisture content in organic waste is about 50%
iii) Hotels generate SW @750gm/bed and contains about 50% organic matter and remaining 50% is inert materials
iv) Market SW contains about 80% bio degradable matter and remaining 20% is inert materials
iv) Assumed that trade waste contains about 10% bio degradable matter and remaining 90% is inert materials
v) Assumed that Agricultural waste contains about 100% bio degradable matter neglecting the very few inert materials
vi) In hospital waste
a) Infectious & hazardous waste is 0.094 MT
b) Non-hazardous waste is 0.281 MT

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ARAMBAGH MUNICIPALITY
REQUIREMENT OF TRANSFER STATIONS AND VEHICLES

Table - 24

Zone No	Ward Nos	Distance from the Dumping site in KM.	No. of Holdings	Population	Domestic Waste generate in MT	Daily & Wholesale Market		Commercial Centres		Hotel			Total quantity of waste (MT)	Type of Transfer Station to be Deployed		No. of House to House Collection Bucket	Type of Prime Mover to be Deployed								
						No.	SW Quantity (MT)	No.	SW Quantity (MT)	No.	No, of bed	SW Quantity (MT)		LB	CB		HLDC	HLD	TR	RT	HDT	TCV	BOT	WB	ComM
A	1	3	660	3461	0.95	0	0.0	0	0.0	0	0	0	0.95	5	7	1320									
	2	4	1774	6974	1.92	1	0.3	0	0.0	3	20	0.02	2.27	13	20	3548									
	3	4	972	4656	1.28	2	1.2	0	0.0	3	22	0.02	2.53	7	11	1944									
	4	3	701	2633	0.72	2	0.7	0	0.0	0	0	0.00	1.37	5	8	1402									
	5	3	694	3124	0.86	2	1.1	0	0.0	0	0	0.00	1.96	5	8	1388									
	6	3	800	4283	1.18	2	1.2	2	1.0	3	21.0	0.02	4.40	6	9	1600									
	13	4	1105	3654	1.00	1	0	0	0	8	62	0	1.11	8	12	2210									
	14	4	710	2974	0.82	1	1	0	0	3	15	1	2.70	5	8	1420									
Sub Total	**Avg.**	**3.5**	**7416**	**31759**	**8.73**	**11**	**5.48**	**2**	**1**	**20**	**140**	**1.05**	**17.29248**	**54**	**83**	**14832**	4		3	4	1	20	9	50	1
B	7	5	478	3005	0.83	0	0.0	0	0.0	12	80.0	0.06	0.84	4	5	956									
	8	5	396	2573	0.71	0	0.0	0	0.0	0	0.0	0.00	0.72	3	4	792									
	9	5	626	3400	0.94	0	0.0	0	0.0	0	0	0.00	0.94	5	7	1252									
	10	5	576	3430	0.94	0	0.0	0	0.0	0	0	0.00	0.94	4	6	1152									
	11	6	397	2507	0.69	0	0.0	0	0.0	0	0	0.00	0.69	3	4	794									
	15	3	714	4979	1.37	0	0	0	0	0	0	0	1.37	5	8	1428									
	16	5	625	4065	1.12	0	0	0	0	0	0	0	1.12	5	7	1250									
	17	5.0	414	2513	0.69	0	0.0	0	0.0	0	0	0.00	0.69	3	5	828									
	19	4.0	1155	3764	1.04	1	0.5	0	0.0	0	0	0.00	1.56	9	13	2310									
Sub Total	**Avg.**	**4.8**	**5381**	**30236**	**8.3149**	**1**	**0.52**	**0**	**0**	**12**	**80**	**0.06**	**8.8664**	**41**	**59**	**10762**	5	1	3	4	1	25	9	15	
C	12	2	405	2322	0.64	0	0.0	0	0.0	0	0	0.00	0.64	3	4	810									
	18	2.0	345	1858	0.51	0	0.0	0	0.0	0	0	0.00	0.51	3	4	690									
Sub Total	**Avg.**	**2.0**	**750**	**4180**	**1.1495**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.1495**	**6**	**8**	**1500**	1	0	1	1	0	5	2	0	
TOTAL	**Avg.**	**3.9**	**13547**	**66175**	**18.198**	**12**	**6**	**2**	**1**	**32**	**220**	**1.107**	**27.308**	**101**	**150**	**27094**	10	1	7	9	2	50	20	65	1

Abbreviations :

LB :	Litter Bins (about 20 to 40 lit capacity)	TS :	Transfer Station
HLDC :	Hook Lift Dumper Container (5 - 7.5 Cum. capacity)	ComM	Compactor(Mobile)
HLD :	Hook Lift Dumper Carrier (Hydraulic)	SLSJM:	Sewer Line suction cum Jetting Machine
HDT :	Hydraulic Dumper Truck	RSM :	Road Sweeping Machine
CB :	Community Bins (200 lits.)	TR:	Tractor
WB:	Wheel Barrow	RT:	Covered Refused Trailer with Hydraulic system
TCV :	Try Cycle Van	BOT:	Battary operated trailer

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Note:

I) SLSJM - 1 no., RSM - 1 no. HDT or ordinary truck - 2 nos, 1 tractor & 2 trailer are to be kept and maintained by Central Office and shall be deployed as per the requirement to various Zones to cater unscheduled generation of waste such as waste from festival houses / fairs, garden waste, construction debri etc.

II) Construction Debri is to be carried by hydraulic dumper truck or by ordinary truck as per user charge basis.

III) Hook Lift Dumper Containers (HLDC) may be kept near all market places and that will be lifted by Hook Lift Dumper Carrier (HLD) for transporation to dumping ground.

IV) Wheel Barrow will collect the domestic waste from door to door and also the waste from litter bins and transfer the same to the community bins or hydraulic dumper containers kept at suitable points.

V) There must be 2 community bins at a place; 1 green for bio-degradable waste and 1 yellow for non-degradable waste.

VI) Hook Lift Dumper Carrier (Hydraulic) will go on lifting the waste from the community bins kept at specified places and also the waste from the hotels stored in the containers and transport the same to dumping ground. In areas where quantity of waste is less the waste can be lifted on alternate days.

VII) Provide atleast one 200 ltrs. Bins at each commercial centres.

VIII) Every hotel should keep 1 green container and 1 yellow container for storing their degradable & non-degradable waste respectively which should be collected daily by municipality. No road side vat should be allowed for dumping the hotel waste.

TYPES OF VEHICLES TO BE USED FOR COLLECTION AND TRANSPORTATION OF MUNICIPAL SOLID WASTE AT ARAMBAGH MUNICIPALITY

1. House to House Collection

2. **Hand Cart / Wheel Barrow**

3. **Transfer of SW after Collection through Wheel Barrow**

4. **Litter Bins (LB)**

5. **CGB: Community Garbage Bins (1000 ltr.; Steel bins with swivel castor wheels automatic lifting arrangement**

6. Cess- Pool Emptier

7. Hydraulic Dumper Container
(HDC)

8. Hook Lift / Hydraulic Dumper Carrier / Skip
(HLD)

9 Tractor & Cover Refused Trailer
with Hydraulic system
(TR & RT)

10. Hydraulic Dumper Truck
(HDT)

11. Road Sweeping Machine
(RSM)

12. Sewer Line Suction cum Jetting Machine
(SLSJM)

ARAMBAGH MUNICIPALITY

ABSTRACT COST ESTIMATE

Table - 25

Sl. No.	Particulars	Amount
		(Rs. in lakh)
1	Plant, Machinery, Equipments for Collection, Transportations and Disposal	290.12
2	Development of Land Fill Site	84.02
3	Construction of Bio-gas Plant including Generators etc.	532.35
	Total	**906.49**
	Contingencies @ 3%	27.19
	Grand Total	**933.69**

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REQUIREMENT OF VEHICLES AND ACCESSORIES

Table - 25A

Sl. No.	Particulars	Total Requirements	Remarks
1	Litter Bins (20 - 40 lit.)	101	
2	Hook Lift Dumper Container (HLDC 5 - 7.5 Cum. capacity)	10	
3	Hook Lift Dumper Carrier (Hydraulic)- HLD	1	
4	Community Bins (200 lit. capacity)	150	
5	House to House Collection Bucket	27094	
6	Tractor	7	
7	Covered Refuse Trailer with Hydraulic system	9	
8	Pay-Loader/Bull-dozer	1	
9	Hydraulic Dumper Truck - HDT / Ordinary Truck	2	
10	Cess Pool Emptier	1	
11	Wheel Barrow	65	
12	Battery operated tripper	20	
13	Compactor (mobile)	1	
14	Shovels	300	
15	Spade	300	
16	Gloves , Masks, Gomboot etc.		LS
Note:			

i) Assuming one Wheel Barrow will cover in an average 65 nos. holdings.

ii) House to house bucket shall be supplied to each family only once. Replacement of those bucket whenever required due to damage shall have to be arranged by the individual family.

iii) Community Bins should have necessary arrangement for tilting the same, either manualy or mechanically, for transfering waste directly to the transportation vehicles

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ADDITIONAL REQUIREMENT OF VEHICLES AND ACCESSORIES

Table - 25B

Sl. No.	Particulars	Total Requirement	Existing nos.	Additional Requirement	Rate (Rs.)	Amount (Rs.)	Remarks
			Total				
1	Litter Bins	101		101	1841	185920.8	
2	Hook Lift Dumper Container (HLDC 5 - 7.5 Cum. capacity)	10		10	106200	1062000	
3	Hook Lift Dumper Carrier (Hydraulic)-HLD	1		1	2918376	2918376	
4	Community Bins (200 lit. capacity)	150	34	116	11653	1351690	
5	House to House Collection Bucket	27094		27094	101	2749499.12	No road side open vat should be allowed.
6	Tractor	7	5	2	1003000	2006000	
7	Covered Refuse Trailer with Hydraulic system	9		9	177000	1593000	1 Cess-pool Emptire - suction pump mounted on tanker-trailers suitable for narrow lane is required to be provided
8	Pay-loader/Bull-dozer	1		1	5310000	5310000	
9	Hydraulic Dumper Truck - HDT / Ordinary Truck	2		2	236000	472000	
10	Cess Pool Emptier (Tanker-Trailer fitted with suction pump)	1	1	0	1239000	0	
11	Wheel Barrow	65	18	47	11623	546281	
12	Try cycle van (special type)	50	16	34	29500	1003000	
13	Battery operated tripper	20		20	224000	4480000	
14	Compactor (mobile)	1		1	5074000	5074000	
15	Shovels	200		200	448	89680	
16	Spade	200		200	354	70800	
17	Gloves , Masks, Gomboot etc.					100000	L.S.
					TOTAL	**29012247**	**lakh**
					Say Rs.	**290.12**	

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Cost of Development of LandFill Site

Table - 25C

SL. NO.	PARTICULARS	AMOUNT Rs. (in lakh)
1	Renovation of Approach Road to landfill site 500 mt. length width 3.5m. @ Rs. 1000 per m.	5.0
2	Site Development	5.0
3	Grass covering over existing dumped waste	36.5
4	Cost of providing linear (for 5 years dumping)	6.0
5	Construction of protection wall (CRM)	10.0
6	Construction of surface run-off diversion drain	8.0
7	Construction of leachate circulation & treatment system at Landfill site	10.0
8	Tree plantation	1.0
9	Construction of Site Office	2.5
	TOTAL	84.02

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Estimate for Grass Covering

Table - 25C(i)

Area: 1 acres
4046 sq m

Height 10 m

Item	Unit	Quantity	Rate	Amount (in Rs.)
Excavation	cu.m	0	181.45	0.00
Waste Backfill	cu.m	20230	59.49	1203482.70
Compacted clay	cu.m	1213.8	237.96	288835.85
Leachate collection I	m	100	298.00	685400.00
Grass tiles	sq.m	6069	203.43	1234616.67
Gas Extraction Vents	m	500	120.00	240000.00
Total				**3652335.22**

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ARAMBAGH MUNICIPALITY

Estimated Cost for Bio gas Plant

Table - 25D

Sl No.	Item	Cost (in Rs.)
1	Civil Cost	**10,923,955.54**
2	Sorting facility	**5,030,740.00**
3	Mechanical	**33,229,831.86**
4	Gas storage	**4,050,000.00**
	TOTAL (Rs.)	**53,234,527.40**

Total Tonnage of Bio- Degradable waste	**16.88** MT
Total Tonnage to be Processed	15.00 MT
Recommended layout:	3.00 Units @5 MT/Units
Total System tonnage	**15 MT**

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Table - 25E

ESTIMATE OF CIVIL WORK FOR FOUNDATION AND COLUMNS ,BEAMS; SLABS FOR PROP. BIOGAS LAYOUT

Sl. No	Description	Page Ref	Quantity	Unit	Rate (in Rs.)	Amount (in Rs.)
1	Earth work in excavation of foundation trenches or drains, in all sorts of soil (including mixed soil but excluding laterite or sandstone) including removing, spreading or stacking the spoils within a lead of 75 m. as directed. The item includes necessary trimming the sides of trenches, levelling, dressing and ramming the bottom, bailing out water as required complete. (a) Depth of excavation not exceeding 1,500 mm.	BUILDING WORKS 2015 P-1 It-2.a	645.00	m3	120.47	77,703
2	Earth work in filling in foundation trenches or plinth with good earth, in layers not exceeding 150 mm. including watering and ramming etc. layer by layer complete. (Payment to be made on the basis of measurement of finished quantity of work) (a) With earth obtained from excavation of foundation	BUILDING WORKS 2015 P-1 It-3.a	130.00	cu.m	78.31	10,180
3	Ordinary Cement concrete (mix 1:2:4) with graded stone chips (20 mm nominal size) excluding shuttering and reinforcement,if any, in ground floor as per relevant IS codes. a) Pakur Variety	BUILDING WORKS 2015 P-12 It-5.a	62.69	cu.m	6229.46	390,552
4	Ordinary Cement concrete (mix 1:1.5:3) with graded stone chips (20 mm nominal size) excluding shuttering and reinforcement if any, in ground floor as per relevant IS codes (i) Pakur Variety	BUILDING WORKS 2015 P-15 It-7.i	681.21	cu.m	6965.47	4,744,931
5	Hire and labour charges for shuttering with centering and necessary staging upto 4 m using approved stout props and thick hard wood planks of approved thickness with required bracing for concrete slabs, beams and columns, lintels curved or straight including fitting, fixing and striking out after completion of works (upto roof of ground floor) (c) Steel shuttering or 9 to 12 mm thick approved quality ply board shuttering in any concrete work	BUILDING WORKS 2015 P-27 It-12.c	3349.13	sq.m	403.00	1,349,700
6	125 mm. thick brick work with 1st class bricks in cement mortar (1:3) in ground floor.	BUILDING WORKS 2015 P-32 It-30	1400.24	sq.m	810.00	1,134,197
7	Reinforcement for reinforced concrete work in all sorts of structures including distribution bars, stirrups, binders etc initial straightening and removal of loose rust (if necessary), cutting to requisite length, hooking and bending to correct shape, placing in proper position and binding with 16 gauge black annealed wire at every intersection, complete as per drawing and direction. I. SAIL/ TATA/RINL	BUILDING WORKS 2015 P-28 It-15.a.i	36.41	MT	69,483.00	2,529,868
8	Plaster (to wall, floor, ceiling etc.) with sand and cement mortar including rounding off or chamfering corners as directed and raking out joints including throating, nosing and drip course, scaffolding/staging where necessary (Ground floor).[Excluding cost of chipping over concrete surface] (iii) With 1:3 cement mortar (b) 15 mm thick plaster	BUILDING WORKS 2015 P-164 It-2.iii.b	3155.44	sq.m	188.00	593,223
9	Neat cement punning about 1.5mm thick in wall,dado,window sill,floor etc. NOTE:Cement 0.152 cu.m per100 sq.m.	BUILDING WORKS 2015 P-166 It-8	2463.16	sq.m	38.00	93,600
Total						**10,923,956**

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RATE ANALYSIS OF CEMENT CONCRETE ITEMS

Railway Yards Tarakeswar

Type of Concrete Ordinary Cement concrete (mix 1:1.5:3)

Zone All district except hill area of Darjeeling

District Howrah/ Hoogly

Work Site : **Arambagh**

Distance from Tarakeswar Rly yard to Arambagh work site = 27.10 KM

Say, 27.00 KM

Sl No.	Description	Volume cum.	Rate	Amount
1	7(a) Ordinary Cement concrete (mix 1:1.5:3) Pakur Variety			5216.00
2	Rates of Pakur variety stone aggregates at Tarakeswar Railway yards [Table : T-1, p-1]			
	20 mm Nominal Size	0.573	1686.00	966.08
	10 mm Nominal Size	0.287	1519.00	435.95
3	Road carriage from Tarakeswar RLY yeard to work site = 27 KM			
	Carriage upto 5 Km. = Rs. 124.00			
	From 5 to 10 Km. @ 10.90Km. = Rs. 54.50			
	From 10 to 20 Km. @ 10.10Km. = Rs. 101.00			
	From 20 to 27 Km. @ 9.50Km. = Rs. 66.50			
	Total Carriage Cost **Rs. 346.00**	0.86	346.00	297.56
4	Loading & Unloading *[TABLE :T-3]*	0.86	58.00	49.88
	Total Cost at Site per Cum.			**6965.47**

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RATE ANALYSIS OF CEMENT CONCRETE ITEMS

Railway Yards Tarakeswar

Type of Concrete Ordinary Cement concrete (mix 1:2:4)

Zone All district except hill area of Darjeeling

District Howrah/ Hoogly

Work Site : Arambagh

Distance from Tarakeswar Rly yard to Arambagh work site = 27.10 KM

Say, 27.00 KM

Sl No.	Description	Volume cum.	Rate	Amount
1	5(a) Ordinary Cement concrete (mix 1:2:4) Pakur Variety			4427.00
2	Rates of Pakur variety stone aggregates at Tarakeswar Railway yards [Table : T-1, p-1]			
	20 mm Nominal Size	0.660	1686.00	1112.76
	10 mm Nominal Size	0.220	1519.00	334.18
3	Road carriage from Tarakeswar RLY yeard to work site = 27 KM			
	Carriage upto 5 Km. = Rs. 124.00			
	From 5 to 10 Km. @ 10.90Km. = Rs. 54.50			
	From 10 to 20 Km. @ 10.10Km. = Rs. 101.00			
	From 20 to 27 Km. @ 9.50Km. = Rs. 66.50			
	Total Carriage Cost Rs. 346.00	0.88	346.00	304.48
4	Loading & Unloading *[TABLE :T-3]*	0.88	58.00	51.04
	Total Cost at Site per Cum.			**6229.46**

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ARAMBAGH MUNICIPALITY

Table - 25F

ESTIMATE FOR ELECTRO-MECHANICAL

Item	Specification	Qty	Rate (in Rs.)	Amount (in Rs.)
Blower	337 m3/hr , 4.98 psig, 7.5 hp	4	108376	433,504.00
Mixer	800 kg/hr, 10 hp	5	402960	2,014,800.00
Sludge Pump	50 m3/hr, 26 mtr head, 7.5 hp	4	52677	210,708.00
Solar Panel	650 litres, 7ft x 14 ft with 3 kw heater	3	168015	504,045.00
Compressor	23 CFM, 8.5 kg/cm2 , 5 hp	4	93628	374,512.00
Generator Set	125 KVA	2	2851200	5,702,400.00
Generator Auxileries (scrubbers, dehumidifiers etc.)	For electricity	2	2410320	4,820,640.00
Piping	AS PER REQ	LUMPSUM	6500000	6,500,000.00
Steel Tank	Per Kg	60116	135	8,115,594.86
nstallation for Fabrication (Scaffolding incl of Labour)			300000	300,000.00
Gas Burner	BIOGAS	4	8500	34,000.00
Gas Meter	BIOGAS	4	22655	90,620.00
pH Meter		4	8832	35,328.00
Electricals		LUMPSUM	2500000	2,500,000.00
Protective Coating	GLASS EPOXY COATING	LUMPSUM	600000	600,000.00
Transportation	of steel plates		300000	300,000.00
Shed for equipment building (sq.ft)	Steel structure	968	200	193,680.00
Small Incinerator		1	500000	500,000.00
			Total	**33,229,831.86**

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Weight of steel tanks

	Main Digester	Pre Digester 1		
A. Base Plate				
Dia (mtr)	8.5	5.5		
Thickness (mtr)	0.006	0.006		
Metal Volume (m3)	0.3	0.1		
Steel weight (kg)	**2,672.69**	**1,119.02**		
B.Shell Plate				
Dia (mtr)	8	5		
Height (mtr)	4.5	4.5		
Thickness (mtr)	0.005	0.005		
Metal Volume (m3)	0.6	0.4		
Steel weight (kg)	**4,439.07**	**2,774.42**		
C.Baffle Plate				
Av. Width (mtr)	5.33	5		
Height (mtr)	3.5	3.5		
Thickness (mtr)	0.005	0.005		
Numbers	3	1		
Metal Volume (m3)	0.3	0.1		
Steel weight (kg)	**2,198.00**	**686.88**		
.Roof Plate				
Dia (mtr)	8.5	5		
Thickness (mtr)	0.005	0.005		
Metal Volume (m3)	0.3	0.1		
Steel weight (kg)	**2,672.69**	**924.81**		
E.Dome shell				
Dia (mtr)	8.5			
Height (mtr)	0.8			
Thickness (mtr)	0.005			
Metal Volume (m3)	0.1			
Steel weight (kg)	**838.49**			
E.Stiffener wt. & other	1,059	654		
Total Steel wt	**13,879.60**	**6,158.90**		

Total Steel wt of one set of pre & main digester	**20,038.51**
No. of units	3

Total project weight of steel for pre & main digester tanks **60,115.52**

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ARAMBAGH MUNICIPALITY

MECHANICAL ITEMS

Table - 25F(i)

Sl No.	Item	Brief Spec	Basic rate per unit	P&F, Taxes & duties, Transportation and loading-unloading etc.	Total material cost to site	Cost of erection & commissioning	Contingency, adminisrative , Finance & margin	Total budget	Vendor
1	Blower	337 m3/hr , 4.98 psig, 7.5 hp	67000	19740	86740	7500	14136	108376	ROOTECH
2	Mixer	800 kg/hr, 10 hp	280000	60400	340400	10000	52560	402960	SMART
3	Sludge Pump	50 m3/hr, 26 mtr head, 7.5 hp	36700	8106	44806	1000	6871	52677	DEBSON
4	Solar Heater	650 litres, 7ft x 14 ft with 3 kw heater	120000	24100	144100	2000	21915	168015	INSILICA
5	Compressor	23 CFM, 8.5 kg/cm2 , 5 hp	66878	13038.04	79916.04	1500	12212	93628	ZENTECH
6	Generator Set	125 KVA	2000000	366000	2366000	10000	475200	2851200	URJA
7	Auxiliaries of generator system	Scrubber, Dehumidifier & blower	1840000	341200	2181200	10000	219120	2410320	URJA
8	Gas Meter		15000	4450	19450	250	2955	22655	ST Instruments
9	pH Meter		6000	1680	7680		1152	8832	ST Instruments

Conveyor system for sorting Platform area

10	Conveyor		2,160,000	398800	2558800	300,000.00	428820	3287620	DRB Engineering

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ARAMBAGH MUNICIPALITY

FACILITY OF GAS STORAGE & SORTING PLATFORM

Gas Storage facility			
Total Storage capacity			450 kg per day
Volume of gas to be stored:			13500 liters at 4 kg pf pressure
Cost of gas storage facility			300000 per 1000 liters
Total cost of gas storage facility			4050000

Sorting Platform			
Sorting platform structural & flooring	968.40	sq ft	1743120
Conveyor system with bucket elevator			3287620
		Total	5030740

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ARAMBAGH MUNICIPALITY

Table - 26

ESTIMATION OF LABOUR COST FOR HOUSE TO HOUSE COLLECTION

SL.NO.	HEAD	NOS.	RATE PER MONTH (Rs.)	AMOUNT (Rs.)
1	For House to House collector	60	4500	270000
2	Supervisor for House to House collection	3	6000	18000
TOTAL				**288000**

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