Fig 3.3: Adhunik DRI Plant at Durgapur - Angadpur Industrial Area

Durgapur during the last five years got more than 8 engineering and technology, management as well as professional study colleges (under graduate level).Housing co-operatives and flats, shopping malls, multiplex, science and energy park, Software Technology park (STPI), Hotels and stadiums have also come up. In 2007, a shopping mall by ADDA, named Suhatta is opened by Chief Minister Budhadeb Bhattacharya. He inaugurated 7 institutes that day including a Polytechnic college and Hotel GINGER. Currently Durgapur consists of 3 departmental stores and a multiplex.

During the years 2001-2007 Durgapur saw the setting up of 10 to 15 middle/ large scale industrial investment in iron and steel manufacturing sector including value added products like sponge iron, Wire Rod, TMT bar (Thermo Mechanical Treatment) for construction, Iron Casting powder etc. The prominent investors are MB Group, Balaji Group, SPS group, Adhunik Group of Industries, Neo Metaic, Stolberg India, Super Smelters Ltd, Shyam Steel, Ultratec Cement etc.

Some other important changes are Regional Engineering College being upgraded to National Institute of Technology - the first Deemed University in Durgapur, 'SRIJONI'- a public hall equipped with technically advanced systems (audio & video).

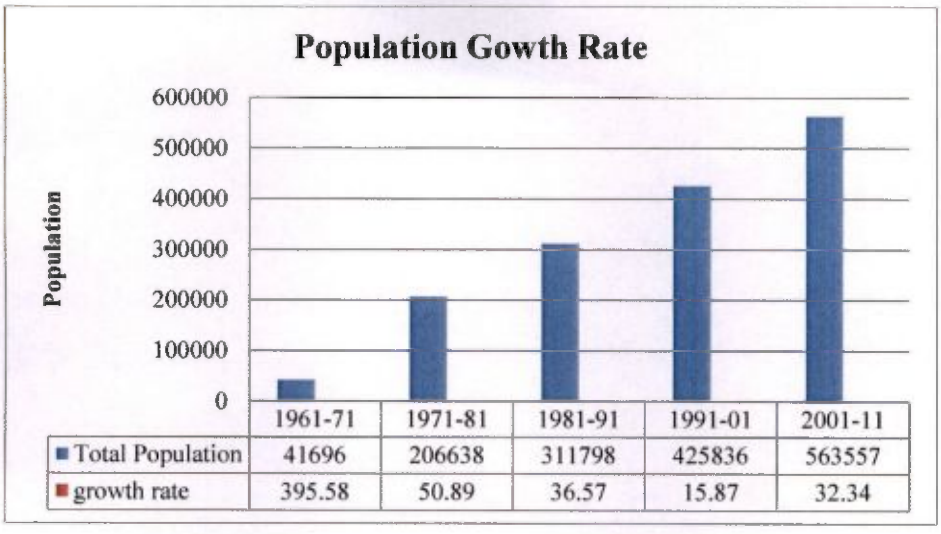
3.8 DEMOGRAPHIC GROWTH AND POPULATION PROJECTION

As of 2011 India census, Durgapur had a population of 5, 63,557. Males constitute 52% of the population and females 48%. Durgapur has an average literacy rate of 83%, higher than the national average of 59.5%: male literacy is 89% and, female literacy is 76%. In Durgapur, 10% of the population is under 6 years of age.

Table 3.2: Overall Population & Growth Rate

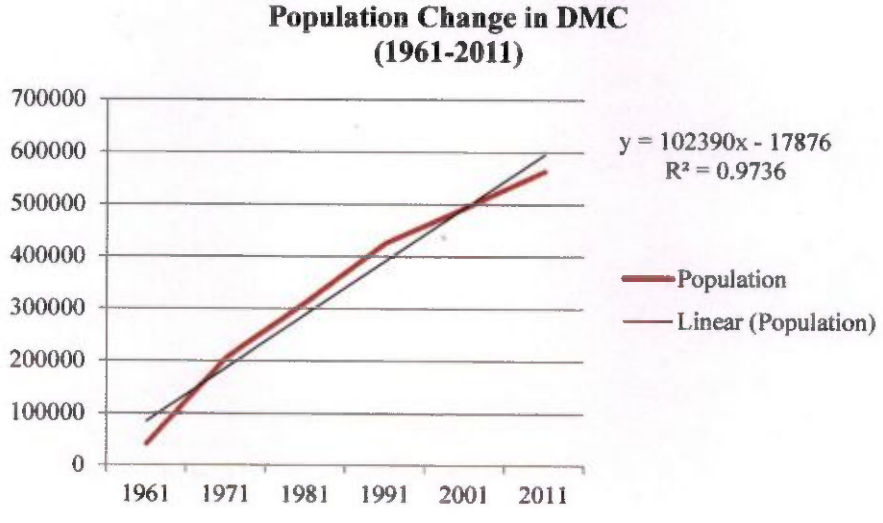
Year	Total Population (No.)	Growth Rate
1961	41696	---
1971	206638	395.58
1981	311798	50.89
1991	425836	36.57

2001	493405	15.87
2011	563557	32.34



Graph 3.1: Decadal Growth Rate of Population of Durgapur Municipal Corporation

The Decadal growth rate in Durgapur experience changes in consecutive decades since 1961-71 till 2001 to 2011. There was enormous increase in population from 1961 to 1971. Due to the industrial growth in the region there was a huge influx of population occurred. People from all over the country, particularly from the neighboring sate Jharkhand (then Bihar) and Bihar came to Durgapur for employment and job opportunities. SAIL created township for their employees. The population growth was optimized in 1991 to 2001 with 15.87% growth rate. Again in 2001 to 2011 the city faces a huge growth of population of 32.34%.



Graph 3.2: Graphical Representation of Population Change in Durgapur Municipal Corporation

As per consultation, it was decided that the method of projection that is more relevant to the population of 2011 (as per Census - 2011) should be adopted for projection. For this the population of Year 2001 was taken as base data and thereafter the population of year 2011 was projected using arithmetic progression, geometric progression and incremental increase method. Now after comparing the statistics of the projected population with the population as per Census 2011, it is observed that variation is minimum in the case of arithmetic progression and incremental increase method. But the result getting from geometrical progression method is very conflict with Census data of 2011. Therefore, the averages of arithmetic and incremental methods have been considered for population projection for 30 years.

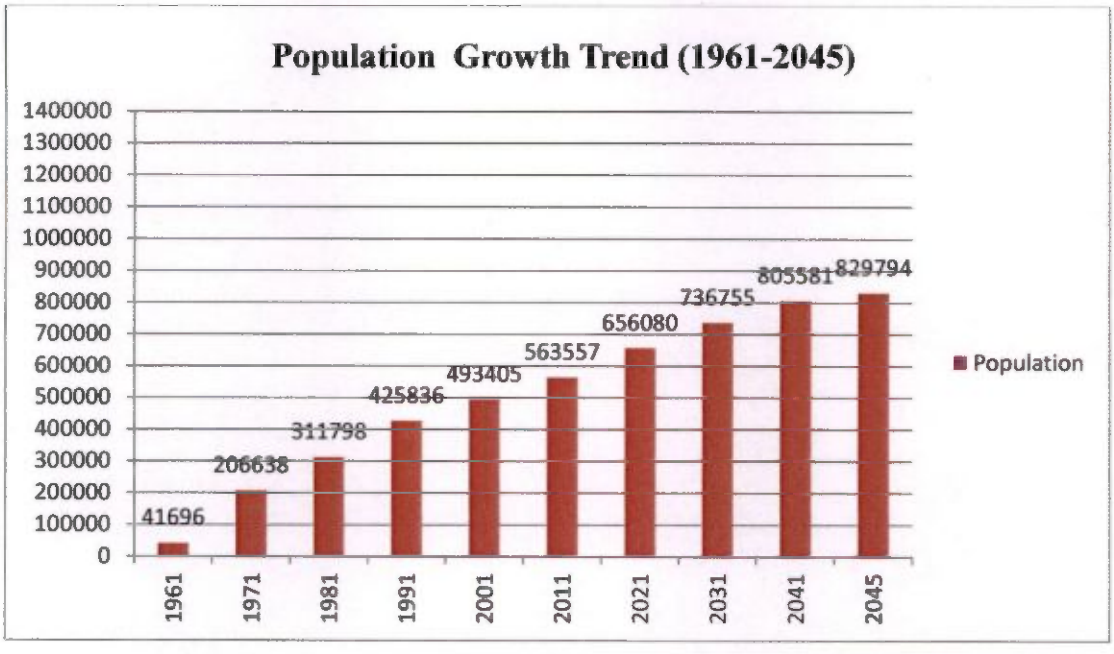
Table 3.1: Projected Population of Durgapur Municipal Corporation

Year	Arithmetic Increase	Incremental	Design population
2012	573994	572691	573343
2013	584431	581588	583010
2014	594869	590248	592558
2015	605306	598671	601988
2016	615743	606857	611300
2017	626180	614806	620493
2018	636618	622518	629568
2019	647055	629993	638524
2020	657492	637231	647361
2021	667929	644232	656080
2022	678366	650996	664681
2023	688804	657523	673163
2024	699241	663813	681527
2025	709678	669866	689772
2026	720115	675682	697899
2027	730553	681262	705907
2028	740990	686604	713797
2029	751427	691709	721568
2030	761864	696578	729221
2031	772301	701209	736755
2032	782739	705603	744171
2033	793176	709761	751468
2034	803613	713681	758647
2035	814050	717364	765707
2036	824488	720811	772649
2037	834925	724020	779473
2038	845362	726993	786177
2039	855799	729728	792764
2040	866236	732227	799232

2041	876674	734489	805581
2042	887111	736513	811812
2043	897548	738301	817924
2044	907985	739851	823918
2045	918422	741165	829794

The populations of Durgapur City have been plotted from the previous census available till 2011 and then the trend has been formulated to forecast the future projections. Based on the above, the total population of the DMC area is expected to reach to about 13.5 lacs by Year 2045.

The Durgapur Urban region has been experiencing a steady growth in population due to a mix of factor in including annexation, natural growth and migration. The major reason for migration is because of people from the other areas migrating to join the workers who have entered into the region. In fact, employment is the important (full) factor bringing about migration to this area, which accounted for an overwhelming majority of migrants.



Graph 3.3: Year Wise Population Trend

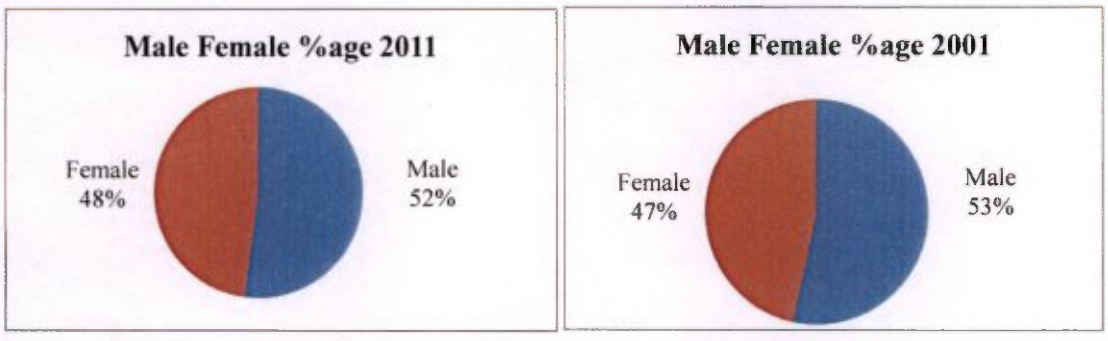
3.9 SEX RATIO AND AGE GROUP

If we look at the sex ratio of DMC area in 2001, against 1000 male the number of female population was 871. But in 2011 that figure increases to 919. Male female ratio in Durgapur municipal corporation area shows that as per 2001 census out of the total population of 493405 male populations constitutes 53% and female constitutes 47%. As per 2011 census total population increases to 563557 and out of that male constitutes 52% and female constitutes 47%.

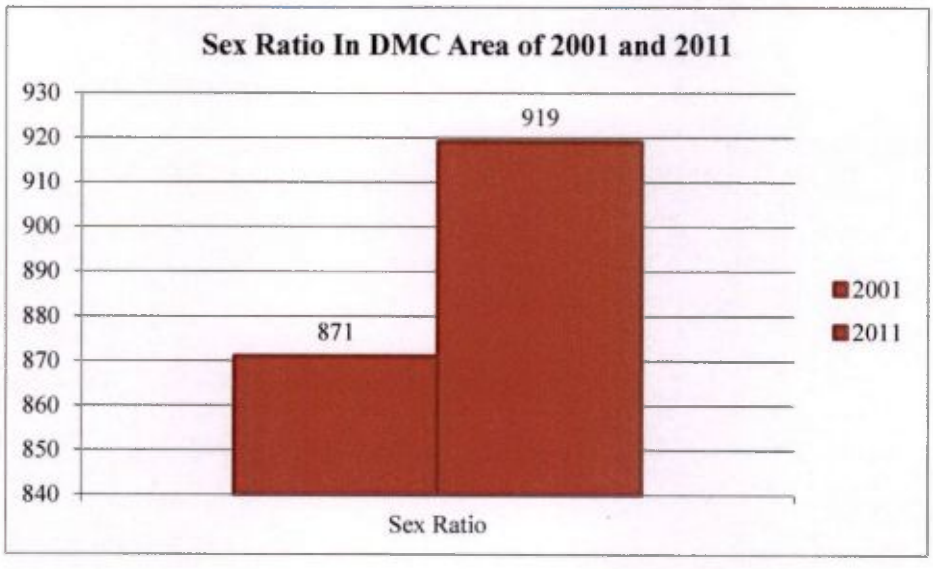
Table 3.4: Sex ratio of 2011 and 2001

Sex Ratio-919(2011)	
Male	Female
293731	**269826**
52%	**48%**

Sex Ratio- 871(2001)	
Male	Female
263721	**229684**
53%	**47%**

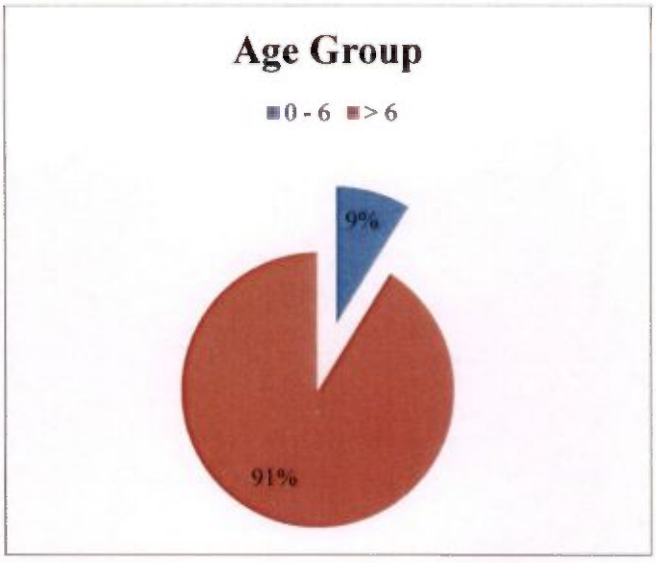


Graph 3.4: Male female Percentage



Graph 3.5: Sex Ratio of 2001 & 2011

In DMC area less than 10% of the total population is in the age group of 0-6.



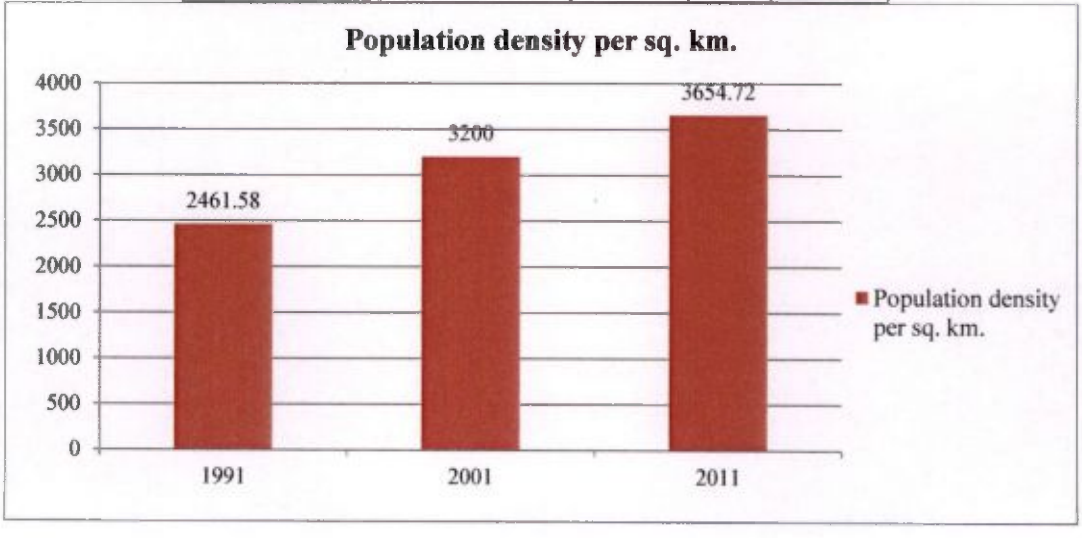
Graph 3.6: Age group percentage (0-6 Yrs)

3.10 POPULATION DENSITY

Durgapur has a very high population density 154.2 sq.km. area of Durgapur Municipal Corporation has accommodate 563557 persons as per 2011 census. Population density in DMC area has increased gradually. In 1991 population density was 2761.58 persons/sq. km. which increased to 3200 persons in 2001. In 2011 the figure is 3654.72.

Table 3.2: Population Density

Census Year	1991	2001	2011
Population density per sq. km.	2761.58	3200	3654.72



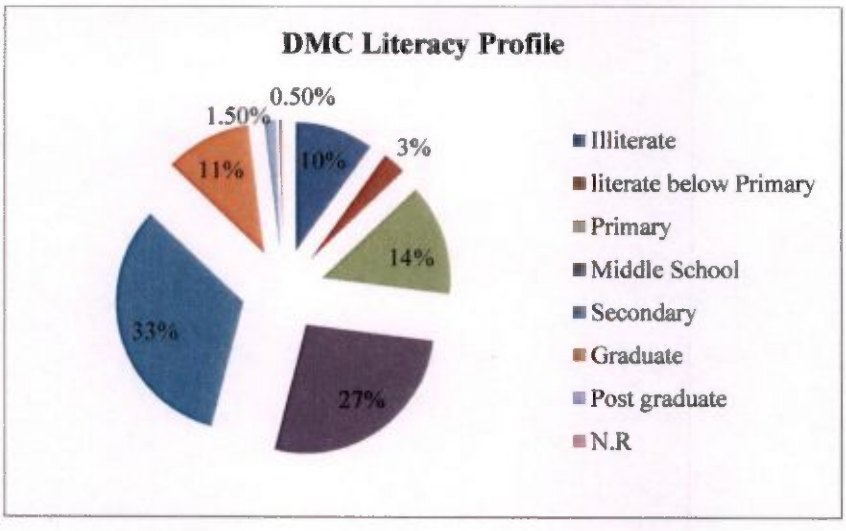
Graph 3.7: Population Density

3.11 LITERACY RATE

The current literacy rate (percentage of literate population to the total population above 7 years of age) in Durgapur Municipal Corporation is 79.9 per cent (male literacy rate of 80.81 per cent and female literacy rate of 68.78 per cent as per 2001 census) - Table below shows the percent of literacy in the city.

Table 3.3: Durgapur Literacy Profile

City	Illiterate	literate below Primary	Primary	Middle School	Secondary	Graduate	Post graduate	N.R.
DMC	10	3	14	27	33	11	1.5	0.5



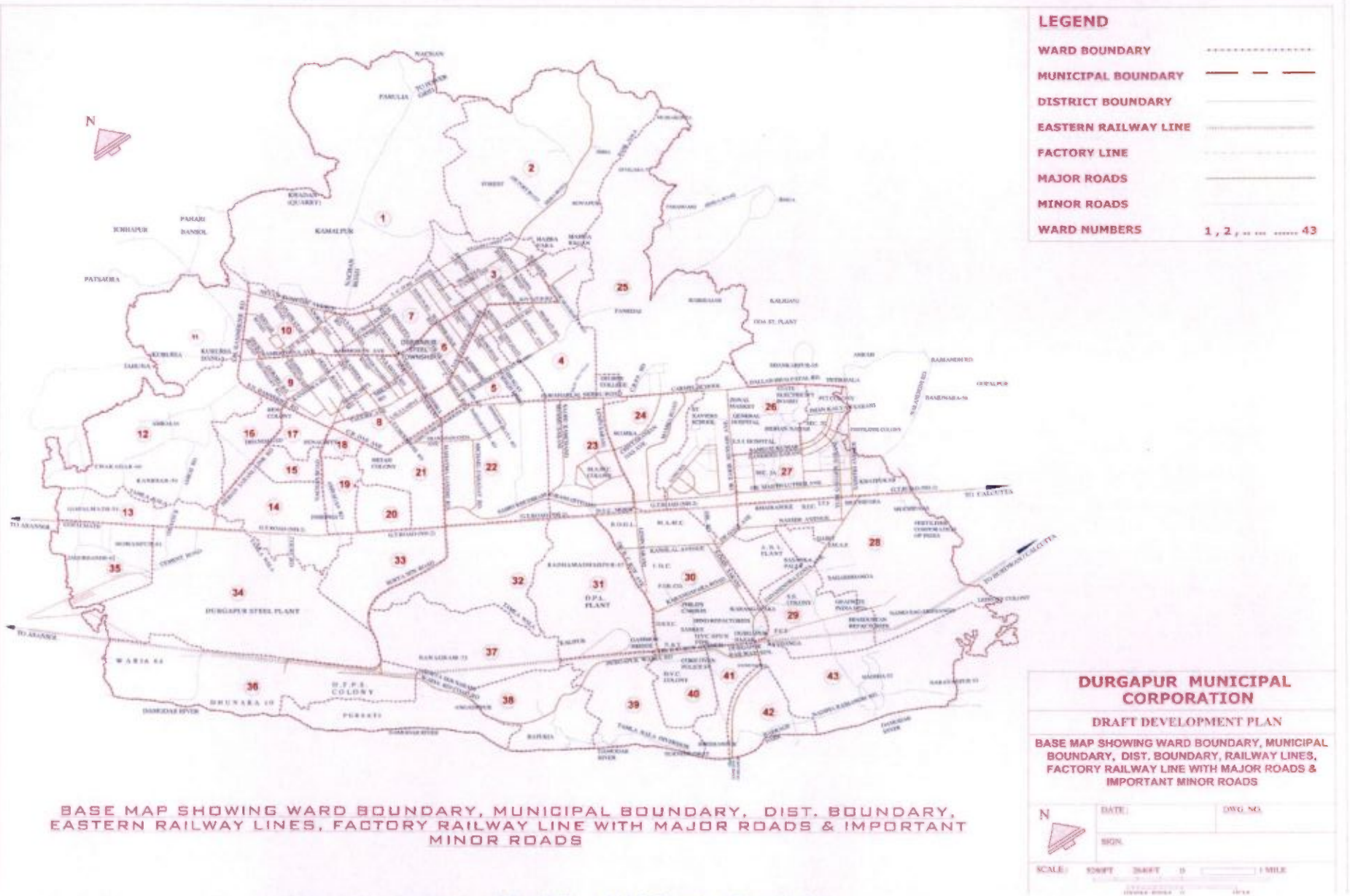
Graph 3.8: Durgapur Literacy Profile

Table 3.4: Ward Wise Demographic Scenario of Durgapur Municipal Corporation

Ward	Total Population				Sex Ratio	% of 0-6 Persons to Total Population	% of 0-6 male to total Male Population	% of 0-6 Female to total Female Population	Total Literacy Rate (7 years and above)	Male Literacy Rate (7 years and above)	Female Literacy Rate(7 years and above)	0-6 Age group population				No. of Literates (age 7+)			
	Persons	Males	Females	Others								Persons	Males	Females	Others	Persons	Males	Females	Others
1	2	3	4	5	6	7	8	9	10	11	12	12	12	14	15	15	17	18	19
1	19868	10188	9680	0	950	11.3	11.0	11.7	73.8	81.8	65.5	2251	1121	1130	0	13010	7413	5597	0
2	5986	3057	2929	0	958	12.1	11.7	12.5	65.8	74.4	56.8	724	358	366	0	3463	2007	1456	0
3	11681	6045	5636	0	932	7.4	7.2	7.6	94.2	96.4	91.9	864	433	431	0	10193	5410	4783	0
4	16067	8332	7735	0	928	9.3	8.7	10.0	86.7	90.6	82.4	1499	728	771	0	12631	6892	5739	0
5	17239	8809	8430	0	957	7.9	8.0	7.8	95.0	97.0	92.9	1362	705	657	0	15076	7858	7218	0
6	8752	4515	4237	0	938	7.5	7.2	7.8	91.0	93.8	88.0	654	323	331	0	7370	3933	3437	0
7	14560	7322	7238	0	989	7.0	7.1	6.9	92.3	95.5	89.1	1020	520	500	0	12498	6496	6002	0
8	13019	6794	6225	0	916	8.9	8.8	9.1	85.9	90.6	80.8	1164	599	565	0	10185	5614	4571	0
9	14502	7534	6968	0	925	7.5	7.8	7.1	95.2	97.7	92.5	1083	585	498	0	12771	6789	5982	0
10	12834	6660	6173	1	927	6.6	6.8	6.4	96.7	98.3	95.0	852	456	396	0	11591	6101	5489	1
11	9867	4991	4876	0	977	9.8	10.0	9.5	80.9	88.5	73.1	963	500	463	0	7199	3973	3226	0
12	11437	5934	5503	0	927	10.1	10.0	10.3	85.9	92.2	79.1	1160	595	565	0	8831	4924	3907	0
13	15967	8657	7310	0	844	13.0	12.7	13.3	83.5	91.0	74.6	2072	1101	971	0	11602	6874	4728	0
14	24893	13045	11848	0	908	9.6	9.4	9.8	86.7	91.6	81.3	2388	1225	1163	0	19516	10824	8692	0

15	22852	11822	11030	0	933	8.3	8.1	8.5	89.5	94.3	84.2	1895	962	933	0	18749	10245	8502	0
16	22934	11870	11064	0	932	8.8	8.7	8.8	89.5	94.6	84.1	2013	1034	979	0	18726	10246	8480	0
17	19359	10098	9261	0	917	8.1	8.4	7.8	90.3	93.9	86.5	1568	845	723	0	16073	8685	7388	0
18	6731	3498	3233	0	924	9.5	9.5	9.5	85.5	87.1	83.6	639	333	306	0	5206	2758	2448	0
19	11346	5837	5509	0	944	6.6	7.1	6.1	93.3	96.3	90.1	748	412	336	0	9884	5224	4660	0
20	14389	7434	6955	0	936	8.2	8.4	7.9	93.0	95.5	90.3	1176	625	551	0	12289	6505	5784	0
21	13284	6731	6553	0	974	9.2	9.0	9.3	86.8	91.4	82.1	1218	606	612	0	10477	5599	4878	0
22	14445	7249	7196	0	993	6.4	6.7	6.0	95.7	96.1	95.3	921	486	435	0	12941	6500	6441	0
23	12174	6377	5797	0	909	9.2	9.8	8.6	86.0	91.1	80.6	1121	622	499	0	9508	5240	4268	0
24	13816	7143	6673	0	934	7.6	7.3	7.9	91.7	94.8	88.4	1051	522	529	0	11704	6275	5429	0
25	9852	5015	4837	0	965	9.8	9.8	9.7	83.9	88.9	78.7	963	493	470	0	7458	4020	3438	0
26	14569	7546	7022	1	930	8.4	8.0	8.8	90.5	94.3	86.4	1223	606	617	0	12079	6547	5532	0
27	15300	7633	7667	0	1004	5.6	5.8	5.3	96.7	97.8	95.6	852	443	409	0	13968	7029	6939	0
28	18151	9488	8663	0	913	9.9	10.0	9.8	83.0	89.4	76.1	1797	948	849	0	13581	7637	5944	0
29	12884	6696	6188	0	924	8.1	8.2	7.9	93.6	96.1	90.8	1040	549	491	0	11084	5909	5175	0
30	18705	9928	8777	0	884	11.3	10.6	12.0	83.8	89.3	77.6	2109	1055	1054	0	13913	7922	5991	0
31	9990	5242	4748	0	906	10.4	10.6	10.1	79.5	86.9	71.5	1038	557	481	0	7121	4069	3052	0
32	2079	1061	1018	0	959	9.3	9.7	8.9	89.4	96.8	81.8	194	103	91	0	1685	927	758	0
33	9699	5108	4591	0	899	11.4	10.9	11.9	74.6	76.5	72.3	1104	559	545	0	6409	3482	2927	0
34	2132	1148	984	0	857	11.3	10.8	11.9	46.7	57.5	33.9	241	124	117	0	883	589	294	0

35	3895	2011	1884	0	937	8.3	7.9	8.8	87.4	93.6	80.7	324	159	165	0	3120	1733	1387	0
36	12554	6724	5830	0	867	12.6	11.9	13.4	71.8	77.9	64.6	1582	798	784	0	7875	4616	3259	0
37	13951	7338	6613	0	901	9.9	9.8	10.1	85.8	92.7	78.1	1387	717	670	0	10780	6137	4643	0
38	10039	5241	4798	0	915	9.8	8.9	10.7	88.6	94.2	82.5	982	468	514	0	8029	4496	3533	0
39	7431	3831	3600	0	940	6.9	6.9	7.0	94.1	97.3	90.8	515	263	252	0	6511	3471	3040	0
40	8094	4164	3930	0	944	7.6	6.9	8.4	87.9	92.4	83.1	617	287	330	0	6576	3584	2992	0
41	8051	4214	3837	0	911	8.3	8.1	8.6	81.4	88.0	74.1	671	340	331	0	6007	3409	2598	0
42	16444	8503	7922	19	930	7.7	7.2	8.1	97.2	98.6	95.6	1262	617	645	0	14751	7781	6960	10
43	18644	9625	9019	0	937	8.5	8.7	8.3	86.7	91.6	81.5	1582	835	747	0	14792	8054	6738	0



Map 1 Base MAP Showing Boundaries

3.12 SLUM PROFILE

Usually, Urban Slum areas are heavily populated with the poor people who have migrated from the poor rural backgrounds. Under section-3 of the Slum Area Improvement and Clearance Act, 1956, slums have been defined as mainly those residential areas where dwellings are in any respect unfit for human habitation by reasons of dilapidation, overcrowding, faulty arrangements and designs of such buildings, narrowness and faulty arrangement of streets, lack of ventilation, light or sanitation facilities or any combination of these factors which are detrimental to safety, health and morals. Thus, conceptually slums are compact overcrowded residential areas (and not isolated or scattered dwellings) unfit for habitation due to lack of one or more of the basic infrastructure like drinking water, sanitation, electricity, sewerage, streets etc.

In ULB like Durgapur, an industrial based city, migration has played an important role in accelerated urban growth. However, it concomitantly results in transfer of rural poverty to urban areas. These rural migrants are attracted to Durgapur for economic reasons regardless of the fact that physical infrastructure in terms of housing; drinking water supply; drainage etc. is not so adequate in Durgapur.

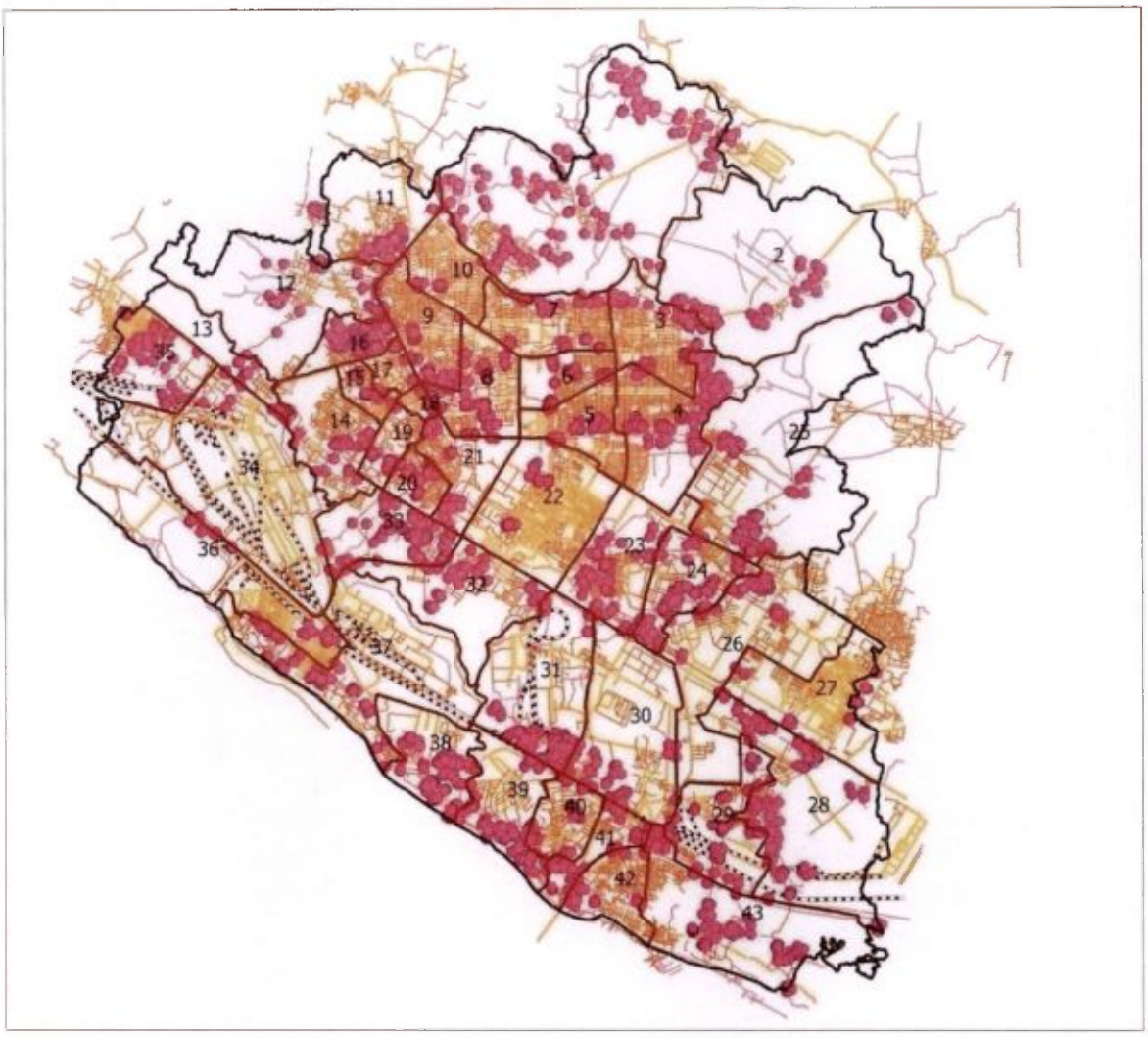
3.12.1 Salient features of slums In Durgapur:

- There are **total 336 slums** identified by Durgapur Municipal Corporation.
- Total **population**: 160238,
- Total **Area**: 2950.37 acre.
- Total no. of **households** (approx): 320476.
- **Average House Hold Size:** 5.
- **Land Tenure Status:** Public Land Encroached

Table 3.8: Ward Wise Slum Population

Ward No.	Total No. of Slums	Total Slum Population	Total No. of House Holds
1	13	11785	2357
2	12	3207	641
3	4	1436	287
4	12	4645	929
5	4	1355	271
6	3	1005	201
7	5	3508	702

8	8	6855	1371
9	5	1670	334
10	1	230	46
11	8	3291	658
12	13	5930	1186
13	4	4422	884
14	7	7920	1584
15	6	4700	940
16	13	4707	941
17	3	324	65
18	4	2412	482
19	3	1950	390
20	7	6797	1359
21	7	821	164
22	4	2850	570
23	5	4233	847
24	13	7512	1502
25	10	5480	1096
26	13	9357	1871
27	4	2038	408
28	17	8308	1661.6
29	7	2063	413
30	11	6578	1316
31	14	1230	246
32	5	1196	239
33	10	4397	879
34	4	2744	549
35	5	1403	280.6
36	24	9490	1898
37	9	2332	466
38	8	2696	539
39	4	1529	306
40	7	804	161
41	8	2456	491
42	5	1163	233
43	7	1409	282



Map 2: Location of Slums in Durgapur

3.13 EXISTING LAND USE PATTERN

A land use classification system was adopted for the study of the present nature of land use in the Durgapur Municipal Corporation as well as for future proposals. The major land use categories are summarized below:

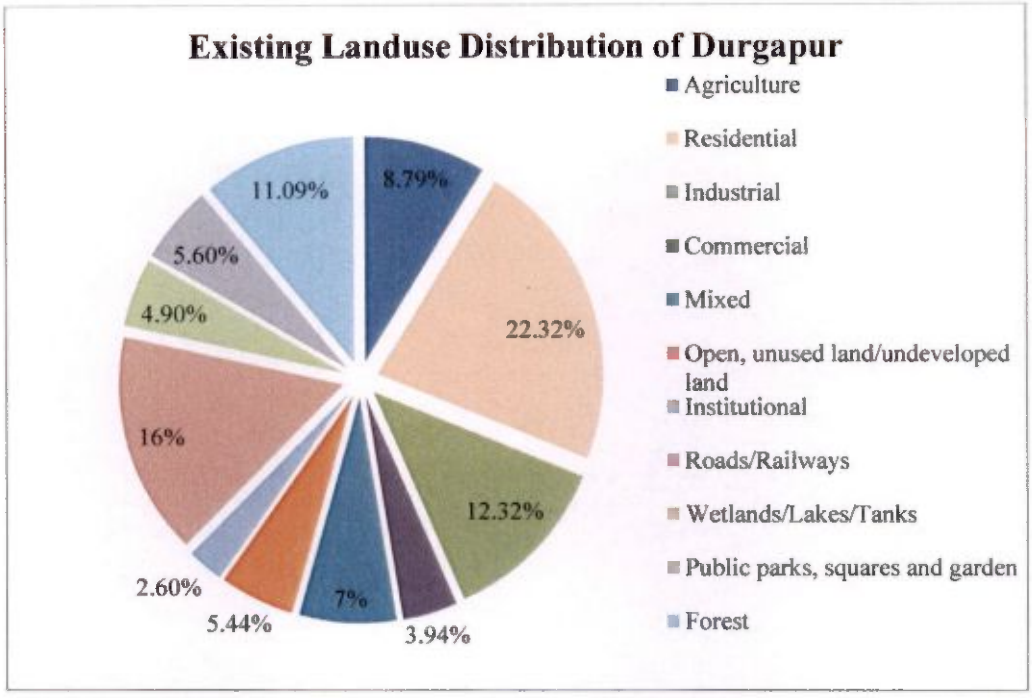
- Residential
- Commercial
- Industrial
- Public / Semi-Public
- Transportation
- Parks and Open Spaces/recreational
- Undeveloped comprising of the following:
  - Agricultural and Vacant Land

- Water bodies (including river)

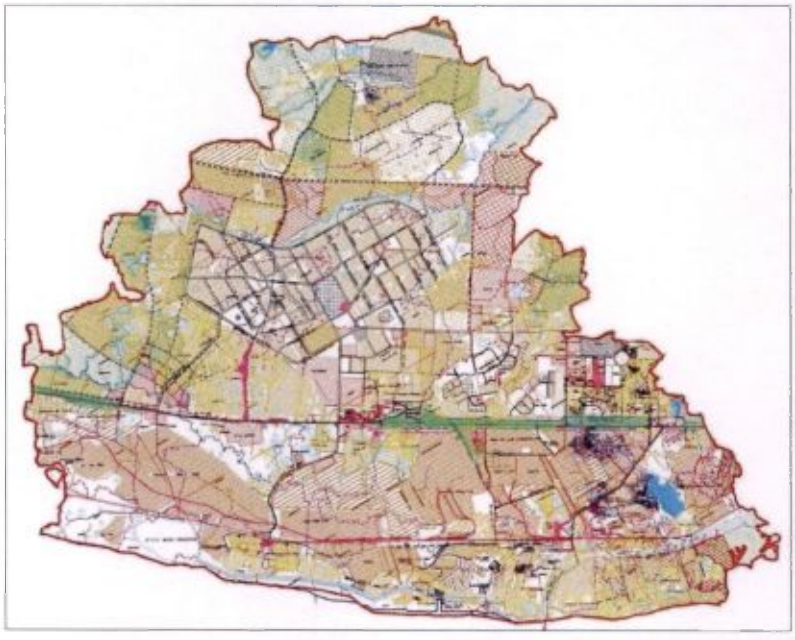
The predominant existing land use of Durgapur Municipal Corporation is a mixed one. The Corporation area is predominantly residential with large chunk of land earmarked for industrial use. There are large open spaces in some of the wards with small and large water bodies spread all across the wards. Commercial area is comparatively small. Public and semi-public areas are mostly predominant in few wards. The core area of the city is also major commercial/trading hub where all wholesale and retail activities are performed. The trade/market places acted as the pull factor for the growth of the city. This has resulted in intense development in the core, diminishing towards to the periphery.

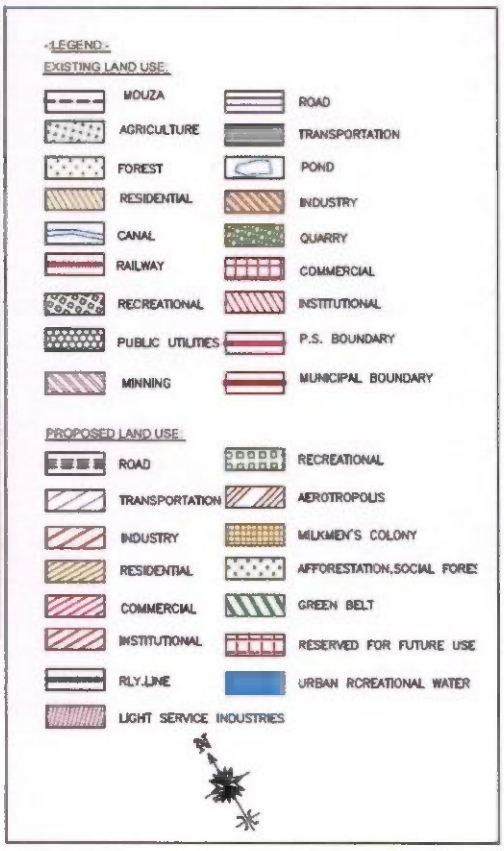
Table 3.9: Existing Land Use Pattern of the Durgapur Municipal Corporation

Sl. No.	Land Use	Area (In Sq. km.)	Percentage to total area of the Municipality
1	Agriculture	13.55	8.79
2	Residential	34.41	22.32
3	Industrial	18.99	12.32
4	Commercial	6.08	3.94
5	Mixed	10.8	7.00
6	Open, unused land/undeveloped land	8.39	5.44
7	Institutional	4.01	2.60
8	Roads/Railways	24.67	16.00
9	Wetlands/Lakes/Tanks	7.56	4.90
10	Public parks, squares and garden	8.64	5.60
11	Forest	17.1	11.09
	Total	**154.2**	**100**



Graph 3.9: Existing Land Use Pattern of the Durgapur Municipal Corporation





Map 2: Durgapur LUDCP Map

3.14 PLACES OF INTEREST

- Bhabani Pathak's Tilla – near city Centre. It earlier had a tunnel system leading to the Damodar River but now that is closed. People can visit the Tilla only.
- Rahreswar Shib Mandir – 800 years old temple complex on the Muchipara-Shibpur road.
- Ichhai Ghosh's garh (fort) – now in ruins - and the Shyamarupa temple.
- Santiniketan – location of Rabindranath Tagore's Visva Bharati is about 60 km from Durgapur
- Vishnupur – the famous terracotta temple town and home to major art and craft is about 70 km from Durgapur. The Bankura horse, symbol of Indian handicrafts is produced at Panchmura, near Vishnupur. It is also the home of the Baluchari sari, initially woven with Ramayana and Mahabharata motifs but now modernised.
- Joydeb-Kendubillo – temple and birthplace of Sanskrit poet Joydeb, on the banks of the Ajay River, is about 30 km from Durgapur. Makar Sankranti mela with bauls (religious singers with a detached philosophy and spontaneity of their own) participating is held in mid-January.
- Bakreswar – hot spring and temple is about 60 km from Durgapur
- Churulia - here the famous poet - Kazi Nazrul Islam was born. He is considered the national poet of Bangladesh. The village is about 60 km from Durgapur, and contains a museum with his works and a memorial for him. See Asansol map for location.

3.15 FESTIVALS

Durgapur has a rich religious heritage which is evident from the temples situated all over the town and also the region. Festivals are held almost throughout the year. The most important is Rahreswar Shib Puja. The 250 years old Basanti Puja is held here every year in summer Season. This festival lasts for five days and the Mela, used to be held on this occasion, for over those five days. Durgapur takes a festive mood during this period. People from all over the region use to assemble here during this festival. Apart from these festivals, festivals like Hul Utsav, Charak, Rathajatra, Kalpataru Utsav, Lokosanskriti Utsav etc. also held here every year in a pompous way.

3.16 TRADITIONAL ARTS/CRAFTS

The Bamboo crafts, terracotta and clay works are the important traditional crafts of the Durgapur town and the surrounding region.

3.17 SOIL AND GROUND WATER SCENARIO

The soil character of the town is mainly Laterite Ultisols and Alfisols Older Alluvium.The Ground Water Source of the area is decretive. Hence, the main aim is to go for switching over to surface water and slowly the wells and tube wells will be obsolete. The town will be fed only through surface water in near future. To achieve this, initiative is taken for rain water harvesting technique.

3.18 MUNICIPAL OFFICE

Durgapur is an industrial metropolis in the state of West Bengal, India, located about 160 km from Kolkata.

Fig 3.4: Dr. B.C. Roy at Durgapur DMC Office Building

It was a dream child of the great visionary Dr. Bidhan Chandra Roy, the second chief minister of the state. The well laid out Industrial Township was designed by Joseph Allen Stein and Benjamin Polk It is home to the largest industrial unit in the state, Durgapur Steel Plant, one of the integrated steel plants of Steel Authority of India Limited. Alloy Steels Plant of SAIL is also located here. There are a number of power plants, chemical and engineering industries. Some metallurgical units have come up in recent years. Durgapur is the second largest city of West Bengal after Calcutta.

Durgapur the fastest emerging city of West Bengal, India is growing to become one of the mega city of eastern India. Durgapur popularly known as the Steel city of eastern India is varying its image and emerging also in the fields of medical and education to become one of the multipurpose city of India. Durgapur has a huge base of industries with two key steel plants Durgapur Steel Plant and Alloy Steel Plant with their glowing township. There are a number of power plants, chemical and engineering industries and many small scale factories. Among them Durgapur Projects Limited (DPL), DTPS, NTPC, DVC, CMERI, Durgapur Cements, Durgapur Chemicals, Graphite India Ltd, Philips Carbon Black Ltd.(PCBL), Ultratech Cement Ltd., ALSTOM Projects India Ltd, are well known. The City Centre is the nucleus of Durgapur city's administration. The D.M.C. Durgapur Municipal Corporation Office, ADDA - Asansol Durgapur Development Authority office, The Durgapur Sub Regional employment Exchange, The Durgapur Sub divisional Court, The Income Tax office, The professional Tax office, The marriage registry Court, The West Bengal Tourism office, and many other Government and non-Governmental offices are located in City Centre. Durgapur provides a wide range of opportunities to its residents and visitors from outside location. Here opportunities for career to business are for any sex, caste or religion. People of Durgapur are liberal minded and hence sex, men or women are humanizing to be successful in career.

Durgapur City is well connected with through railway and roads. A list of detail social infrastructure is identified and provided in below matrix.

Table 3.10: List of Social Infrastructure in Durgapur

1	Name of the District :	Burdwan
2	Year of establishment :	1962
3	Area (in sq. Km) :	154.20 Sq. Km
4	No. of wards :	43
5	Distance from District Headquarter :	75 Km
6	Population (census 2011) :	
6.1	Male	293731
6.2	Female	269826
6.3	Total	563557
7	Density of Population (Per sq. km.) :	
8	Break up of Population (2011) :	
8.1	Scheduled Caste	75233
8.2	Scheduled Tribe	13606
8.3	Minorities	
9	Date when last election held	2012
10	Assessment of Property:	
10.1	Total holdings	80550
10.2	Total no. of holdings whose assessment has been done	69228
10.3	No. of holdings to whom demand notice are issued	10644
10.4	Total demand for 2013-14	254412635.64
10.5	Total Collection for 2013-14	106860713.03
10.6	Year of Last assessment by West Bengal Valuation Board	2005-2006
10.7	Year / quarter of Imposition of current Property Tax	2nd Qtr, 2005-06
11	Literacy : (2001)	
11.1	Male	213117
11.2	Female	157983
11.3	Total	371100
11.4	Percentage of Literate Population(2011)	
12	Number of BPL Household (as per SUDA Survey) :	29438
13	Scenario of Slum :	
13.1	Total No. of Slum	334
13.2	Total Slum Population (as per USHA survey)	150000 (approx)
13.3	Percentage of Slum Population to the total population	26 %
13.4	No. of Slum where Slum Infrastructure Improvement sanctioned under BSUP/ IHSDP	32
13.5	No. of Slum where Slum Infrastructure Improvement already done under BSUP/ IHSDP-	35
14	Housing status for Urban Poor :(as on 31.03.2014)	

14.1	No. of dwelling units targeted to be provided under BSUP/ IHSDP	1094
14.2	No. of beneficiaries already provided with Houses under BSUP/ IHSDP	4218
14.3	No. of beneficiaries provided with Houses under " Housing for Urban Poor "	333
15	Road :	
15.1	Length of Metalled Road (in km.)	
15.2	Length of Non-Metalled Road (in km.)	966
15.3	Length of other Roads (in km.)	121
15.4	Total length of Road (in km.)	14
15.5	Total no. of wards fully covered with Metal/Cement Concrete Rd.	1101
16	Drainage :	
16.1	Length of Kutcha Drain (in km.)	544
16.2	Length of Pucca Drain (in km.)	782
16.3	Length of underground / covered Drain (in km.)	3.8
16.4	Total length of Drain (in km.)	1329.8
16.5	No. of wards fully covered with Pucca Drain	NIL
16.6	No. of wards partly covered with Pucca Drain	43
17	Water Supply : -	
17.1	No. of Water Treatment Plant	1
17.2	No. of Deep Tube well	0
17.3	No. of Hand Tube well	318
17.4	No. of Street Stand post	2809
17.5	Length of Water pipeline (in kilometer)	1380.03
17.6	No. of Underground Reservoir	6
17.7	No. of Overhead Reservoir	30
17.8	No. of wards fully covered with water supply pipeline	18
17.9	No. of houses connected with Water Supply Network	22443
17.1	Who is maintaining water supply – Municipality / PHE Dept./ KMWSA	ULB
18	Sewerage and Sanitation :	
18.1	No. of sanitary latrine constructed	3643
18.2	No. of family provided with Sanitary Latrine under ILCS + BSUP / IHSDP+ HUP (together)	6122
18.3	No. of Community Latrine /Public Toilet	75
18.4	Length of Sewer Line (in kilometer)	470
18.5	No. of Sewage Treatment Plant (STP)	1
19	Solid Waste Management :	
19.1	No. of Dumping Ground, if any	1
19.2	No. of Landfill site , if any	1
19.3	No of Mechanical Sweeper, if any	1
19.4	No. of Compactors, if any	2
20	Street Light :	
20.1	No. of Light Post	21050

20.2	No. of High Mast Light Post	23
20.3	No. of Trident Light Post	57
20.4	No. of other Ornamental Light Post	Nil
20.5	No. of Wards covered with light posts	35
21	Health :	
21.1	No. of Hospital (ULB + Govt. + Others)	32
21.2	No. of Municipal Maternity Home	2
21.3	No. of Regional Diagnostic Centre	2
21.4	No. of Extended Specialist Out Patient Department (ESOPD) (IPP-VIII)	2
21.5	No. of Municipal Health Sub-Centre	57+2
21.6	No. of Municipal Health Administrative Unit (HAU)(IPP-VIII)	8
21.7	No. of Municipal Dispensaries	NA
21.8	No. of Municipal Ambulances	2
21.9	No. of Hearse Car	1
22	Education :	
22.1	No. of Higher Secondary School (Municipal)	Nil
22.2	No. of Higher Secondary School (others)	23
22.3	No. of Secondary School (Municipal)	Nil
22.4	No. of Secondary School (others)	9
22.5	No. of Primary School (Municipal)	2
22.6	No. of Primary School (others)	102
22.7	No. of Sishu Siksha Kendras (SSK)	78
22.8	No. of ICDS Centre	188
22.9	No. of Junior High School	Nil
22.10	No. of beneficiaries under SC/ST scholarship	
22.11	No. of beneficiaries under Minority scholarship	
23	Other Infrastructure :	
23.1	Bridge	Big:8, Bridges:17
23.2	Flyover	2
23.3	Stadium	5
23.4	Parks	52
23.5	Playground	81
23.6	Auditorium/Community Hall	Audt:5 , C.H.-26
23.7	Borough Office	5
23.8	Ward office	Nil
23.9	ULB Market	2
23.10	Burning Ghat	1
23.11	Electric Crematorium	1
23.12	Burial Ground	8
23.13	Public Library	3
23.14	Bus Terminus	3
23.15	Ferry Ghat	Nil

23.16	Guest House/ Tourist Lodge	T. Lodge:-1, G.H.:8
23.17	Road Roller	1
23.18	Cess Pool	1
23.19	No. of Slaughter House:	Nil
23.19.1	Municipal Slaughter House	Nil
23.19.2	Other Slaughter House	Nil
23.20	Others (Please specify)	
24	Community Structure under SJSRY : -	
24.1	Total No. of CDS -	5
24.2	Total No. of NHC -	64
24.3	Total No. of NHG -	750
24.4	No. of Thrift & Credit Group (TCG)-	500
24.5	No. of SHG-	20
24.6	No. of DWCUA formed -	20
25	National Social Assistance Program (NSAP) : -	
25.1	No. of beneficiaries under Indira Gandhi National Old Age Pension Scheme (IGNOAPS) -	4201
25.2	No. of beneficiaries under Indira Gandhi National Widow Pension Scheme (IGNWPS) -	2444
25.3	No. of beneficiaries under Indira Gandhi National Disability Pension Scheme (IGNDPS) -	121
25.4	No. of beneficiaries under National Family Benefit Scheme	300
26	No. of Annapurna Antodaya Yojana (AY) card holder : -	14440
27	No. of Annapurna Anno Yojana (AAY) card holder : -	250
28	No. of beneficiaries under Janani Suraksha Yojana (JSY) : -	NIL
29	No. of beneficiaries under AYUSHMATI scheme: -	
30	No. of beneficiaries under KANYASHREE scheme: -	
31	No. of beneficiaries under YUBASHREE scheme: -	
32	Municipal Staff(as on 01.04.2014) : -	
32.1	Total No. of sanctioned Post -	595
32.2	Actual Staff Strength(Regular) -	453
32.3	Actual Staff Strength(Contractual, not Casual) -	10
33	Registration of Births and Deaths during 2013-14 : -	
33.1	Whether Birth & Death Certificate issued through e-governance System – Yes / No.	Yes
33.2	No. of Births Registered -	
33.3	No. of Birth Certificate issued -	
33.3.1	Male	
33.3.2	Female	
33.4	No. of Death Registered -	3597
33.5	No. of Death Certificate issued -	4080
33.5.1	Male	2359
33.5.2	Female	1238
34	Own Revenue (2013-14)(Rs in Lakh)	
34.1	Tax Revenue	1467.29 Lakh

34.2	Non-Tax Revenue	1778.96 Lakh
34.3	Total Revenue	4558.32 Lakh
34.4	Percentage of collection of Own revenue to Budgeted (2013-	51%

3.20 ECONOMY ACTIVITY

Durgapur is a new industrial city. It all started with the dreamer first Prime Minister of independent India, Jawaharlal Nehru. His dream of transforming the backward agricultural country into an industrially advanced nation was picked up in West Bengal by Dr. B.C. Roy. At the earlier stages for the selection of a proper site for a new industrial township, Jnananjan Niyogi, a great business organizer and planner, was involved. Modernist American architect Joseph Allen Stein, invited to head the newly formed Department of Architecture and Planning at the Bengal Engineering College in Calcutta, plunged into a major project as soon as he reached India in 1952—the designing of Durgapur city along with Benjamin Polk, another American architect already living in Calcutta at that time. Thereafter it was the task of local leaders such as Ananda Gopal Mukherjee and bureaucrats such as K.K. Sen. to get Durgapur going.

Fig 3.5: Queen Elizabeth at Durgapur

Prior to independence, only one small refractory plant of the Martin Burn group was located at Durgapur, the abandoned chimney of which is still visible near the station. Damodar Valley Corporation constructed Durgapur Barrage in 1955 and shortly followed with the Durgapur Thermal Power Station.

There was a massive follow up – Durgapur Steel Plant (commissioned 1960), Alloy Steels Plant (commissioned 1965), Durgapur Projects Ltd. (established 1961), Mining and Allied Machinery Corporation, ACC-Vickers Babcock (later ACC-Babcock and now Alstom Power Boilers), Hindustan Fertilizer Corporation, Philips Carbon Black Ltd., Sankey Wheels (a unit of GKW), Bharat Ophthalmic Glass Ltd, Durgapur Cement Ltd. (now Birla Cement) (established 1975), Graphite India Ltd. (established 1967), Durgapur Chemicals and many others. A great new industrial city was bubbling with enthusiasm.

Durgapur Steel Plant was a showpiece of Indo-British cooperation in independent India. Dr. Rajendra Prasad, the first president of India, came for the inauguration of the first blast furnace. Prime Minister Jawaharlal Nehru was a regular visitor. He called these plants temples of new India. Many senior leaders

and important foreign leaders visited Durgapur to see and to cheer. Displaying a rare gesture of solidarity, Queen Elizabeth came on a state visit.

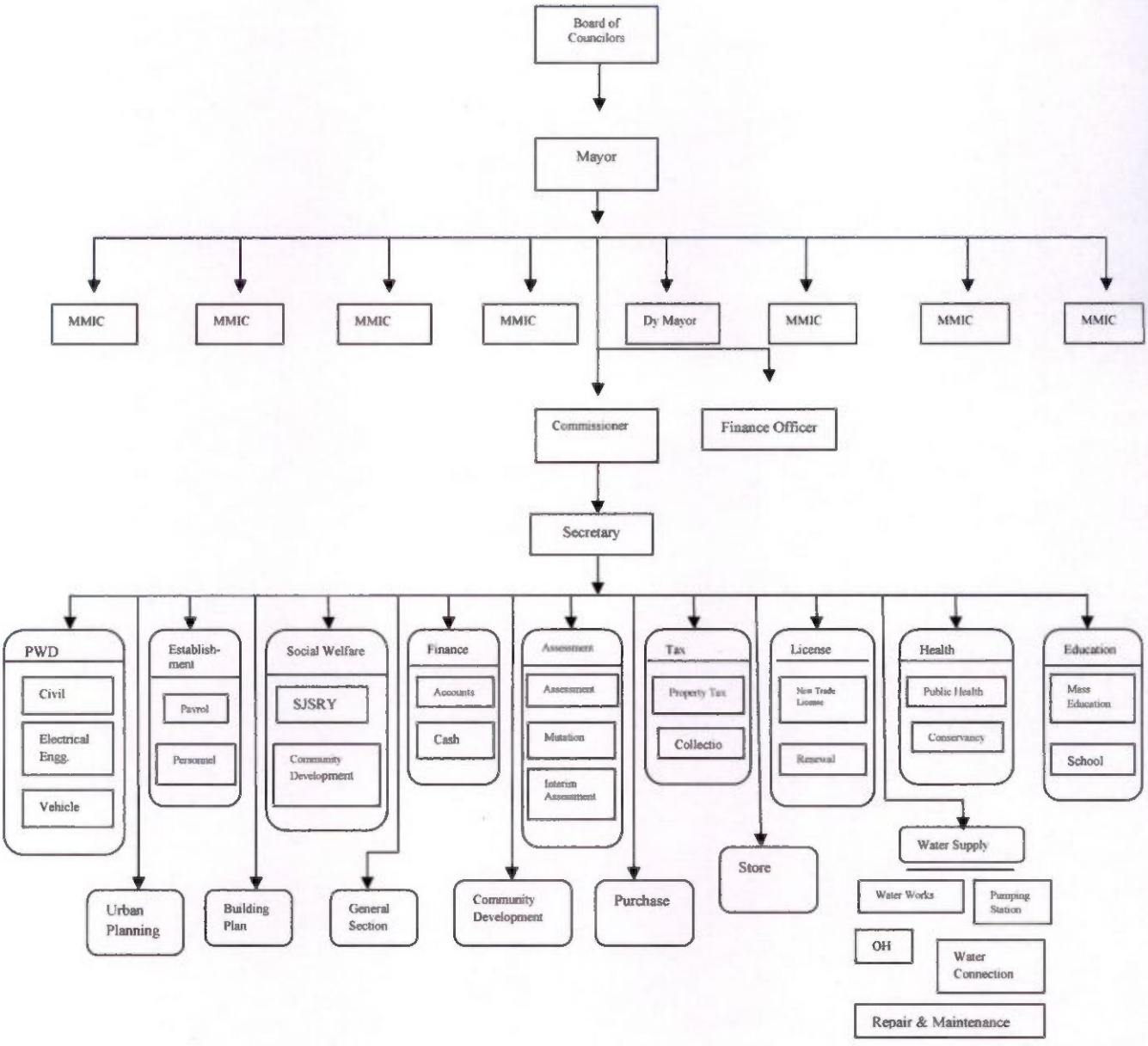
As the numerous chimneys merrily belched out smoke – black, white and reddish brown – as pollution control norms were still some way off (for the past few years all the 65 chimneys of Durgapur Steel Plant are pollution free), the townships grew and prospered. Regional Engineering College (established 1960) (now renamed National Institute of Technology) and Central Mechanical Engineering Research Institute (established 1958) added to the stature of the new township. Schools, hospitals, parks, and playgrounds – all came up. It was new life in new India.

3.21 ORGANIZATION STRUCTURE OF DMC

The Mayor is the First Citizen of the Corporation. The administration of the Corporation is run by the Mayor-in-Council constituted the Mayor, the Deputy Mayor and the maximum of 10 other elected members of the Corporation. There is a Chairman, elected by the Councilors who exercise the powers in the Corporations which is similar to that of the Speaker of the Legislative Assembly. The Mayor nominates one of the Councilors as the Deputy Mayor.

For further decentralization there is a borough setup. Corporation constitutes 5 boroughs which are groups of contiguous wards. Each borough committee's civic administration in borough areas is supervised by a borough committee constituted by a Councilors of the wards of concerned borough. The Chief Administrative Officers of the Corporation is the Commissioner in the case of Durgapur Municipal Corporation, and Chief Executive Officer in the case of other Municipal Corporations.

Flow Chart of Organization Structure of DMC



CHAPTER 4 EXISTING SOLID WASTE MANAGEMENT

This chapter reveals an overview of existing solid waste management system in Durgapur City. The various sources of waste generation, the current primary and secondary waste collection practices, waste transportation and disposal mechanisms. The gaps are identified in accordance to the MSW Rule 2016 in this chapter.

A comprehensive study is undertaken for quantitative and qualitative analysis of municipal solid waste generated from various sources. The information provided in this chapter is based on discussions with various stakeholders, Durgapur, local residents and site investigations and detailed survey performed by consultant's project team.

4.1 SOURCE IDENTIFICATION

Identification of waste generation sources were undertaken in accordance to CPHEEEO MSW Rules 2016 and stakeholder's consultation viz Health Officer, Durgapur City, IT Officer, Urban Planner, Education Officer, Sanitary inspector, Safai karamcharis, residents, etc. Based on the discussion with various stakeholders (related to the waste generation & its management) & primary information of core sources of waste generation has been identified. This exercise has carried out to get the focus points of waste generation & its management.

The primary sources of solid waste generation in Durgapur are the local households, markets, commercial establishments / shops, hotels & restaurants, institutions, function/marriage halls, Offices, Hospitals etc. This has been done with the understanding that waste generated from various parts of the city is dumped into the open dumps/dustbins, if available (waste collection points). In addition, commingled waste collected from the secondary collection points, is ultimately dumped into disposal facilities i.e. dumpsites/trenching grounds.

4.1.1 Domestic Households

Households of various categories primarily contribute domestic waste. Based on the assessment of the DMC, it is estimated that of the total 5, 63,557population residing in DMC area. The households of the city based on the housing typology can be categorized as independent bungalows, independent houses of low, middle and high income groups, tenements, individual flats, apartments and huts or economically weaker section dwellings.

Fig 4.1: Household Waste Collection

4.1.2 Street Sweeping and Drain Cleaning

One of the major activities of the solid waste management is street sweeping, which is time consuming and labor intensive. Due to open drainage system, desilting of drains is also necessary. Since throwing and indiscriminate disposal of waste on to streets is prevalent, collection of waste is mainly through street sweeping. Sweepers use traditional brooms to sweep, collect and transport waste up to collection points using tricycle. The drains get de-silted when they get filled up to brim with sewage or before the start of monsoon rains to prevent water logging. The silt is left on road side for drying for a day or two before being disposed of. Open defecation was observed in open dumps.

Fig 4.2: Drain Cleaning Activity

4.1.3 Commercial Establishments

The major contributors of solid waste after households are commercial establishments within the town area. The contribution from informal sector is also significant in this category. According to DMC the major commercial activities are concentrated along Grand Trunk Road, Maulana Azad Sarani, Nazrul Sarani, Ambedkar Sarani, Sahid Khudiram Sarani, Preeyalata Wadedar Sarani, Michael Faradey Road, Kabiguru Sarani, Rani Rashmoni Path, Mahatma Gandhi Road, , Bidhan Sarani, Lenin Sarani, Jawarlal

Neheru Road, Naim Nagar Masjid Road, Dr. Zakir Hussain Ave., Surya Sen Sarani, Hannemann Sarani, Dr Sahid Sukumar Banerjee Sarani, Armstrong Ave., Durgapur- Purulia Raghunathpur Road etc.Street vending is prevalent near railway station, bus stand areas etc.

Besides above, there are markets for vegetables at Bidhan Chandra Roy Ave.,Ananda Gopal Mukherjee Sarani Road,Faridpur Main Road, etc. These markets are located along the major roads and create congestion in high traffic zones. The total numbers of vendors in Durgapur are approximately 15000.

These establishments comprise wholesale and retail shops, general shops, pan shops, food products, bakeries, dairies, juice shops, hardware, electrical and electronics, workshops, cloth merchant etc.

Fig 4.3: Waste Collection from Commercial Establishments

4.1.4 Bulk Generators- Hotels, Restaurant & Cinema Halls

Hotels, lodges, restaurants and cinema halls are considered as special case under commercial establishment's category due to their solid waste generation rates and characteristics. There are number of hotels and restaurants in especially in City Center area, Nachon Road, Railway Station Road area of Durgapur.

Fig 4.4: Waste Collection from Bulk Wasted Generators

4.1.5 Markets

Number of commercial markets, vegetable markets, flower, and road side daily and weekly markets are operating in Durgapur city. Waste contributed from these markets is generally organic in nature and is one of the major sources of solid waste generated in the City.

Fig 4.5: Market Waste Collection

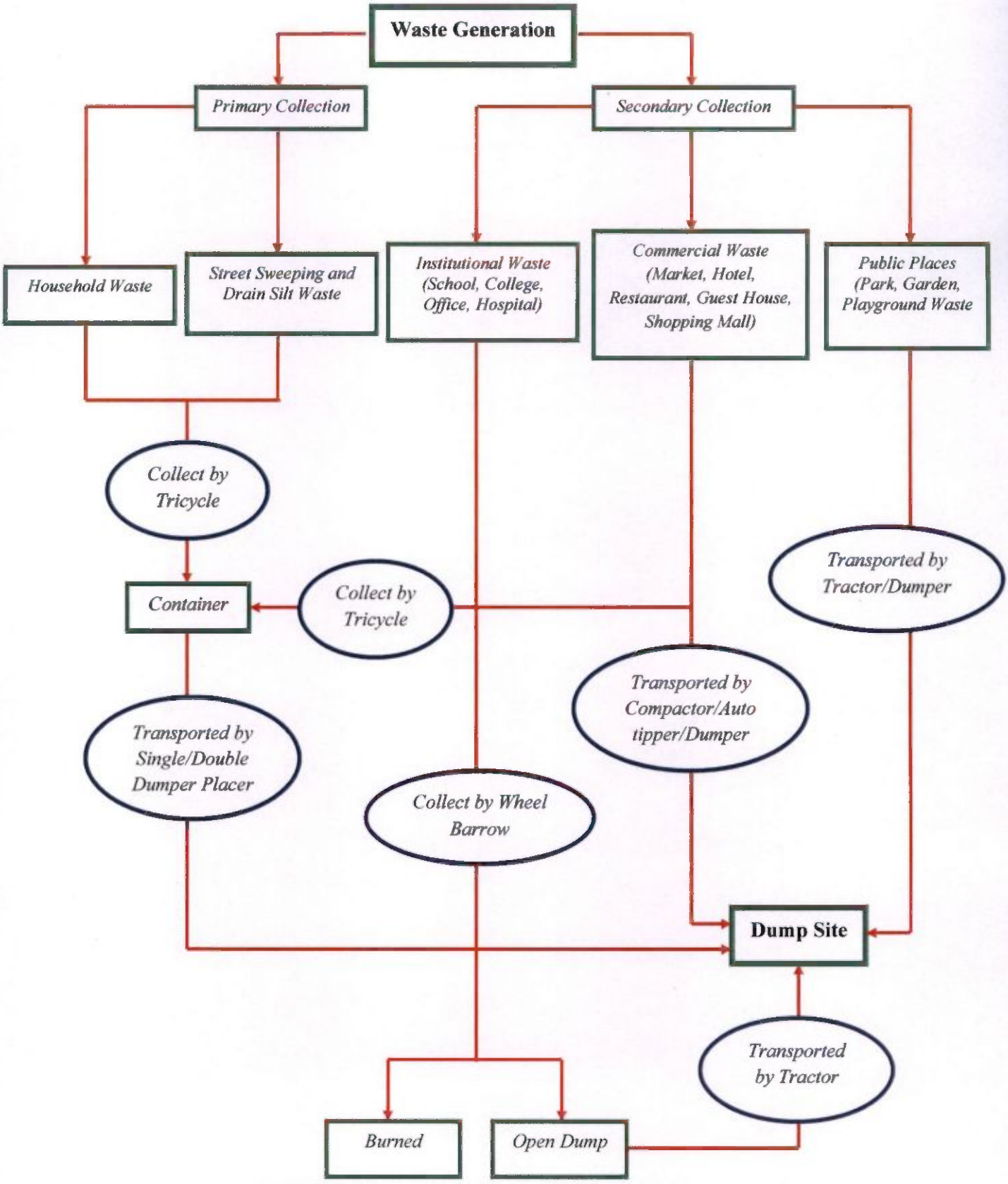
4.1.6 Hospitals & Nursing Homes

There are about 48-50 hospitals, nursing home clinic and Pathos lab while some major hospitals namely D.S.P Hospital, S.D.H Bidhannagar, E.S.I Hospital, Vivekananda Hospital, Central Nursing Home, Jeevandeep Nursing Home, West Midland Nursing Home, Heritage Nursing Home, D.V.C.D.T.P.S Hospital, Dr. B.C. Roy Medical Institute, Durgapur Nursing Home etc. are situated in DMC area. Beside above, there are several numbers of allopathic, ayurvedic and homeopathic and other dispensaries. Record of total bed strengths of the hospitals and nursing homes are approximately 3000.

Generally, bio-medical waste is classified in terms of body tissues, bandages, syringes, needles, glass and plastic bottles and Chemical and Pharmaceutical waste. As according to CPHEEO Guidelines, the per capita waste generated by hospitals will be around 1.5 kg/bed/day, of which 75 per cent will be domestic waste and 25 per cent, will be bio-medical waste.

Fig 4.6: Waste at Hospitals

4.2 COLLECTION SYSTEM



4.3 PRIMARY COLLECTION SYSTEM

4.3.1 Household Waste Collection System

The Household Waste Collection of Durgapur is currently being practiced in 28-30 wards among 43 wards. Primary collection would be carried out by deploying of tricycles. Tricycles are used in predominantly HIG and MIG residential areas. Door to door collection is not practiced at slum areas. People generally throw the waste in front of the house or shop or on the streets from there sanitary workers collect the waste in Tricycle, simultaneously sweeping the streets. The sanitary workers place the collected waste at the nearest secondary open collection point. At the places where containers are kept the waste is placed in the nearest container. Collection starts from 6:00 am and continue up to 12 noon. After completion of work, waste handlers kept their vehicles into different areas like Borough office, ward councilor's house, club area etc.

4.3.2 Street Sweeping Waste Collection System

A major portion of sanitary worker's time is spent in street sweeping operations. With a total road length of 2202 km, street sweeping waste is the other major component of solid waste in DMC area. Since throwing and indiscriminate disposal of waste on to streets is prevalent, collection of waste is mainly through street sweeping. DMC has employed nearly 200 workers for street sweeping only. Sweepers use brooms to sweep, collect and transport waste up to nearer container using tricycle. Whereas at some areas, street sweeper dumped waste beside road. Dumper vehicle collects all waste and unload into disposal site.

4.3.3 Drain Silt Waste Collection System

As observed during reconnaissance survey of the town, there is no connectivity between road-side drains which result in accumulation of sewage at dead ends and resulting in unhygienic condition for the residents. Waste is observed to be dumped mainly in drains and some open plots by the residents, shop keepers etc. The total length of the drains in Durgapur is 1329.8 km. DMC has employed nearly 1100 workers for drain cleaning only. During survey, it has been observed that most of the drain networks not with adequate in size and damaged at many places and it is improper to drain out the rain water, causing water logging problems in many wards. Apart from that at some areas, drain cleaning work progressing in proper way.

Table 4-1: Manpower Details in DMC

Manpower Details	Borough 1	Borough 2	Borough 3	Borough 4	Borough 5
Supervisor No.	31	8	21	34	14
Door to Door Collection Labour no.	0	30	Run by NGO's	21	15

Street Sweeping Labour no.	42	60	28	56	Door to Door Collectors are used for Street Sweeping and Drain Cleaning for 1 times in a month
Drain Cleaning Labour no.	306	249	200	320	
Septic Tank Sludge Cleaning Labour no.	0	-	10	nil	-

Table 4-2: Equipment Details in DMC

Equipments Used for Primary Collection	**Borough 1**	**Borough 2**	**Borough 3**	**Borough 4**	**Borough 5**
Tricycle	-	70	39	56	29
Pushcart	1	-	-	-	10
Wheel Barrow	-	-	-	Daily-4 Emergency case-4	

Nearly 1337 temporary and permanent sanitary workers working in the DMC area. There are 205 vehicles engaged for collection of solid waste during primary collection. Waste handlers make 4 trips and collect waste at average 200 nos. houses at daily basis. At present door to door, collection is done in only 25-30% area of total area of a ward at daily basis. Thus, DMC need to engage more infrastructure and resources to initiate the 100% door-to-door collection of waste.

Fig 4.7: Waste collection in DMC

4.4 SECONDARY COLLECTION SYSTEM

As discussed, in primary collection system, Primary waste collectors dispose waste into nearer big containers which is secondary collection point. All Secondary Collection Vehicles start from Sidhu Kanu Stadium in the morning at 6:00 am and continue up to 2:00 pm. The waste from secondary collection points is transported by using 4 single container dumper placer, 5 double container dumper placer, 6 auto tippers, 13 dumpers, 4 compactors, 1 tractor and 1 truck dumped into Present Dumping Site at Sankarpur. Secondary collection points including road side bins would be aesthetically designed with adequate capacity and placed at optimal locations on all roads with high density. DMC has dust bins and open collection points in terms of secondary collection arrangements.

Fig 4.8: Secondary Collection in DMC

4.4.1 Waste Collection from Markets

In Durgapur, the big markets identified with capacity of more than 500-600 nos. shops at Dr. Bidhan Chandra Roy Avenue, Ananda Gopal Mukherjee Sarani Road, Mamra Bazar Market Road, Hannemann Sarani etc. Mostly, Compactor and Dumper engaged for collection of market waste in the morning on everyday. After collection of waste, vehicles unload into dump site. Small market identified with capacity of 100-200 nos. shops at Chandidas Avenue, Bhagat Singh Marg, Bypass Road, Red Cross Road etc. DMC send dumper vehicle or compactor for collection of these markets once or two times in a week.

Fig 4.9: Waste Collection from Markets

4.4.2 Waste Collection from Street Shops

The street shops identified in Grand Trunk Road, Maulana Azad Sarani, Nazrul Sarani, Ambedkar Sarani, Sahid Khudiram Sarani, Preeyalata Wadedar Sarani, Michael Faradey Road, Kabiguru Sarani, Rani Rashmoni Path, Mahatma Gandhi Road, , Bidhan Sarani, Lenin Sarani, Jawarlal Neheru Road, Naim Nagar Masjid Road, Dr. Zakir Hussain Ave., Surya Sen Sarani, Hannemann Sarani, Dr Sahid Sukumar Banerjee Sarani, Armstrong Ave etc.Some street shops put waste into nearer container which collected by single container dumper placer vehicle. During house-to-house collection, some waste handlers collect waste from those shops that pay them user fees and put into container.

Fig 4.10: Waste Collection from Street Shops

4.4.3 Waste Collection from Hotels & Restaurants

There are 125 Hotels and 34 Restaurants in Durgapur. The waste from these establishments includes left-over food and dry horticulture waste (leaves, twigs, etc.). Workers of the respective establishments dump the wastes into the Auto tipper, when it arrives for collection of the same, to be finally transported to dumpsite. 12 hotel & restaurants have been surveyed. The survey details show that amount of waste being generated in peak season is much higher than the waste being generated in slack season.

Fig 4.11: Waste Collection from Hotels & Restaurants

4.4.4 Waste Collection from Schools & Colleges

There are 236 Schools and colleges in Durgapur. The waste from these establishments includes food, bottles, packets etc. At present, DMC doesn't send any vehicle for collection of institutional waste. Most of the institutions hire waste collectors for sweeping and collecting waste. Workers of the respective establishments dump the wastes into the roadside by using wheel barrow or burned the waste. Dumper or tractor collects these roadside waste and unload into dumpsite. 10 institutions have been surveyed. The survey details show that amount of waste being generated from school and colleges which are not dispose into dump site at sankarpur.

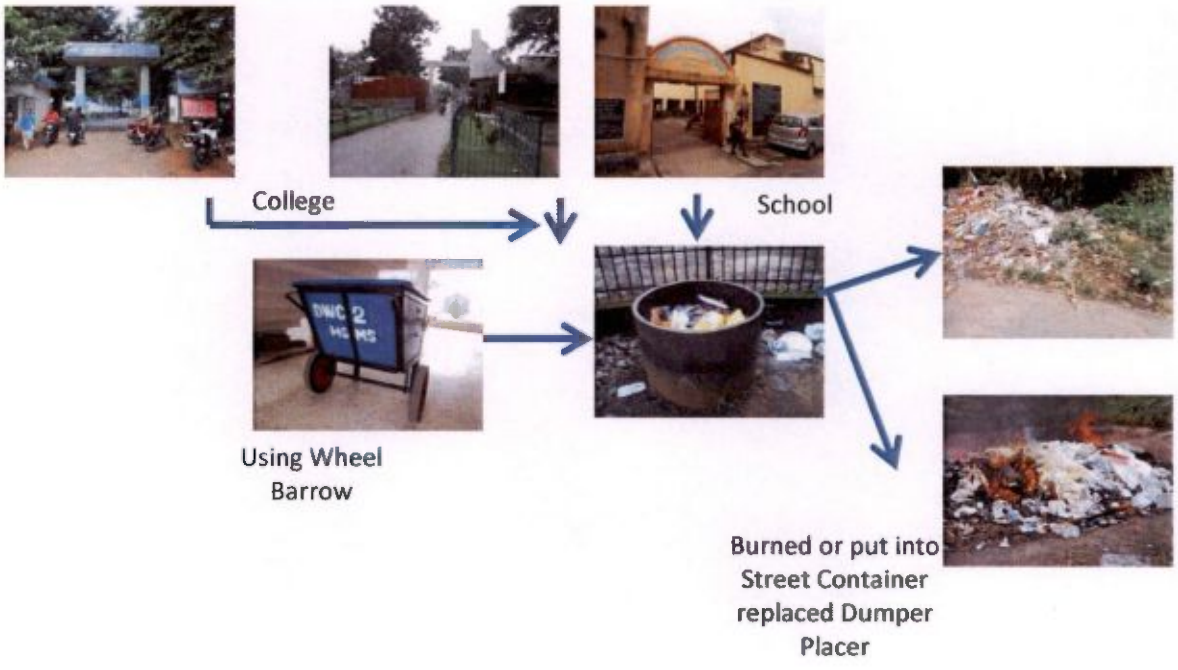


Fig 4.12: Waste Collection from Schools & Colleges

4.4.5 Waste Collection from Hospitals

Durgapur Municipal Corporation has 49 hospital and nursing homes and 59 health sub center,. These medical establishments were surveyed to get present scenario of Bio-medical Waste (BMW) management. Auto tipper vehicles are engaged for collection of food waste from hospitals and dump into sankarpur site. It was observed during survey that BMW from these medical establishments is self-managed by hospitals.

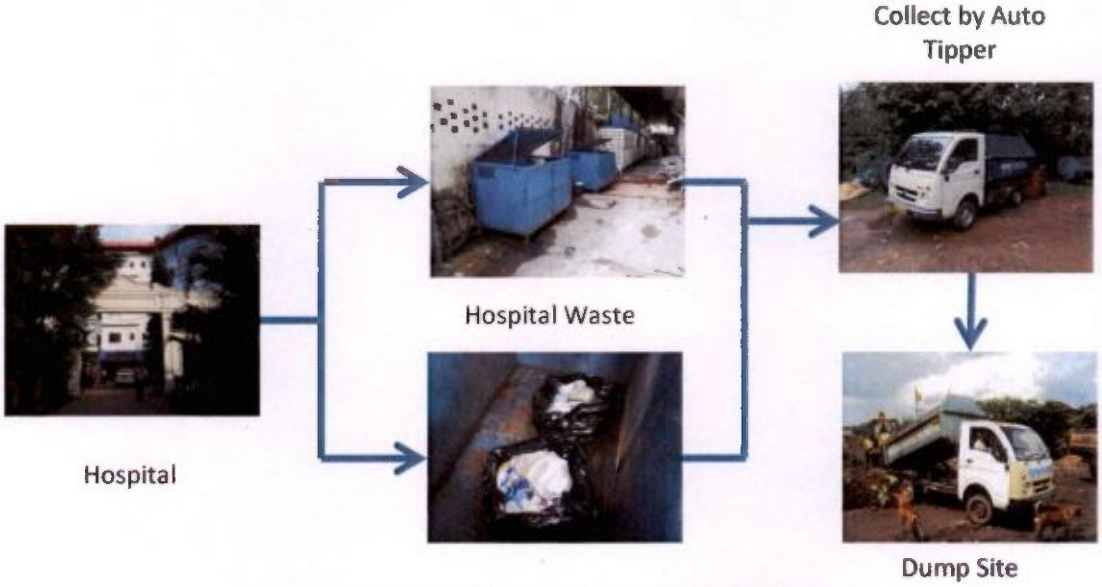


Fig 4.13: Waste Collection from Hospitals

4.4.6 Construction and Demolition Debris

This Waste varies from time to time depending up on the construction or demolition activities in Durgapur city. A major portion of construction/demolition waste is generally used in reconstruction activities or for filling up of the low lying areas or kutcha roads. The individual generating construction waste generally engages dumpers or tractors to collect the construction waste and dump it disposal site at sankarpur for a nominal cost. As such, there are no standard practices for disposal of construction/demolition waste in Durgapur city.

4.5 SECONDARY COLLECTION POINTS

Secondary collection points are the places of waste disposal conveniently identified by the waste handler for the disposal of waste collected from households, street sweepings and drain cleanings, from where the corporation vehicles pick up to transport the waste to the transfer stations. There are 116 secondary collection points (containers) and as many open dumps are located at irregular intervals in 43 wards of the city. DMC vehicles directly attend these points and transport the waste to dump locations. Most of the container waste doesn't remove at regular basis. Sometimes it removes after one week. There are lots of

small container and open dumps beside roadside area and average spacing between small containers is about 1-2 km. The waste collection from small containers is done once or twice in a month.

Fig 4.14: Secondary Collection Points

4.5.1 SCP Locations in entire DMC area

Table 4.3: List of SCP locations

Sl. No.	Borough 1	Borough 2	Borough 3	Borough 4	Borough 5
1		Gosai Para	Anandapuri (beside Durga mandir)	Zonal Centre	Near DSP Flyover
2		Health center	Sardar palli pukur par	School Para	Near Petrol Pump (Repairing pump house)
3		Shikha Nikatan	Khudiram Math	Santibon Park	Sarada palli (Repairing pump house)
4		Indra Prsatha Shibtala	54 Rabi Sabji Dokan	Sadhona Medical	Kada Road More (Repairing pump

Sl. No.	Borough 1	Borough 2	Borough 3	Borough 4	Borough 5
					house)
5		Panjabi Gali	Khudiram Math	SCN Market	Near Kamarsala (Repairing pump house)
6		Nimtala	City Centre Daily Market	Rabindra palli	BPL quarter
7		Court More	City Centre Bus Stop	D-Math (Korongo Para)	High School
8		Benachiti High School	Sail co-op (BBD Sarani)	Ambagun	Nicher Bazar
9		Kaizar More (Lane)	Cameri Barat Calony	Dhakinayan	Nabo wariar
10		Nibidita Place	Cameri Basti	Shyampur	Payala (Kora para)
11		Devinagar battala	Michael Marade Road	Muchi para	Bauri Para
12		Jhandabad Taltala	Michael Marade Road	Mrittunjoy Housing Complex	Near health center
13		Jhandabad Sam	DMC Saff Quarter (front)	P.N.T Road	Near UBI bank (Tamla Bridge)
14		Sukantapalli Paschim	Cameri Colony	Mondal Nursing Home	Kada Road
15		Rishi Arabinda Palli	Kavi Guru (2nd)	Bihari D-Math (Bus Stand)	Gamon colony
16		Masjid Maholla	Bengal Ambuja		Near water tank (Repairing)
17		Deshbandhu Nagar	Junction Mall		Near Bazar (Gopal Math bazaar)
18		Annapurna Nagar Bypass	Cameri Sonartori		Rai Para
19		Uttarpalli	City Centre Court		Rail quarter
20		Rabins Salbagun	City Centre Party office		Sujara plot
21		Salbagun	B zone bazaar		Sujara Hari Mandir
22		Jolkhabar Goli	Nabin Pally		Old electric office
23		Sawnanir	Ganatantra Colony		Angthpur Barui para
24		Bhiringi Village	Mamra Burah, CD quater front		Arjunapur tetultala
25		Subhas Pally	Mamra Jaganath Mandir		Dutta ParaMatri Sadan
26		Bhiringi Water	Bidhan Pally 04		Cinema Hall

Sl. No.	Borough 1	Borough 2	Borough 3	Borough 4	Borough 5
		Tank	NoStreet		
27		B.T Road Dharam Pukur	Sarat Pally 3 No street		Purasha
28		Ashram	Fuljhare shibaji Park (Main Rd)		
29		Samiti Office	Vambay Colony		
30		Chayan math + suryasen	BidhanNagar Ispact Pally		
31			Hudco Bidhannagar		
32			Paschim Palyy basti (fornt side)		
33			SAP Barak		
34			Nivedita Park		
35			Bidhannagar Zonal Market		
36			Bidhan School		
37			Muchi Para Market		
38			Pubali Main Road		
39			PCBA Main Road		
40			Bidhannagar Pump House		
41			Bengal Engineering College		
42			N.H Office		

4.6 MSW TRANSPORTATION SYSTEM

The vehicles involved in the solid waste transportation which perform on an average 3 to 4 trips per day which are not sufficient to manage the transportation of entire garbage collected in the city. All the vehicles unload into TS&CP at Sankarpur.

Table 4.4: Solid Waste Collection and Transportation Infrastructure of DMC

Sl No.	Vehicle Type	Numbers	Remarks
1	Auto Tipper	6	Working Condition Used to collect waste from Hotel, Restaurant, Guest

			house, Hostel etc. and transport to the TS&CP.
2	Dumper	13	Working Condition Used to collect waste from small markets and street waste and transport to the TS&CP.
3	Compactor	4	Working Condition Used to collect waste from big markets and transport to the TS&CP.
4	Tractor	1	Working Condition Used to collect waste from open dumps and street waste and transport to the TS&CP.
5	Single/Double Container Dumper Placer	9	Working Condition Used to collect container with full of waste and transport to the TS&CP.

Fig 4.15: Waste Collection Procedure of Vehicles

4.7 VEHICLE MAINTENANCE

DMC is not having any proper Vehicle Garage and Vehicle Depot. At present all the vehicles are placed within Sidhu Kanu Stadium and do small repairing and washing. But, when require large requirement for maintenance of Vehicles then call mechanic from outside.

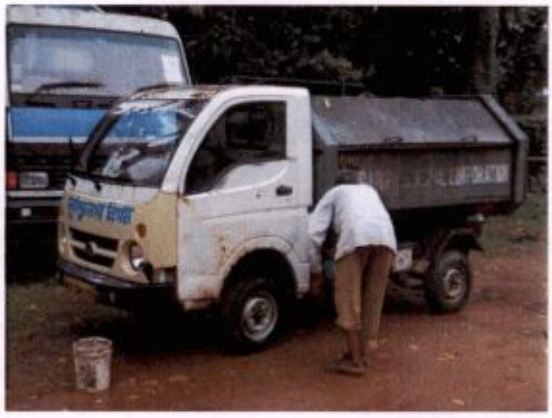


Fig 4.16: Maintenance System of Vehicle

4.8 PROCESSING OF SOLID WASTE

At present there is no scientific solid waste processing and disposal facility in Durgapur City. Thus, creating unhygienic and environmentally unsafe conditions.

4.8.1 Recyclables Waste

The recyclable wastes are segregated manually by rag-pickers at Container location points. The kabadiwalas purchase recyclable waste from residential and commercial establishments (mainly glass bottles and newspaper) while rag-pickers collect recyclables from market places, dustbins, and dumping sites, and sort them before selling off. However, these recyclables are not segregated to the maximum possible extent, thereby allowing them to be a part of the final disposed waste.

4.8.2 Bio-degradable Wastes

The bio-degradable waste is not segregated either at the Primary & Secondary collection points (households, shops, hotels, restaurants, dhabas and institutions), intermediate storage & secondary collection points, or final dumping sites. Most of the bio-degradable waste was found to be eaten by animals at the open dumping sites.

4.8.3 Non-biodegradable Wastes

Street sweepings and drain silt is a major constituent of the non-biodegradable wastes. This type of waste is disposed of at the dumping sites along with other wastes without any prior processing.

4.9 DISPOSAL OF SOLID WASTE

Presently, all the transportation vehicle of DMC disposes into TS&CP which covered 12 Acre area with coordinates 23.542611 and 87.360111 at Sankarpur, Durgapur.

Fig 4.17: Disposal Site of Durgapur

Fig 4.18: Vehicles unload into Disposal site

4.10 DEFICIENCY ANALYSIS–EXISTING SOLID WASTE MANAGEMENT SYSTEM

The solid waste management system of Durgapur city is not a properly structured collection and transportation system. There are issues that need to be addressed such as mixed composition of waste, absence of segregation practice, door to door collection is running in only 30% area of the each of the total 43 wards, improper handling of waste by waste handler, deficit of safety management, lack of awareness about disposal of waste among the people and absence of scientific disposal options. The issues identified with the current management Solid Waste Management practices in Durgapur City need improvements to make it more effective and efficient. The following aspects of the present system shall be addressed to establish a Regional Solid Waste Management System for the city.

Table 4.5: Deficiency Analysis in present scenario of SWM in Durgapur City

Components	Remarks
Segregation at Source	• Absence of segregation of waste at the source of generation. • Recyclables including newspapers, plastics and metals are collected by rag pickers.
Primary Collection	• Door to Door collection is going in only 25% - 30% area of total area of each ward. • Door to Door collection is regular in only 28 wards among 43 wards. • Waste Collection is not practiced in Slum area. • Unhealthy and unhygienic waste disposal practices followed by the big generators. • Absence of proper Safety equipments like hand gloves, mask etc.
Secondary Collection	• Insufficient number of Secondary collection points. • 70% - 80% Container are not removed by dumper placer on every day. • Absence of provision to dump the waste in separate biodegradable (green)/recyclable (blue) containers. • Poor maintenance of collection points.

	• Mixing of drain silt at this level. • Open dump waste, Street wastes are not removed at regular basis.
Street Sweeping& Drain Cleaning	• Inefficient Street sweeping & drain cleaning operations. • The current sweeping does not cover all the roads, drains and streets • Absence of proper Safety equipments like hand gloves, mask etc.
Transportation	• Absence of arrangement for lifting of waste from congested by lanes of markets and remote areas of the city. • Absence of proper Vehicle maintenance system
Community Participation	• Community participation is totally absent.
Public Awareness	• Absence of significant educational programs, campaigns, NGO activities for public awareness on solid waste management, significance of recycling, reuse and segregation of MSW.
Disposal	• Absence of waste processing practices. • Absence of scientific disposal • Absence of proper processing plants. • Absence of recorded data regarding quantity of waste dumping at dump site on every day.

CHAPTER 5 QUANTIFICATION AND CHARACTERIZATION OF SOLID WASTE

5.1 INTRODUCTION

Estimating the quantity and projection of solid waste generated in DMC is one of the primary tasks of the present study. These projections are strongly influenced by climatic, social, cultural and economic status of the society. A comprehensive assessment was carried out for waste quantification and characterization. Waste composition, characteristics and quantities of solid waste is essential for the following reasons;

- It provides the basic data on which the waste management system is planned, designed and operated.
- The trend of changes in composition and quantity of waste over a period of time are known which help in future planning.
- It provides the information for the selection of quantum of equipment and appropriate technology.
- It indicates the amount and type of material suitable for processing, recovery and recycling.

The waste generation rates have been worked out on the basis of field surveys, waste sampling and discussion with the different waste generators and the officials of the corporation. The results of the study are set out in this section.

5.2 ESTIMATION OF PRESENT WASTE QUANTITY

To arrive at the present quantity of waste generated, Sample surveys for estimation of per capita generation from various sources of waste generation and an assessment of waste collected by the solid waste carrying vehicles and uncollected waste on a typical day has been carried out. Some portion of the waste is also picked by the rag pickers and is being recycled.

5.3 PER CAPITA WASTE GENERATION – SURVEY METHODOLOGY

A detailed inventory of waste generating sources and comprehensive surveys to arrive at the per capita waste generation trends for domestic sources and assessment surveys for non-domestic sources. Project team has provided sampling polythene bags to the households and commercial establishments for collection of solid waste produce in a day in plastic bags and same was collected on next day. On site quantity assessment has been carried out by survey team through weighing machine.

5.3.1 Domestic Households

The Households per capita assessment surveys were carried out for seven days i.e. from 7th (Wednesday), 8th (Thursday), 9th (Friday), 10th (Saturday), 13th (Tuesday), 14th (Wednesday) and 15th (Thursday) of September 2016. Before the start of sampling survey, the survey team selected HIG, MIG and LIG households and made three individual groups. A day before the sampling survey, each of the selected households were briefed about the purpose of the study and modalities of waste collection, given a sampling bag and were requested to put all the accumulated domestic waste in the bag for collection on the next day.

On the day of sampling, the survey team collected the waste from each of the identified sample households of individual income group at around 8:00 am in the morning with waste handler and sample of waste put into tricycle after weighing and a fresh sample bag was handed over to the households for the next day's sampling. The same procedure was followed for all the seven days of sampling.

While at average 67nos. households were selected for sampling survey of individual income groups, the survey results as illustrated in the table below. Present a wide variation ranging from around 35 gm per capita per day to a maximum of around 1575 gm per capita per day.

Table 5.1: Sampling Details for Domestic Households

Type of Groups	No. of Samples	Per Capita Generation Range, (in grams)	Average Per Capita Generation of Individual Groups (in grams)	Average Per Capita Waste Generation (in grams)
HIG	73	35 - 1575	355.93	294.97
MIG	54	55 - 1200	273.84	
LIG	72	40 - 950	255.13	

Thus, average per capita generation from households is estimated to be around 294.97 gram/day. To arrive at the waste generated by households the per capita generation rate has been applied to the population. Thus, the total waste generated by domestic household in DMC is around **180.3 MT/day**.

Table 5.2: Estimation of MSW Generated from Households

Description	Description Value
Per Capita Generation of household waste in gm./day	294.97
Population of Durgapur - 2016	611300
Total Quantity of Waste Generated, T/day	**180.3**

Fig 5.1: Household Quantification Survey

5.3.2 Commercial Establishments

There are at about 550commercial Establishments operating in Durgapur, majority of them are Markets, Hotel, Restaurants, Community Hall, ICDS Center etc. These contribute to the solid waste generated in Durgapur. In order to assess the waste generated by these establishments, field visits and assessment surveys were carried out at commercial areas like along Redcross Road, Sahid Khudiram Sarani, Abanindr Bithi Road, Maulana Azad Sarani, Dr. Bidhan Chandra Roy Avenue, Ananda Gopal Mukherjee Sarani Road etc.

Samples were selected randomly with the support of DMC and survey was conducted to estimate the unit generation rate. The survey has been conducted five days i.e. from 9th (Friday), 10th (Saturday), 13th (Tuesday), 14th (Wednesday) and 15th (Thursday) of September 2016. Total of 28 nos. establishments were selected and field assessments surveys were carried out.

Table 5.3: Sampling Details for Commercial Establishments

Sl No.	Type of Establishments	No. of Samples
1	Vegetable/Fruit/Fish Markets	14
2	Hotels	6
3	Restaurants	5
4	Community Hall	1
5	Guest House	2

Table 5.4: Solid Waste generated by Commercial Establishments

Type of Establishments	Quantity	Unit Waste Solid Waste Generation Range, kg/unit/day	Unit Waste Solid Waste Generation Rate, kg/unit/day	Waste Generation in T/day

Markets			32735.1	32.7
Hotels	125	30-35	32.5	4.1
Restaurants	34	20-25	22	0.7
Community Hall	31	20-25	22	0.7
Guest House	9	15-20	18	0.16
Total				**38.36 T**

Based on the survey it was concluded that Commercial Establishments in Durgapur generates **38.36 T** of solid waste on every day.

5.3.3 Institutional Waste

To estimate the waste generated by institutional activities like educational institutes, hospitals (non-bio-medical waste), ICDS Center, Park Garden, Play ground etc. the per capita generation rate as indicated by CPHEEO has been considered. With reference to the CPHEEO manual the per capita waste generation by institutions is 0.05 to 0.2 kg/capita/day. Total of 15 nos. establishments were selected and field assessments surveys were carried out.

Table 5.5: Sampling Details for Institutional Establishments

Sl No.	Type of Establishments	No. of Samples
1	School	7
2	Research Institute & Engg. College	4
3	Hospital	2
4	Regional Diagnostic Center	1
5	Bus Terminus	1

Table 5.6: Solid Waste generated by Institutional Establishments

Type of Establishments	Quantity	Unit Waste Solid Waste Generation Range, kg/unit/day	Unit Waste Solid Waste Generation Rate, kg/unit/day	Waste Generation in T/day
Higher Secondary School	23	40-50	45	1.04
Secondary School	9	30-40	34	0.31
Primary School	104	20-25	23	2.4
Sishu Shikka kendra	78	10-20	16	1.23
Research Institute & Engg. College	22	75-85	81	1.8
ICDS Center	188	10-15	13	2.4
Hospital	43	40-50	44	1.9
Municipal Maternity	2	20-25	22	0.04

Home				
Regional Diagnostic Center	2	10-15	12	0.03
Extended Specialist Out Patient Dpt.	2	20	20	0.04
Municipal Health Sub-center	59	10-20	16	0.9
Park & Garden	52	15-20	18	1.0
Play Ground	81	12-15	14	1.1
Bus Terminus	3	15-20	15	0.04
Public Library	3	18-22	20	0.06
Burial Ground	8	20-25	23	0.18
Total				**14.47 T**

Based on the survey it was concluded that Waste generates from institutions in Durgapur **14.47 Ton** every day.

5.3.4 Street Sweeping, Drain Silting and Construction Debris Waste

Street sweeping waste is mainly inert waste comprising of dust, sand, dry leaves and small stones. This waste also contains litter and animal droppings. As observed during reconnaissance survey of the town, Waste is observed to be dumped mainly in drains and some open plots by the residents, shop keepers etc. The silt is left on road side for drying for a day or two before being disposed off. There are no standard practices for disposal of construction waste in Durgapur City. As discussed with DMC officials and borough supervisors the quantity of waste generate from street sweeping, drain silting and construction debris are near about **14-15 T/day.**

5.4 QUANTITY OF WASTE GENERATION

The average daily waste generation from Durgapur is around 250 TPD. Table below provides breakup of waste generation from various sources and percentage distribution of waste generation from different sources.

Table 5.7: Total Quantity of Solid waste generated by Durgapur

Sources of Solid Waste Generation	Solid Waste Generation in T/day	Percentage Distribution of Waste Generation
Residential Households	180.3	72.96%
Commercial Establishments	38.36	15.52%
Institutions	14.47	5.85%
Street Sweeping, Drain Silting & Construction Debris	14	5.76%
Total	**247.13**	**100%**

5.5 WASTE COLLECTED BY VEHICLES

Durgapur Municipal Corporation has engaged 4 single container dumper placer, 5 double container dumper placer, 6 auto tippers, 13 dumpers, 4 compactors, 1 tractor and 1 truck vehicles for collecting and transporting waste from collection points to the disposal site. Each of the vehicles is allotted specific areas for collection & transportation and around 2 to 3 conservancy labour assigned with each vehicle. For each vehicle daily collection and alternate day collection locations have been studied. The collection vehicles attend designated collection points daily and the other locations as per the schedule or as per the directions of the sanitary inspector. However the vehicle movements are not monitored on field and there is no record of the exact collection schedule of the vehicle. The vehicle movement at dumpsite is observed and analyzed for total number of vehicles on road, average number of trips performed by each vehicle type and quantity of waste collected every day. The data has been critically analyzed and to identify the positioning of the fleet on road. On an average the vehicles are performing 2-3 trips per day for collecting solid waste.

Table 5.8: Vehicle Movement Analysis and Assessment of Avg Waste Collection

Vehicle Type	No. of Vehicles unload into Dump Site	Capacity (Ton)	Total No of trips per day	Avg. Waste Collected at Dump Site T/day
Tractor	2	3	2	5
Dumper	11	3	38	105
Single Container	3	4	4	14
Double Container	2	3.5	5	16
Compactor	2	9	2	16
Auto Tipper	2	1.5	8	9
Total				**165**

5.6 WASTE COLLECTED BY RAG PICKERS

Based on the current practices of rag picking activities in Durgapur and in order to estimate the quantity of waste recycled, the street collectors, rag pickers, and dealers in the city were interviewed. The discussions revealed that there are around 150 rag pickers operating in the city. Each rag picker collects about 12-15 kg of recyclable materials like paper, cardboard, plastic, glass and metals every day. The rag pickers are operating either as a group comprising 2-3 people.

The recycled materials are being sold to dealers based on the type and condition of the material. On an average one kg of paper fetches Rs.2, one kg of cardboard fetches Rs.5, one kg of plastic fetches Rs.6-7, one kg of metal fetches Rs.10-12 and each glass bottle fetches Rs.1. on an average each rag picker makes Rs.60-75/day by collecting recyclables.

Thus analysis of this data reveals that about 2.25T of waste is being recycled every day. The waste collected by rag pickers amounts to about 0.91 per cent of the total waste generated in the city. However, it needs mention that no efforts to organize the rag pickers either by the local body or Non-Governmental

Organizations were noticed during these field investigations, which if ensured will result in more efficient recycling activity in Durgapur.

Figure 5.2: Recyclables Collected by Rag Pickers

5.7 FUTURE GENERATION TRENDS

5.7.1 Population Growth

The population growth and the changing habits of the people influence future generation trends of solid waste. The decadal growth rates of Durgapur from 1961-2011 is given in the table 5.7. The population projection methods namely, arithmetic progression, geometric progression and incremental increase method have been used. But the result getting from geometrical progression method is very conflict with Census data of 2011. Therefore, the averages of arithmetic and incremental methods have been considered for population projection for 30 years.

Table 5.9: Decadal Growth Rates of Population of Durgapur from 1961 – 2011

Year	Population	Growth Rate (%)
1961	41696	---
1971	206638	3.96%
1981	331798	0.51%
1991	425836	0.37%
2001	493405	0.16%
2011	563557	0.14%

5.7.2 Population Projection

Considering the development in the city influenced by the regional political conditions and future expansion the city is expected to experience exponential population growth due to;

- Natural growth
- Migration
- Merger of surrounding area

Waste quantities generated by an individual are linked to economic activity and resource consumption. The consumption of raw materials and finished product by the community is directly proportional to the Gross National Product (GNP) of the country. The solid waste quantities generated by an individual are directly proportional to the quantity of material consumed and thus the increase in per capita solid waste quantities would be directly proportional to the per capita increase in GNP. Various studies, as mentioned below, are been made to assess the increase in the per capita waste generation per annum based on which the increase in per capita waste generation for Durgapur is adopted.

As per the report published by Urban Development Sector Unit, East Asia and Pacific Region of The World Bank in 1999, the urban per capita waste generation rate for most of the low income countries will increase by approximately 0.2 kg per annum because these countries have relatively high annual growth rates of GNP and urban population.

As stated in the paper titled Municipal solid waste management in Indian cities – A review by Mufeed Sharholy, Kafeel Ahmad and Gauhar Mahmood of Department of Civil Engineering, Jamia MillialslamiaUniversity and R.C. Trivedi of Central Pollution Control Board in the journal of Waste Management 28 (2008) 459–467, The amount of MSW generated per capita is estimated to increase at a rate of 1 – 1.33% annually.

Mr. Kurian Joseph, Senior Lecturer in Environmental Engineering from Center for Environmental Studies, Anna University in his publication "Perspectives of Solid Waste Management in India" has quoted that the estimated annual increase in per capita waste quantity is about 1.33% per year. Thus considering the various references, the average annual growth rate of per capita generation rate has been taken as 1.33%.

Assuming this projection rates, it is projected that the per capita generation in Durgapur will increase from 404 gm/day to 588 gm/day by the target year 2045 and the total waste generated from 247 MT/day to 488 MT/day.

Table 5.10: Project Generation Trends of Solid Waste in Durgapur

Year	Design Population	Per Capita Generation, gm/day	Waste (TPD)
2016	611300	404	247
2017	620493	409	254
2018	629568	415	261
2019	638524	420	268

2020	647361	425	275
2021	656080	431	283
2022	664681	437	290
2023	673163	442	298
2024	681527	448	305
2025	689772	454	313
2026	697899	460	321
2027	705907	466	329
2028	713797	472	337
2029	721568	478	345
2030	729221	484	353
2031	736755	490	361
2032	744171	497	370
2033	751468	503	378
2034	758647	510	387
2035	765707	516	395
2036	772649	523	404
2037	779473	530	413
2038	786177	537	422
2039	792764	544	431
2040	799232	551	440
2041	805581	558	449
2042	811812	565	459
2043	817924	573	468
2044	823918	580	478
2045	829794	588	488

5.8 PHYSICAL CHARACTERISTICS OF SOLID WASTE

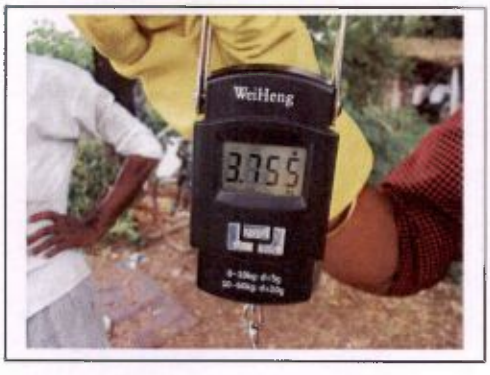
The physical characteristics of solid waste are analyzed in this section. For this purpose, sampling surveys were carried out Abanindra Bithi at city center area of the city. The sampling program comprised collecting seven days i.e., 7th (Wednesday), 8th (Thursday), 9th (Friday), 10th (Saturday), 13th (Tuesday), 14th (Wednesday) and 15th (Thursday) of September 2016 and performing on site characterization of the same. In order to represent the waste characteristics from different parts of the city, the samples were collected from different secondary collection points collecting waste from various parts of the city. The sample analysis comprised;

- For the purpose of sampling survey a temporary weighing arrangement was prepared at the sampling site. The equipment used to carry out the analysis were
- Onsite characterization by way of segregation and weighing the percentage of each constituent in terms of paper, plastic, rags, organic and inorganic components at site

For each sampling, collect 10kg – 15kg mixed fresh waste from 4-5 different container locations on everyday. The origin of each weight of waste is recorded. Then mixed thoroughly 40 - 60 kg of waste and divided into four equal parts. Using coning and quartering method about 40 - 60 kg of composite sample from original collected solid waste. The two diagonally opposite parts are retained for analysis and the other two are discarded. The retained parts are again mixed thoroughly and samples of 10 - 15 kg are taken for physical analysis. The sample was then segregated into eleven major categories of;

Fig 5.3: Physical Characterization of MSW

1. Food Waste and Garden Waste
2. Plastics
3. Metals
4. Glass & Ceramics
5. Rags/Cloth/Cotton
6. Rubber & Synthetics
7. Leather
8. Stone, Debris & Boulders
9. Paper
10. Coconut Shells
11. Any Other (Vhar)



The segregated materials were then weighed separately and the weights of each fraction were noted in the standard format. The sampling schedule is as follows:

Table 5.11: Waste Dumpsite Analysis

Date of Sampling	Location	Weight of Sample Collected from SCP	Total Weight of Sample per day in Kg	Average Weight of Sample in Kg per day
7/9/2016	Panchabati Tala	11.02	44.70	11.18
	Panchabati Tala	10.08		
	Michale Faradey	11.52		
	Bengal Ambuja	12.08		
8/9/2016	Mamra Market	11.22	63.84	10.64
	Mamra Market	10.62		
	Daily Market	10.55		
	Michale Faradey	11.02		
	CMERI More	10.03		
	Non Company More	10.40		
9/9/2016	Zakir Hussain Avenue	9.56	38.86	9.72
	Subhas Palli Uporpara	9.52		
	Dakshin Palli	9.56		
	Nibedita Place	10.22		
10/9/2016	Chandi Das Market	10.38	42.83	10.71
	Tapaban Abasan	10.23		
	Srinagar Palli	11.12		
	Chayan Math	11.10		
13/9/2016	Raj Mahal Road	10.10	61.35	10.23
	Shantiban Park	10.41		
	Gopinathpur	10.82		
	Sagar Bhandar	9.82		
	ITI Aambagan	9.97		
	Forest Road Bidhannagar	10.23		
14/9/2016	Panchabati Tala	10.65	44.14	11.04
	Bengal Ambuja	12.15		
	Chandidas Market	11.09		
	Srinagar Palli	10.25		
15/9/2016	Michale Faradey	11.80	46.75	11.69
	Zakir Hussain Avenue	10.66		
	Nibedita Place	11.72		
	ITI Aambagan	12.57		

Graph 5.1: Graphical Representation of Constituents of Solid Waste

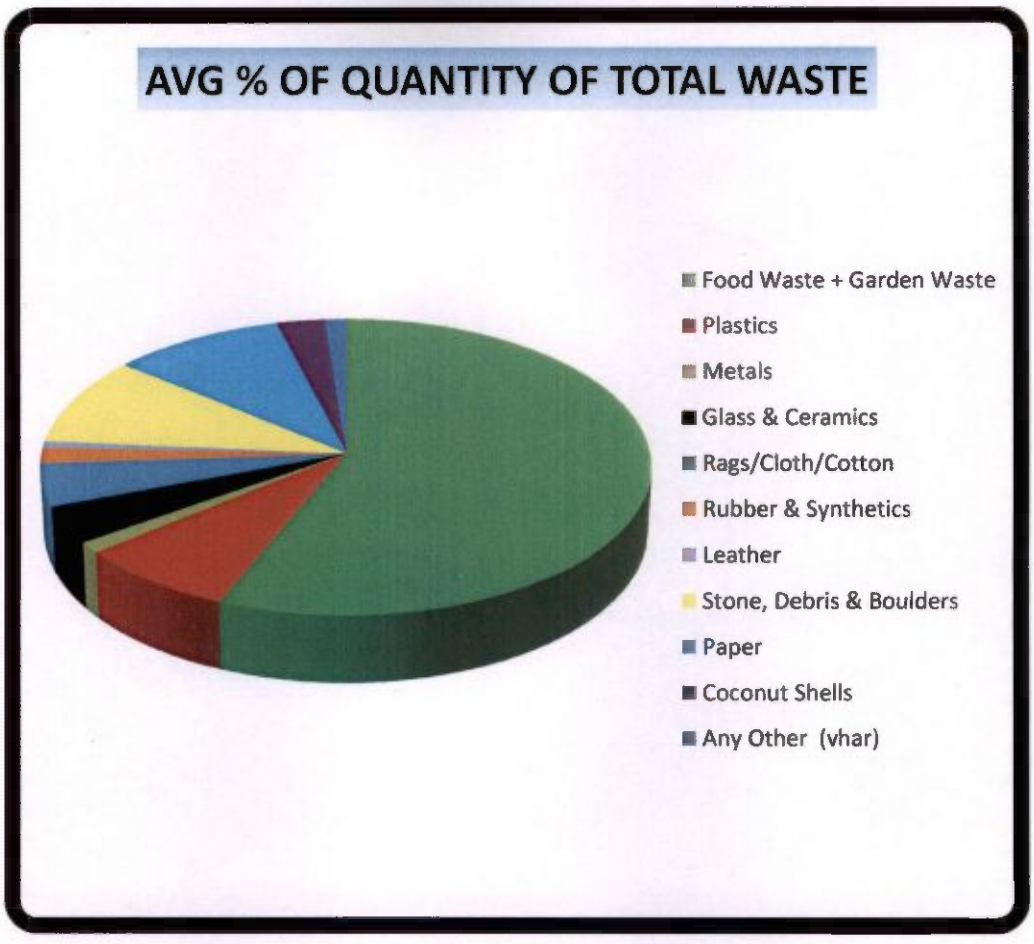


Table 5.12: Physical Characteristics of MSW Samples

Sl no.	DATE / Parameter	9/7/2016 % of each Parameter in Total quantity of Solid Waste	9/8/2016 % of each Parameter in Total quantity of Solid Waste	9/9/2016 % of each Parameter in Total quantity of Solid Waste	9/10/2016 % of each Parameter in Total quantity of Solid Waste	9/13/2016 % of each Parameter in Total quantity of Solid Waste	9/14/2016 % of each Parameter in Total quantity of Solid Waste	9/15/2016 % of each Parameter in Total quantity of Solid Waste	AVERAGE % of each Parameter in Total quantity of Solid Waste (7 days)
1	Food Waste + Garden Waste	55.62%	35.89%	68.98%	58.66%	67.51%	54.56%	52.20%	56.20%
2	Plastics	8.98%	6.40%	7.17%	11.85%	5.08%	7.25%	8.35%	7.87%
3	Metals	2.30%	0	0	0	0	2.40%	3.50%	1.17%
4	Glass & Ceramics	3.89%	7.43%	0.45%	3.19%	6.08%	3.85%	3.20%	4.01%
5	Rags/Cloth/Cotton	8.59%	10.80%	0	5.65%	1.62%	1.98%	4.20%	4.69%
6	Rubber & Synthetics	0	0	5.42%	0	0	2.60%	3.80%	1.69%
7	Leather	0	0.40%	0	0	1.73%	1.50%	1.30%	0.70%
8	Stone, Debris & Boulders	4.09%	12.20%	8.36%	7.53%	10.93%	11.60%	12.80%	9.64%
9	Paper	12.53%	18.58%	7.72%	12.26%	2.31%	8.60%	7.80%	9.97%
10	Coconut Shells	2.10%	7.73%	1.30%	0.86%	4.74%	1.66%	1.30%	2.81%
11	Any Other (vhar)	1.90%	0.57%	0.60%	0	0	4%	1.55%	1.23%

CHAPTER 6 PROPOSED MSW MANAGEMENT SYSTEM

This chapter provides an integrated SWM plan for primary and secondary waste collection systems and transportation system for Durgapur city. The proposed plan also includes the infrastructure requirements, quantities, and corresponding cost estimates for the collection and transportation systems. The proposed SWM system is broadly based on the 4R Environmental Protection Rules (Reduce, Recycle, Reuse, and Recover) and is in accordance with the MSW 2016 Rules. The primary aspects of the proposed plan include the following:

- Compliance with Municipal Solid Waste Management & Handling Rules of 2016
- Compulsory segregation at the source,
- provision of collection and transportation of segregated waste,
- processing and proper disposal is considered for MSW handling
- Elimination of manual handling of waste, provision of the proper PPEs to the workers 100% collection and transportation of the generated waste
- Maximum recovery of resources by segregating recyclables and biodegradable Advocate 4R's i.e. reduce, recycle, reuse, and recover materials in MSW management,
- Adopt proven technologies for waste processing, Promote information education and communication across the stakeholders to ensure system efficiency and sustainability
- Ensure economic sustainability of the proposed system by introducing public private partnership in MSW management,
- Adequate health and safety provisions for workers at all stages of waste handling,
- Regular environmental monitoring at waste processing and disposal facilities,
- Have robust complaint-handling system in place,
- Conduct regular internal and external independent audits on the efficiency of entire SWM system

6.1 PROPOSED INTEGRATED SOLID WASTE MANAGEMENT SYSTEM (ISWM)

The proposed system is designed for ISWM includes following major components:

Collection & Transportation of Waste – a well define system for waste collection at source level (door to door collection), secondary storage and collection bins (household bins, community bins), Vehicles for primary collection and transportation to processing facility and regional landfill site.

Processing Facility – Collected waste from various sources will be transported to processing facility. The received waste will be segregated to recyclable and processing. The processing would design in line with waste quality and quantity for composting and RDF.

Sanitary Landfill Site – Compliance with client input regional landfill site to be designed and developed for cluster cities. The proposed site for regional landfill is located at Bhagalpur. The proposed regional landfill detail is given chapter Regional landfill site.

6.1.1 Basis of Design for Proposed SWM Plan

In order to propose a waste management plan and infrastructure/equipment for primary and secondary waste collection and transportation systems for Durgapur city, the following points were considered:

- Past population estimates based on Census surveys
- Projected populations for the design period Spread of Durgapur city
- Current MSW quantities as per Consultant's field survey data
- Projected MSW quantities based on the current values
- Current and projected per-capita waste
- Characterization of the current and projected waste quantities
- Ward wise quantity of waste generation
- Existing waste dumping sites/secondary waste collection locations

Table 6.1: Population Estimates, Waste Quantities, and Waste Characterization

2011 Population (Census Data)	563557
2016	611300
2020	641637
2025	804701
2030	912135
2035	1035446
2040	1178410
2045	1345553
Waste Composition	**Percentage Waste**
Biodegradable	56.2%
Non Biodegradable	43.8%
Total	100%
Density (Kg/m3)	415
Moisture Content	35.6
Per-capita Waste (kg/capita/day): 404 gpd	

(Source; Sampling & Analysis Results)

The waste; construction waste, drain silt, street sweepings and mixed waste comes under non-biodegradable category

All medical facilities shall compulsorily segregate their waste at source and send their waste to the authorized waste treatment and disposal facility. The State Pollution Control Board shall monitor all medical facilities in Durgapur and ensure that all of them dispose off their waste as per the rules.

6.2 SUGGESTED SYSTEM FOR WASTE STORAGE AT SOURCE

It was observed that the municipal solid wastes generated from households, market entities, shops, restaurants, hotels etc do not follow storage at source. Lack of proper storage at source coupled with absence of door-to-door collection system is leading to throwing of wastes on streets, roads sides.

In view of the above, waste storage at source and collection should be strengthened through awareness campaigns. The following measures are to be implemented at Durgapur to improve the overall environmental conditions at the earliest.

- For maintaining streets, roads and other public places clean, it is extremely important that the public effectively participate/co-operate in the waste management efforts of local bodies.
- Residential households shall store waste in two bin system, supplied to them by DMC and deposit to the waste collectors who come for door-to-door collection at a specified time every day.

The collection shall be on daily basis for biodegradable wastes. Further, to avoid other problems like odour and fly/insects nuisance, the wastes are to be kept in closed bins. Non- biodegradable wastes and hazardous domestic wastes shall be collected separately once in a month.

6.2.1 Individual Households

- To begin with, the segregation shall be done in two categories - one bin for the wet waste or biodegradable waste (Kitchen waste, house sweepings, etc) and the second bin for the Dry Waste or non-biodegradable wastes (Recyclables such as paper, plastics, metals, glass, etc).
- The biodegradable waste degrades and generates liquid, it is advisable to use non-corrosive container with lid for the storage of food/bio-degradable/wet waste. A container of 10 liters capacity for a family of about 5 to 6 members would generally be sufficient for wet waste. However, it is advisable that a household should keep larger container or standby container to store the additional wastes produced in 24 hours. The household may have a spare capacity of 100% to meet unforeseen delay in clearance or unforeseen extra loads. Wet wastes should preferably not be disposed of in plastic carry bags.
- Dry wastes may be stored in similar container but of different colour.
- The recommended colour coding system for storage of different types of wastes is mentioned below in Figure **6.2**.
- Dry waste can be also stored in bags.

Every household shall be covered by waste collectors on daily basis for collection of biodegradable wastes. Two bins (10 liters capacity each, blue and green) shall be supplied free of cost one time (approx. 48000 HHs x 2 =9600 HDPE bins will be required for storage of MSW in residential households).

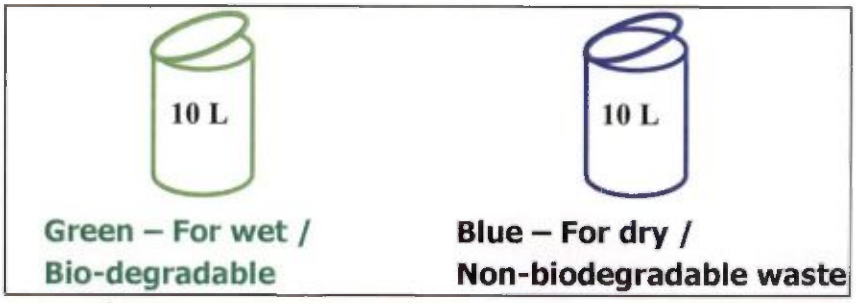


Fig 6.2: Recommended Waste Storage Containers at Source

6.2.2 Housing Complexes/Society

In case of multi storied buildings and housing complexes/society, it is practically difficult to have door-to-door collection system. It is recommended to have community bins within the premises of such housing complexes and societies. Every household should have small 10 Liter waste bin for storage of wet and dry wastes and the wastes may be transferred to the waste community bin placed for such multi storied buildings or group of such buildings as the case may be based on quantity of waste generation. Municipal Corporation Durgapur may ask the housing societies to place suitable bins or in turn may place such bins on cost recovery basis. Daily services will be provided by DMC to collect wastes from such places in tipper vehicles.

6.2.3 Commercial Establishments

All shops and establishments may be instructed not to throw their solid waste/sweepings etc. on the road. They should store their waste as and when generated in suitable size containers. The size of the container may vary from shop to shop depending upon daily waste generation and should be adequate to hold the waste that they generate daily with 100% spare capacity to meet unforeseen delay in clearance or unanticipated extra loads in plastic containers – one for biodegradable items and another for non-biodegradable items..

The hazardous wastes generated from these establishments should be stored separately and municipality should be consulted for arranging for disposal of such wastes.

Non- biodegradable wastes and domestic hazards wastes shall be collected by DMC once in a month.

6.2.4 Hotels & Restaurants

The hotels and restaurants shall store waste at source in two bin system arranged by them. The container should be such that it is easy to handle and empty. To this effect, container should have appropriate handle or handles on the top or side and rim at the bottom for ease of emptying.

Door to door service will be provided by DMC either through waste collectors in tricycles or tipper vehicles (1 m^3 capacity) on payment basis.

They may be directed to keep hazardous waste separately as and when produced and dispose it off as per the directions of the Durgapur Municipal Corporation (DMC) and shall be collected separately once in a month or as per call basis when required.

6.2.5 Vegetable markets

Vegetable markets produce waste, which is ideal for biological processing. In view of this, it is desirable that all vegetable market waste should be stored and collected separately without allowing it to get mixed with other wastes in mobile garbage bins (1.1 m^3 capacity)

The vegetable market shops should be clearly instructed not to throw their waste on road/street side. This is very much essential as the vegetable waste causes nuisance due to faster degradation rate and also by attracting stray animals.

DMC should ensure that the wastes are lifted from the markets regularly. Further, they shall also instruct shopkeepers to store their wastes in color-coded containers. The shopkeepers may be advised to empty their waste bins into the nearest mobile garbage bins placed by DMC.

6.2.6 Meat & fish markets

Waste from fish/meat market emanates very bad smell and therefore it is desirable that these wastes are not at all thrown outside.

Shopkeepers should be strictly instructed not to dispose or store waste at open places in front of their shops/establishments or anywhere on the streets/road. At these markets, the shops shall be advised to have their own containers of 25 to 50 liters size. The shopkeepers may be advised to empty their waste bins into the nearest separate mobile garbage bins placed by DMC before closing their shops.

6.2.7 Street food vendors

All the street food vendors are not keeping their own dust/waste bins and some of them are throwing their wastes on roadside. This should be strictly prohibited.

They should keep their own dust bin/waste bin of bucket size. At the end of the day, all the vendors should be asked to transfer waste to the nearest mobile garbage bin points.

6.2.8 Marriage / community halls

These are the places, which generate high amount of waste occasionally when such functions are held in these establishments.

These establishments should be instructed to install their own large size containers for storage of waste at source. These establishments should give prior intimation to DMC for any function being organized so that they can direct it's conservancy staff to collect waste from these containers next day or in the evening of the same day. The charges for waste collection/lifting are to be paid in advance to be decided by municipal authority suggested Rs. 100 per tricycle container load.

6.2.9 Bio-medical waste

Bio-medical waste should be stored & treated strictly in compliance with the Bio-medical Waste (Management & Handling) Rules, 1998. They should ensure segregation of infectious and non-infectious waste and store them separately.

Bio-medical waste should not be allowed to be thrown at bins of DMC.

Only those wastes, which are not listed in the Bio-medical Waste (Management & Handling) Rules, 1998 i.e. general waste, which is not infectious or treated bio-medical waste can be stored separately for lifting by the DMC. Separate collection system shall be arranged in biomedical van and directly disposed at predefined locations of landfill site.

The health care establishments should follow the directions of Central & State Pollution Control Board from time to time for the handling, storage and treatment of Bio-medical waste.

6.2.10 Construction & Demolition Waste

No such waste should be allowed to be stored on the road or outside the premises of construction site.

The construction and demolition waste should be stored within the premises itself. As such wastes can be directly reused for filling low lying areas or even in construction of WBM approach road etc. DMC shall collect such waste from each activity spot on advance payment in 1 m^3 capacity vehicle.

In case, it is not feasible for construction site owner to store the construction debris within the premises, they should provide prior information to the DMC and may store their waste in tractor trolley or large container, whichever is feasible for lifting of waste immediately from the site on advance payment to municipality at the rate to be decided by them.

6.3 WASTE SEGREGATION AND PRIMARY COLLECTION

The term sorting indicates separation and storage of individual constituents of waste material so as to facilitate material and energy recovery and reduce the load on the final disposal of solid wastes in the landfill. The desirable sorting recyclable materials - Paper, plastic, cardboard and cartons, streams are:

- Dry containers, packaging, glass, metals, tags, rubber, wood, foils, wrappings, pouches, sachets, tetra-packs (rinsed), cassettes, computer diskettes, printer cartridges and electronic parts, discarded clothing, furniture and equipment;
- Bio-waste and garden waste- Food waste (Including eggshells and bones), flowers and vegetable wastes, house sweepings, household inert (sweepings /ashes);
- Hazardous material in household waste: Aerosol cans, batteries from flashlights and button cells, bleaches and household kitchen and drain cleaning agents, car batteries, oil filters and car care products and consumables, cosmetic items (Chemical based), Insecticides and their empty containers, light bulbs, tube lights and compact fluorescent lamps (CFL), Paint, oils, lubricants, glues, thinner and their empty containers, pesticides and their empty containers, photographic chemicals, Styrofoam and soft foam packing from new equipment, thermometers and mercury - containing products.

6.3.1 Measures

- DMC shall educate for colour coded bins (two nos.) to all householders for storage of waste.
- It is suggested that, all the householders should be asked to segregate wastes at source as per following guidelines to make the solid waste management system more effective by ensuring 100 % segregation.

The residents should be educated that separating it at source for recycling could make profitable use of such material. This will help save national resources and also save the cost and efforts to dispose of such wastes. This can be done by cultivating a habit of keeping recyclable waste material separate from food wastes, in a separate bag or a bin at the source of waste generation.

- DMC should train all of its sweepers/sanitary workers on segregation and recycling and they should also be advised to collect recyclable wastes separately.
- It is essential to save the recyclable waste material from going to the waste processing and disposal sites and use of landfill space. Therefore, the owner of waste processing plant should be advised to carry out waste segregation by hand picking to segregate contraries and sale them to recyclers or if it is not feasible, the processing plant operator should allow registered scavengers to enter the premises of the compost plant and picking recyclable waste. This would ensure reduction in rejects reducing burden on landfill.

- DMC should mobilize voluntary organizations and NGOs to take up the work of organizing street rag-pickers and elevate them to door step "Waste Collectors" by motivating them to stop picking up soiled and contaminated solid waste from streets, bins or disposal sites and instead improve their lot by collecting recyclable clean materials from the door step at regular intervals of time. They should be given uniform, safety kits and necessary tools like trolleys/bags, etc by DMC to do the job. They may collect payment directly from the householders, shopkeepers, hoteliers, etc. This will result in employment of such underprivileged people as well as enable source segregation of waste.
- DMC should associate and involve residents, market & restaurants associations and NGOs in increasing awareness among the people to segregate recyclable material at source and hand it over to a designated waste collector identified by NGOs. The local body may give priority to the source segregation of recyclable waste by shops and establishments and latter concentrate on segregation at the household level. This arrangement could be made on payment basis to such waste collectors for the doorstep service provided to sustain their efforts.

6.4 PROPOSED COLLECTION AND TRANSPORTATION OF WASTE SYSTEM

The proposed Collection & Transportation plan includes following components:

1. Primary Collection-Door to Door collection for Residential area
   - Household bins
   - Primary Collection Vehicles (Tricycle & Auto-tippers)
2. Collection of C & D categories waste
3. Street Sweeping & Drain Cleaning
4. Secondary Waste Storage System
5. Transportation of waste from secondary collection points to the Treatment Facility/landfill.

FLOW CHART FOR WASTE COLLECTION SYSTEM

HOUSE HOLDS

INSTITUTE

COMMUNITY BINS

MARKETS

COMMERCIAL

STREET WASTE

PRIMARY COLLECTION

TRICYCLE

Compactor Bin

AUTO TIPPER

SECONDARY TRANSPORTETION

Stationary Compactors

Movable Compactor

COMPACTORS

Processing plant and SANITARY LANDFILL

6.4.1 Primary Waste Collection System

Primary collection has been proposed to be done on door to door basis by means of household bins and a number of primary collection vehicles.

The efficiency of the proposed waste management plan described below is determined by the segregation of waste at the primary collection level. For this purpose, following approach needs to be adopted by the residents as well as the Durgapur Municipal Corporation (DMC) personnel.

The modus operandi for primary collection of waste should be based on following:

- Door-to-door collection of waste should be initiated;
- As discussed in this chapter for implementation of door step waste collection using tricycles or hand trolleys keeping this in view, it is recommended to do the door step waste collection through public private partnership;
- Private sector's role for door to door waste collection and community awareness has to be clearly defined;
- Door-to-door waste collection system should cater to all the households and efforts should also be made to collect waste from shops and restaurants in daytime;
- Avoid double handling of waste and keep it only two tier as far as possible i.e., first up to waste storage depot and second from waste storage depot to processing and disposal site;
- Waste from litter bins / community bins/containers placed in market areas, hotels, restaurants area, institutional areas, and commercial complexes should be lifted every day and transported to the waste storage depot to avoid flooding of bins or containers.

The waste will be stored by the generators in two separate bins, one for bio-degradable and one for recyclables.

Door-to-door waste collection will be privatized in the entire Durgapur city. Area wise responsibility will be assigned to private operators. Waste collectors will collect waste on a day-to-day basis in two types of bins - green bins for bio-degradable and white bins for recyclables. Door-to-door collection of waste will be through rickshaw trolleys.

DMC safai karamcharis shall do street sweeping on a day-to-day basis. The street sweeping waste will be collected in wheelbarrows. The waste collectors will transfer bio-degradable and non-biodegradable waste to the secondary collection location and will sell the recyclable waste.

The existing infrastructure for secondary collection of waste will be upgraded to comply with MSW Rules 2016 and additional secondary collection locations will be developed to ensure that no primary collection staff has to travel more than 250m for dumping of waste.

The DMC safai karamcharis shall re-use the construction and demolition wastes for filling-up the man-made low-lying areas. The feasibility for recycling of construction waste for making bricks may be explored later with assessment of C&D waste quantity may possible after compliance of proper system of waste collection. The local residents shall hand-over the construction waste generated from private construction activities to DMC workers for proper use.

The waste generated from slaughter houses shall be dealt separately by butchers or slaughter house managers by adopting methods like rendering/ controlled incineration/burial/composting/anaerobic digestion etc. The private workers and DMC safai karamcharis shall be well equipped to avoid direct contact with waste.

6.4.2 Primary Collection of wastes from society / complexes

The bins will be placed at strategic location considering location, population density in consultation with DMC to ensure that the bin or container is easily accessible and convenient to empty.

Awareness program will be conducted for resident's to store their organic (wet) and inorganic (dry) waste separately.

6.4.3 Collection of waste from vegetable & fruits, meat and fish markets

Shop owners in the sabzi mandi shall be directed to directly place their waste in the nearest bins. In addition, sweepers employed shall pick up any waste littered and place it in the bins.

Table summarizes the overall management of MSW at the primary collection level.

Table 6.2: Primary Waste Collection System

Category	Source/Waste Generator	Type of Waste	Requirement	Generator Responsibility	Implementation
I	Residential Commercial Institutional Hotels/ Restaurants/ Eating Joints	Bio-degradable Non-Biodegradable Recyclable	Segregation at source Day-to-day collection	1. Storage in 2-bins	1.Private/NGOs waste collectors 2.Rag-pickers
II	Street sweeping and drain silt	Bio-degradable Non-Biodegradable Recyclable	Segregation at secondary collection Day-to-day collection	--	DMC safaikaramcharis – also to be brought under PPP format overtime
III	Construction	Non-biodegradable	Time of construction	Handover to DMC	DMC waste collectors - also to be brought under PPP format overtime

It is proposed that primary waste collection shall be done by private operators/NGOs. Presently, in Durgapur there is limited system of primary collection of waste. It is proposed that DMC shall identify private operators/NGOs for this purpose and authorize them for undertaking this activity. The private operators/NGOs shall be assigned responsibility area wise. The private operator/NGO authorized for a particular area shall ensure that there is proper waste collection as per the plan from all sources in his area.

6.4.4 Collection of Waste from Households

The door-to-door collection of waste shall be done on a day-to-day basis between 6:00 AM and 1:00 PM. The DMC shall ensure that infrastructure is made available for undertaking this activity in compliance with the MSW Rules 2016.

The proposed infrastructure for primary waste collection is given below. The waste collection infrastructure for construction and demolition shall be provided by the DMC on need basis.

6.4.5 Sweeping of Street & Public Places

All the streets in Durgapur shall be sweeped daily and main market should be cleaned twice a day. The following important things to be considered for sweeping:

- Street sweeping activity shall also include surface drain cleaning
- Handcarts shall be used for collection of waste & shall be transported to the nearest bins.
- In addition, mechanical sweepers shall be procured for this purpose

6.4.6 Suggestion – Banning the Use of Polythene/ Plastic Bags

The use of plastic bags, which has grown exponentially in the last decade, poses a major problem as far as the MSW management is concerned. This is a great concern for any city.

Apart from the fact that plastic waste chokes the drain, suffocates animals to death that eat them, it also makes MSW unfit for any biological treatment. Also, being non-biodegradable, the total quantity of plastic waste cumulatively increases with time. Incineration, the alternative treatment for non-biodegradable waste, has not found a strong foothold in Indian conditions. Also, combustion of plastic leads to air pollution related problems.

The polythene bags being very thin require a large number to be collected before they make up a saleable weight. Since the rag picker normally gets paid per kilo of plastic bags collected, it would take him/her throughout the day to collect about 800 bags needed to make up one kilo to fetch an amount of Rupees 10 to 12. On the other hand, heavier plastics would be faster and easier to collect. Another major use of plastic which is picking up is the use of mineral water bottles and use of disposable plastic glass and cutlery at the restaurants, particularly, the fast food joints.

Numerous measures, which can be taken to cut down the use of plastic items, would include:

- Impose ban on use of thin plastic bags (of thickness < 20 microns). The thick bags being more expensive will discourage the indiscriminate use of plastic bags within the city.
- Encourage the use newspaper bags, wherever possible
- Make jute, cotton bags and thick plastic bags available at the major shopping centers. The citizens should be made to pay a nominal amount to procure these bags.
- Discourage use of packing in fast food joints. Encourage them to use the items made of biodegradable material.

6.4.7 Role of Private sector in Solid Waste Management (SWM)

Role of private sector in SWM is growing in India. Surat, Ahmedabad, Nagpur, Hyderabad, Chennai has seen successful examples of Public Private Partnership in SWM. Outsourcing to private sector improves the financial viability of the SWM. The scope of private sector participation in various activities related to solid waste management is presented in following Table 6.3

Table 6.3: Public Private Partnership Options in Solid Waste Management

Sl. No.	Activity	DMC	Private Sector	Implementation Options
1	Door to Door Collection		Yes	Service Contract
2	Street Sweeping	Yes		Service Contract
3	Procurement and Maintenance of Bins		Yes	BOT and its variance/Separate EPC* and O&M Contract
4	Transportation of waste to integrated facility	Yes	Yes	Concession/O&M Contract
5	Design, development, operation and maintenance of Processing Facility		Yes	DBO/ Separate EPC and O&M Contract
6	Design, development, operation and maintenance of sanitary landfill site		Yes	BOT** and its variance/DBO***/ Separate EPC and O&M Contract

* EPC: Engineering, Procurement and construction
** BOT – Build, Operate and Transfer
***DBO – Design, build and operate

Table 6.4: Examples of PPP in Solid Waste Management in India

Sl. No.	Services on PPP	Examples
1	Door to Door waste Collection	Bangalore, Ahmedabad, Nagpur, Jaipur, North Dumdum, New Barrackpore (West Bengal), Gandhinagar, Vejalpur (Gujarat), Kanpur, Delhi
2	Street Sweeping	Surat, Hyderabad
3	Storage and Transportation	Surat, Ahmedabad, Mumbai, Delhi
4	Integrated Treatment and Disposal	Delhi, Mumbai, Bangalore, Kolkata, Chennai, Hyderabad, and Ahmedabad
5	Integrated primary collection, street sweeping, storage and transportation	Chennai, Kanpur, Delhi, Hyderabad, Ranchi, Aligarh, Moradabad, Varanasi etc.

It is therefore proposed here to implement PPP for SWM in Durgapur.

In PPP, private employed for door to door waste collection shall charge a stipulated amount from the generator. The stipulated charges for different categories of generators shall be well publicized through leaflets, advertisements and posters. DMC shall take strict administrative action for effective implementation of door step waste collection through public private partnership. The different categories of waste generators that shall be charged are as given below in **table 6.5**.

Table 6.5: Categories of waste generators for door to door waste collection

Sl. No.	Category
1	Households
2	Commercial (Offices & Banks etc.)
3	Dhabas, Restaurants & Fast Food
4	Pan/Tea Shop
5	Hotels/Guest Houses
6	Big Offices
7	Schools & Colleges
8	Shops/Pvt. Professional Offices
9	Factories/Workshops/Sheds
10	Cinema Hall
11	Bakeries/Food Joints

6.4.8 Fees for Marriage Halls/Community Halls

For lifting waste from marriage halls, community halls and other public places like parks where functions are held, DMC Durgapur may charge generator fees at nominal rate.

6.4.9 Penalty for littering

Cess / fees to be levied strictly to prevent littering of waste on streets/roads. A provision of penalty should be levied in the municipal laws for throwing waste on road.

6.4.10 Fees for construction/demolition waste

Fees at nominal rate to be charged for lifting construction/demolition waste from the construction site as present case

6.4.11 Role of sweepers

- The role of sweepers engaged for door step waste collection shall be clearly defined. Their roles shall be informed to the residents through resident association, leaflets, advertisements, etc. All the residents shall be requested to cooperate.
- The residents should give their wet & dry waste separately. Collection of dry waste shall be made separately once in two days by the same sweepers or by regularized rag pickers.

- In case, the sweeper gets mixed waste, he should be able to recognize between dry and wet waste so that he can put them separately in two drums.
- In case of non-availability of resident, the sweeper should lift the waste bags/containers left outside, if any.

6.4.12 Required Infrastructure for Households

The infrastructure is calculated at ward level. Considering waste storage separately at household level; 2, 51,828 Nos. of bins estimated for 1, 25,914 household (2 bins/household).

Based on field survey, it is proposed to use Rickshaws and Auto Tipper for door-to-door collection of waste. Rickshaw will be used as a Primary Collection Vehicle. Rickshaw is used to collect waste from residential and commercial areas and transport it to nearest allocated Compactor/ Secondary Collection Points. This facility has been proposed because:

Fig 6.3 Rickshaw Trolley with 4 bins

- Easy to move in narrow lanes.
- Easy to transfer the waste from bins to containers.
- Give faster mode of transportation than Handcarts.

Auto tippers are also proposed for collection with Rickshaw as a Primary Collection Vehicle. Auto tippers are proposed to collect the waste from areas where road are sufficiently wide for turning of vehicle and areas where large quantity of waste is generated and also the area of expanse is large such a markets etc.

This type of vehicle is introduced because of the following reasons:

- To reduce multiple handling of the waste as suggested in MSW rules 2016.
- It gives faster mode of transportation.
- It requires less manpower.
- Can transport large quantity of waste at a time as in case of market
- It collects waste from source and directly unloads at Transfer station or large size refuse collector.

It is assumed that about 20% of House hold will be covered by Rickshaw and remaining 80% will be catered by LCV which will transport waste to compactor which will carry the waste to processing facility.

It is proposed to have Rickshaw with Six 50 litre bins for door-to-door collection of waste. The waste collection from narrow kharanja roads will be done through handcarts while in other areas primary collection will be done by rickshaws. Among 4 bins, 3 bins will be used for collection of biodegradable

waste, 1 bin for recyclables. The distribution of bins for waste collection has been done on the basis of the waste characteristics received from the households. The waste received from the households mainly comprises of biodegradable waste therefore 3 out of 4 bins have been allocated for this purpose.

The ward wise quantity of waste generation from each ward is projected based on projected population (considering ratio of ward wise area) ward and per capita waste generation in Durgapur.

This activity shall be undertaken by private operator. The private operator shall have sufficient number of workers to do waste collection all 365 days a year.

6.4.13 Work Norms

Except the roads and streets with no habitation or less density of habitation, it is strongly recommended to render services pertaining to sweeping, lifting garbage from the community and litter bins, lifting garbage from the waste storage depots on daily basis including Sundays and public holidays.

The DMC should publish notification to this effect and invite general public to complain and bring it to the notice of municipality in case their area is not cleared.

Sanitary services should not suffer due to absence of any sanitation worker. In order to assure this, alternate arrangements must be made to ensure that all sanitary services are provided even when any sanitary worker is on leave or absent.

Clear cut and specific work norms need to be devised for sanitary workers, sweepers, jamadars, sanitary inspectors and health officers who are directly involved in SWM services.

The work norms can be devised depending upon local conditions. It is advisable to start the work as early as possible in the morning so as to avoid interference with routine activities of the residents.

The work norms should be such that they are applicable to individuals so as to allow measurement of their work performance. The work norms for group of sanitary workers are never successful.

The work norms may also be in compliance with government policy and court orders.

6.4.14 Collection of Waste from house hold and Commercial Areas

Households, association of markets, shops and establishments shall organize for primary collection of waste with the help of private waste collectors authorized in their area. Most of the waste from commercial areas is recyclable. Therefore it is proposed that rag pickers shall collect recyclable waste from shops and establishments as soon as they open. There will be a secondary waste collection point in every market area; therefore shopkeepers themselves shall dispose off their waste in these collection points.

The usual timings of waste collection will not be feasible for markets as shops normally open after 9am. It is proposed that street sweeping in market area shall be done in the early morning hours and waste collection shall be done from 7:00 am to 9:00 am.

6.4.15 Collection of Construction and Demolition Waste

The construction and demolition waste will be collected on need basis. It is the responsibility of generator to inform DMC that construction waste need to be collected from the site. The DMC shall collect this construction waste in existing tractors and trucks and transport it for reuse or recycle.

From the survey it was observed that DMC area generate approx 14 T construction debris per day. Assuming that average quantity of construction waste per tripper truck is 2 MT and 1 truck makes 2 trips a day. Therefore approximate number of truck required is 4 for transportation of construction debris.

6.4.16 Secondary Waste Storage System

There are open dumps for secondary waste storage in Durgapur. The existing collection system is taken as a basis to develop secondary waste collection system for Durgapur city.

Proposed Management Plan for Secondary Waste Collection System

It is proposed to provide secondary collection facility for biodegradable and non-biodegradable waste. The recyclables will be sold directly in the market by waste collectors.

MSW at every secondary collection point shall be stored in two separate covered containers – green for bio-degradable and Blue for non-biodegradable.

The bin design and strength shall be able to facilitate its hydraulic lifting by transportation vehicles.

6.4.17 Waste Transportation System

The MSW transportation system for Durgapur city is proposed in combination with the waste collection system described in the preceding section. The requirement of transportation vehicles has been estimated based on the following plan

The DMC workers shall transport the bio-degradable waste (green containers) from secondary collection points to processing facility on a day-to-day basis.

The DMC workers shall transport the non-biodegradable waste (Blue containers) from secondary collection points to a designated integrated waste processing facility at least once in two days.

The waste from bins shall be transported using compactors. Hydraulically operated equipment shall be used for transportation of waste. The waste, under any circumstances, shall not be handled manually.

Cattle lifting vehicles shall be used for lifting of stray animals and dead animals from the city

6.4.18 Tools to be given to Sweepers

Adequate number and types of tools should be given to sweepers to execute efficient sweeping and waste collection.

Requirements of equipments for street sweeping and drain cleaning other than hand carts, wheel barrows have been shown in table 6.6 for the duration 2018-2022.

Table 6.6: Requirement of Equipments for Street sweeping and Drain Cleaning

Sl. No.	Equipments / Implements	Monthly Requirement	Annual Requirement
1	Long hand brooms	136	816
2	HPE Pans	136	816
3	HDPE Plates	136	816
5	M. S. Shovel	136	136
6	Gloves	1127	6762
7	Mask	1196	14352
8	Apron	1196	1196
9	Gum boot	326	326
10	Cap	1196	2392

PPEs required for the street sweeping staff include gloves, boots, safety mask and uniform. Therefore,

6.4.19 Street sweeping & Surface drain cleaning

It is recommended to carry out daily sweeping of streets. Surface drain cleaning shall be done in parallel to street sweeping activity. Therefore same manpower shall be utilized for both activities.

The street sweeping shall be done on a day-to-day basis. It is desirable to split the 8 hours of duty of sweepers into two shifts (5.00 AM – 10.00 AM and 11.00 AM – 2.00 PM). The street sweeping is to be done by DMC safai karamcharis as per the proposed plan.

6.5 PROPOSED INFRASTRUCTURE REQUIRED FOR COLLECTION, HANDLING AND TRANSPORTATION OF MSW

6.5.1 Manpower and Tools Requirement

Fig 6.3: Manpower requirement for Primary Collection, Road Sweeping and Drain cleaning

Sl No.	Equipments	Nos.	Waste cum Sweeper Collector	Drivers	Helpers
1	Tri- cycle Cart- 6 nos. 50 lit bin	333	367		

2	Handcart with 4 nos. of 60 lit bin (Street Sweeping)	324	357		0
3	Drain Cleaning - Wheel Barrow	296	326		
4	Auto tipper	27		27	54
5	Movable compactor	12		12	36
6	hook loader	3		3	3
7	Compactor station	6			12
Total			**1050**	**42**	**105**

Apart from the above following Manpower is also required

- Supervisor @1 per ward = 43
- Sanitary Inspector = One for each Borough – 5 Nos.
- Health Officer = 1 No
- Environment Engineer = 1 No

6.5.1.1 Door to Door waste collection

Door to door waste collection through public private partnership. Handcarts and Tricycle shall be provided to the private party for transferring waste to the bins.

6.5.1.2 Required Infrastructure for Street Sweeping

Table 6.7: Lengths of various categories of roads in Durgapur

Road	DMC	DSP	DPL	MAMC	ABL	DTPS	Total
B T Road	407	380	45				832
Concrete Road	134						134
L T M Road	91						91
W B M Road	30						30
Others Road (Brick)	14						14
Total	**676**	**380**	**45**	**0**	**0**	**0**	**1101**

Length of roads in Durgapur Municipal Corporation = 676 kms, out of which black top road is 407+134 = 541 Km

It is proposed that Road sweeping will be done by Mechanical Sweeper.

It is assumed that 40 % of the road will be cleaned daily

40 % weekly and remaining 20% twice a week

Number of Mechanical Sweeper required is = 10 Nos. of big Mechanical Sweeper

6.5.2 Proposed Numbers of Tools/Equipments

6.5.2.1 Primary collection of Waste

The proposed estimated of tools/equipment required for collection and transportation of waste is as given below in table 6.8.

The secondary waste collectors shall be well equipped to avoid direct contact with waste.

Table 6.8: Proposed infrastructures for Primary and secondary waste collection

Sl. No	Description	Equipment Numbers	Unit Rate	Amount
1	House household	265874	250	66468500
2	Tri- cycle Cart- 6 nos 50 lit bin	333	2500	347500
3	Handcart with 4 nos of 60 lit bin (Street Sweeping)	324	15000	4860000
4	Auto tipper	27	950000	22800000
5	Compactor Garbage Bins 1100 lit	813	45000	36585000
6	Movable compactor	12	3700000	37000000
7	hook lodader	3	3500000	10500000
8	Compactor station construction	6	3000000	18000000
9	Stationary compactor container -10 m3	12	180000	2160000
10	Wheel barrow for Drain Cleaning	296	15000	4440000
Total				**2031,61,000**

Table 6.9: Calculation for Requirement of Equipments

6.5.2.2 Replacement:

Sl no.	Items	Duration
1	1.1 m^3 Compactor bins	Every five years
2	Household bins	Every Five years
3	Tricycle	Every five years
4	Hand Carts	Every 4 year
5	Wheel barrow	Every five years
6	Compactor	Every 12 years
7	L.C.V	Every 7 years

6.5.3 Proposed waste transportation system

The transportation vehicle requirement is based on following assumptions:

It is proposed to use GIS and GPS tools to have a complete hold on the transportation network - GIS to calculate the optimum routing between two points and the GPS which can track the exact location of the trucks in real time. In GIS-base routing system, each secondary collection point will be coded into database along with the street map of the service area. The software then will automatically calculate the shortest route between each stop. Criteria such as total number of stops and estimated waste quantity per stop can be programmed into the system. GIS and GPS system will allow viewing the exact location of trucks and tracking efficiency of the transportation system.

6.5.4 Workshop

The auto workshop should be fully equipped to undertake maintenance of transportation vehicles and should have all infrastructure including waste water treatment plant, etc. as per the statutory requirements. It is proposed that DMC shall have a tie-up with a private workshop for undertaking vehicle maintenance activity and therefore capital cost for parking shed and small maintenance equipments only included in the DPR. Exiting workshop shall only be used for undertaking minor maintenance jobs. The DMC shall identify a private workshop based on equipments/facilities and manpower available with it.

6.6 PROPOSED PROCESS FACILITY

With compliance to the client and stakeholders input process facility to be developed at city level for processing the waste into compost and RDF.

6.6.1 Overview of Different Waste Processing Technologies

The waste treatment and processing technologies can be classified into following categories:

- Thermo-mechanical process
- Bio-conversion Processes
    - Aerobic decomposition
    - Anaerobic decomposition

6.6.2 Thermo-Mechanical processes

Various thermo-mechanical processes are listed below:

6.6.2.1 Pyrolysis/ Gasification

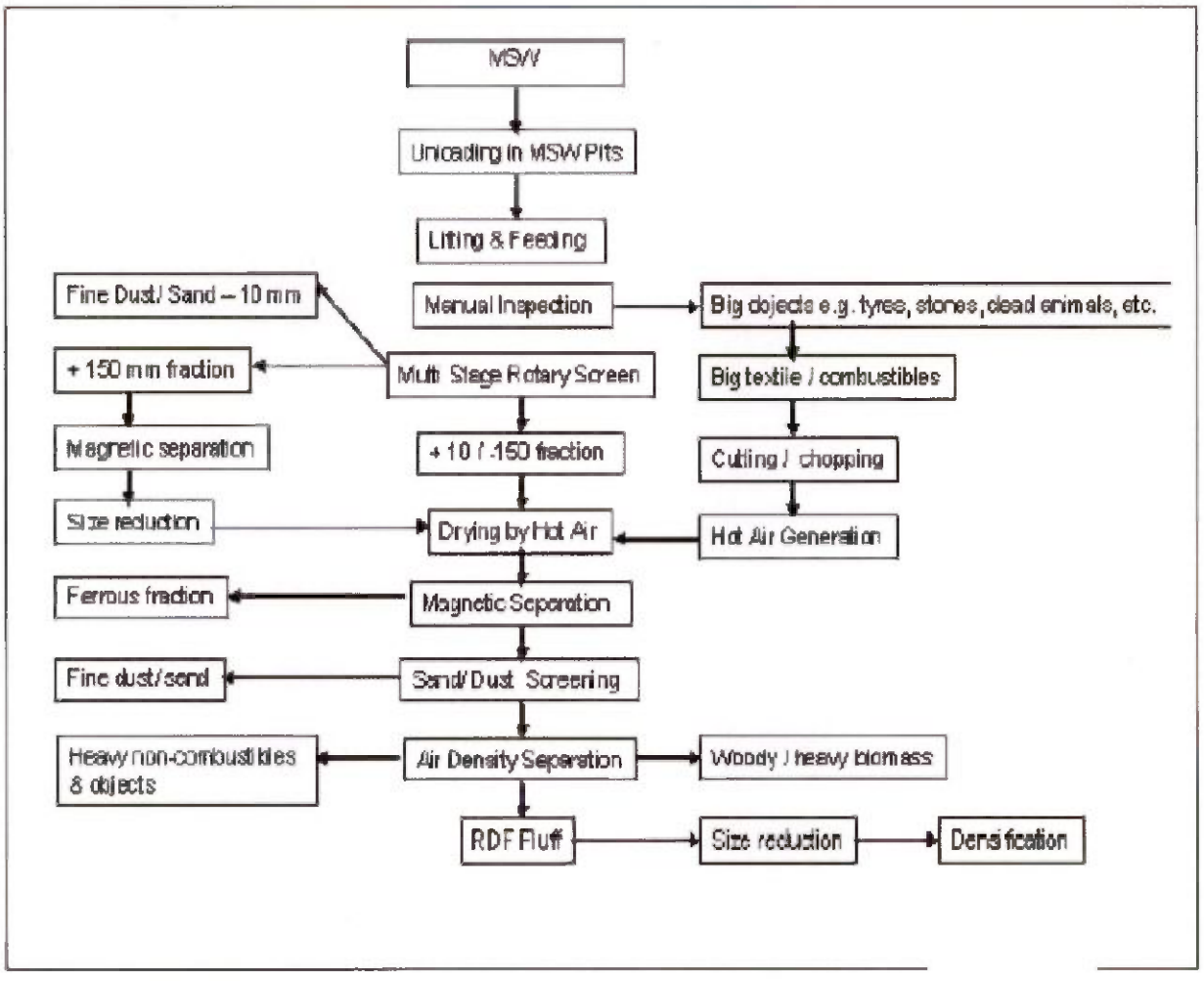
Pyrolysis is also referred to as destructive distillation or carbonization. It is the process of thermal decomposition of organic matter at high temperatures(about 900oC) in an inert (oxygen deficient) atmosphere or vacuum, producing a mixture of combustible carbon monoxide, methane, hydrogen, non-combustible carbon dioxide, water, nitrogen, pyroligenous liquid, chemicals and charcoal. The pyroligenous liquid has a high heat value and is a feasible substitute of industrial fuel oil.

Gasification involves thermal decomposition of organic matter at high temperatures in presence of limited amounts of air/ oxygen, producing mainly a mixture of combustible and non-combustible gas (Carbon monoxide, hydrogen and carbon dioxide). This process is similar to pyrolysis, involving some secondary /different high temperature (>1000°C) chemistry which improves the heating value of gaseous output and increases the gaseous yield (mainly combustible gases CO+ H_2) and lesser quantity of other residue. In these processes, besides energy recovery, proper destruction of the waste is also ensured.

6.6.2.2 Refuse Derived Fuel (RDF) Technology

The process of conversion of garbage into fuel pellets involves primarily drying, separation of combustibles from garbage, size reduction and pelletisation after mixing with binder and /or additives required. Typically, the non-combustible items are removed, separating glass and metals for recycling. The combustible waste is shredded into a smaller, more uniform particle size for burning. Pelletisation involves segregation of the incoming waste into high and low calorific value and shredding them separately, to uniform size. The different heaps of the shredded waste are then mixed together in suitable proportion and then solidified to produce RDF pellets. It is also important to ensure that the RD pellets are not burned indiscriminately or in the open but only in the dedicate incineration facilities or other well designed combustion systems, having all necessary pollution control systems. The calorific value of raw garbage is around 1000 Kcal/kg while the pellets resulting from the solidifying process is around 4000 Kcal/kg. About 15-20 tons of fuel pellets can be produced after treatment of 100 tons of raw garbage (Source: TIMES (TERI Information Monitor on Environmental Science) Volume 5, Number 1. These pellets could be used for heating in the boilers and the steam thus generated, in turn could be used to produce power. Typical flow sheet for RDF technology is shown in below.

Flow Sheet for RDF Technology



6.6.3.1 Aerobic Decomposition

Various aerobic decomposition processes are as following:

a. windrows,
b. static piles,
c. vertical reactors (In vessel Technology) and
d. horizontal reactors (In vessel Technology)
e. Rotating Drum Composting

Each of these composting technologies based on the nature of the air supply, is described below.

6.6.3.2 Composting in windrows

Windrow composting usually relies on natural convection and diffusion for oxygen supply. Pile size and turning frequency are used to balance heat loss in managing temperature control

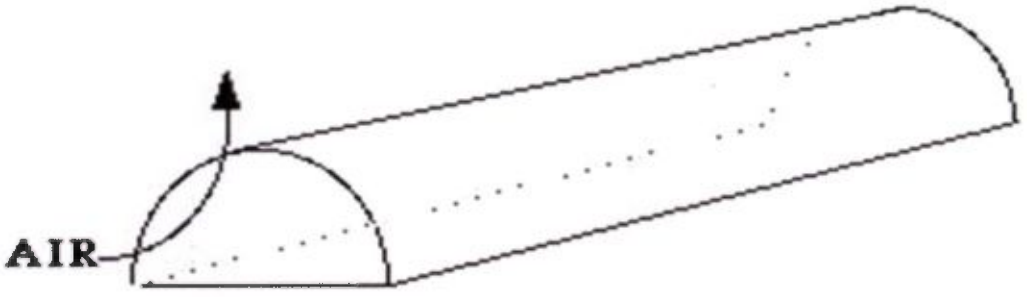


Fig 6.4: Natural Air Circulations in a Compost Windrow

The effectiveness and penetration of oxygen supply in a window system varies with the rate of microbial activity and porosity of the pile. Anaerobic zones can be minimised by decreasing pile size or increasing its porosity, although in practice fully aerobic conditions are difficult to achieve in windrows during the active composting phase. Pile size may be increased in extremely cold weather or when decomposition slows as compost matures. Mechanically turning the pile releases heat and moisture and can temporarily increase the porosity. Agitation can also help break up clumps of material and thereby increase oxygen transfer. Management of convection and diffusion through pile size and turning frequency can be a cost-effective strategy, although decomposition is generally not as rapid as with forced aeration systems.

Windrows are defined as regularly turned elongated piles, shaped like a haystack in cross section and upto a hundred meters or more in length. Process control is normally through pile management as described above, although forced aeration can also be used. The cross-sectional dimensions vary with feedstock and turning equipment, but most MSW windrows are 1.5 to 3 meters high and 3 to 6 meters wide. Individual windrows may be constructed over a period of several days or weeks, but are usually each managed as a single batch. Windrows composed of MSW are usually required to be located on an impermeable surface, which greatly improves equipment handling under inclement weather conditions. Windrows can be formed with a front-end loader, dump truck, or conveyor. A variety of specialised turning machines are available, although front-end loaders can also be used if operators are adequately trained. Windrow turners should perform several functions: increase porosity of the pile, redistribute material to enhance process uniformity, and break up clumps to improve product consistency. Some machines also perform a shredding or macerating function, which may partially substitute for other processing steps and can accelerate decomposition.

6.6.3.3 Static Pile Composting

Static piles can be shaped much like windrows or in an elongated pile or bed. The essential difference is in the name; static piles are not mechanically agitated. Once constructed by conveyor, loader or truck, the piles remain in place until the decomposition slows. The lack of agitation requires the maintenance of adequate porosity over an extended period of time. When composting fine materials like sludge, a coarse stable

substrate such as wood chips is often incorporated in the mix. Inert materials or slowly degrading cellulosic substrates like cardboard or leaves may help supply that stable porous structure in MSW, but this needs to be considered in the pre-processing system design. Process control is normally through pressure and/or vacuum-induced aeration, with either temperature or oxygen as the control variable. Blower piping can be temporary plastic or metal in a bed of coarse material at the base of the pile or recessed into the composting pad under perforated plates. Piles are often covered with a layer of wood chips or mature compost to insulate the active compost from ambient temperatures and/or provide some odour treatment. Both windrows and static piles are often outside and exposed to weather, but can be covered with a roof to minimise the impacts of weather and provide an opportunity for odour capture and treatment.

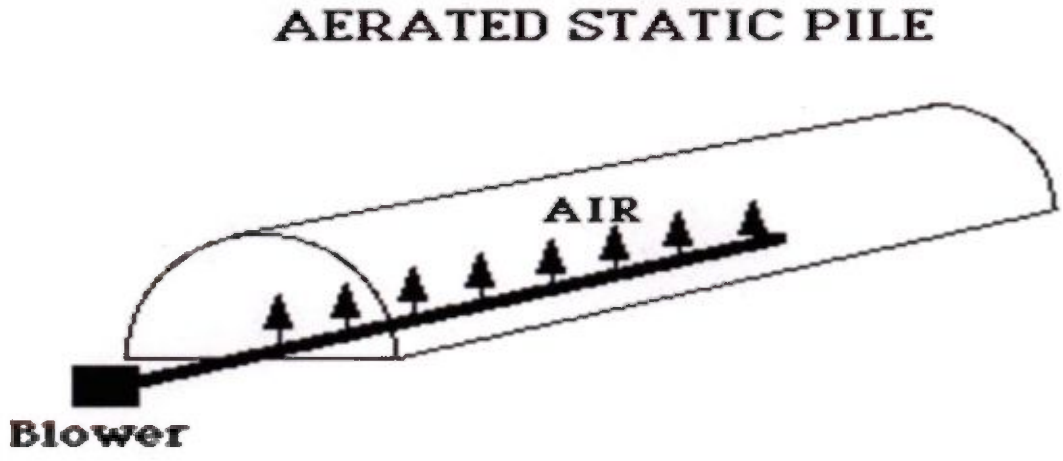


Fig 6.5: Aerated Static Pile

6.6.3.4 Vertical Reactor Composting (In Vessel)

Vertical Composting reactors are generally over 4 meters high, and can be housed in silos or other large structures. Organic material is typically fed into the reactor at the top through a distribution mechanism, and flows by gravity to an unloading mechanism at the bottom. Process control is usually by pressure-induced aeration, where the airflow is opposite to the downward materials flow. The height of these reactors makes process control difficult due to the high rates of airflow required per unit of distribution surface area. Neither temperature nor oxygen can be maintained at optimal levels throughout the reactors, leading to zones of non-optimal activity. Some manufacturers have minimised these difficulties by enhanced air distribution and collection systems, including changing the airflow direction from vertical to horizontal between alternating sets of inflow and exhaust pipes. As with static pile composting, a stable porous structure is important in vertical reactors which usually lack internal mixing. Tall vertical reactors have been successfully used in the sludge composting industry where uniform feed stocks and porous amendments can minimise these difficulties in process control, but are rarely used for heterogeneous materials like MSW.

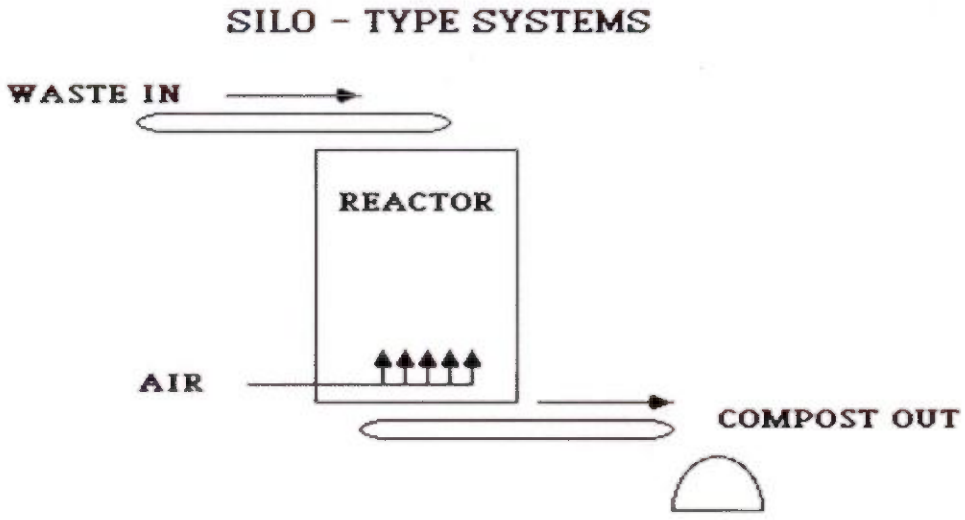


Fig 6.6: Vertical Reactor

6.6.3.5 Horizontal Reactor Composting (In Vessel)

Horizontal reactor avoids the high temperature, oxygen, and moisture gradients of vertical reactors by maintaining a short airflow pathway. They come in a wide range of configurations, including static and agitated, pressure and/or vacuum-induced aeration. Agitated systems usually use the turning process to move material through the system in a continuous mode, while static systems require a loading and unloading mechanism. Materials handling equipment may also shred to a certain degree, exposing new surfaces for decomposition, but excessive shredding may also reduce porosity. Aeration systems are usually set in the floor of the reactor, and may use temperature and/or oxygen as control variables. Systems with agitation and bed depths less than two to three meters appear effective in dealing with the heterogeneity of MSW.

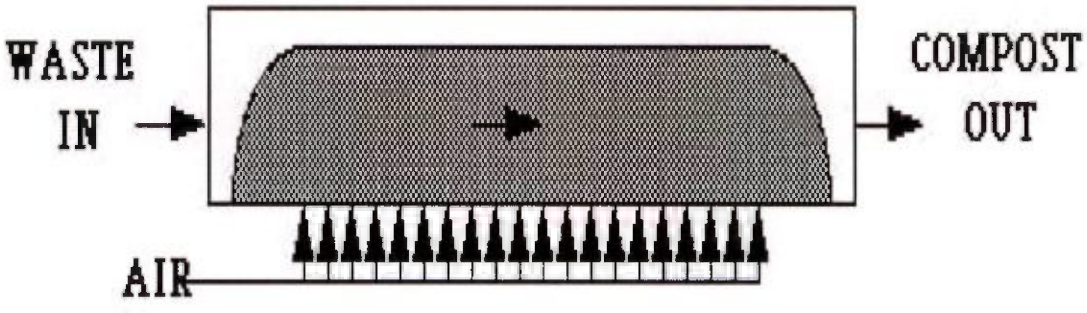


Fig 6.7: Horizontal Bed Reactor

Horizontal and vertical reactors are commonly referred to as in-vessel systems as differentiated from open systems such as windrows and static piles. Because of the higher capital and operation costs associated with these contained systems, residence time in the reactors is rarely adequate for the production of mature compost. Instead, in-vessel composting technologies are often used to help get the material through the early stages of composting when odours and process control are most critical, and the material is then moved into

a windrow or static pile system for the later stages of decomposition and curing. ***Photo No. 6.7*** shows an in vessel composting unit.

Photo Shows in vessel Composting facility

6.6.3.6 Rotating Drum Reactor Composting

Rotating drum reactors take the trade-off between reactor cost and compost residence time to an even further extreme than the horizontal or vertical in-vessel systems. These reactors (sometimes called digesters) retain the material for only a few hours or days. While the tumbling action can help homogenise and shred materials, the short residence time usually means the processing is more physical than biological. While rotating drums can play an important role in MSW composting, they are normally followed by other biological processing, which may include in-vessel, static pile, and/or windrow systems.

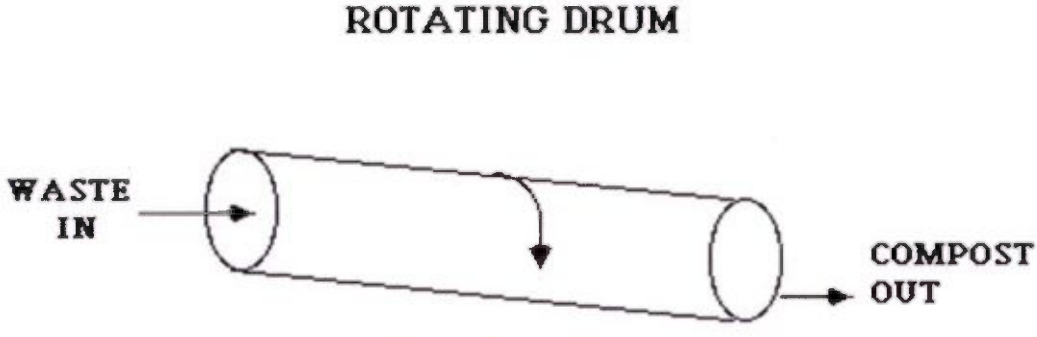


Fig 6.8: Rotating Drum

6.6.3.7 Vermicomposting

Vermicomposting involves the stabilization of organic solid waste though earthworm consumption which converts the material into worm castings. Vermicomposting is the result of combined activity of microorganisms and earthworms. Vermitechnology, a tripartite system which involves biomass, microbes and earthworms is influenced by such a biotic factors as temperature, moisture, aeration etc. The vermicompost is relatively more stabilized and harmonizes with soil system without any ill effects.

6.6.3.8 Anaerobic Decomposition

In this process, also known as biomethanation, the organic fraction of waste is segregated and fed to a closed container (biogas) digester where under anaerobic conditions, the organic wastes undergo bio-degradation producing methane -rich gas and effluent / sludge. The biogas production ranges from 50-150m^3 /ton of waste depending upon the composition of waste. The biogas can be used for cooking /heating applications, or through dual fuel or gas engines or gas /steam turbines for generating motive power or electricity. The sludge from the anaerobic digester, after stabilization can be used as a soil conditioner, or even sold as manure depending upon its composition, which is determined mainly by the composition of the input waste

The waste has to meet certain specifications before it can be subjected to any of the above treatments. These are listed below in ***Table 6.10***

Table 6.10: Important Waste parameters for Technical viability for Energy Recovery

Sl. No.	Waste Treatment method	Basic Principle	Important Waste Parameters	Desirable Range	Energy recovery potential (kW);W = Weight of waste in Tones
1.	Themo-mechanical Processes	Decomposition of organic matter by the action of heat	Moisture content	<45%	14.4 W
			Organic/volatile matter	>40%	
			Fixed carbon	< 15%	
			Total inert	<35%	
			Calorific value(Net calorific value)	>1200 Kcal/Kg	
2.	Bio-chemical conversion	Decomposition of organic matter by microbial action	Moisture content	>50%	11.5 W
			Organic /volatile matter	>40%	
			C/N ratio	25-30	

Indicated values pertain to suitably segregated /processed /mixed wastes and do not necessarily correspond to waste as collected at the treatment facility

5.1 EVALUATION OF VARIOUS WASTE TREATMENT TECHNOLOGIES

The comparison of the different technological options discussed above is as given below in Table 6.11.

Table 6.11: Comparison of the Various Waste Treatments Technological Options for MSW

Sl. No.	Option For Waste To Energy Conversion Of MSW	Advantages	Disadvantages
1.	Composting	▪ Inoculums, enzymes not needed	▪ No energy recovery

Sl. No.	Option For Waste To Energy Conversion Of MSW	Advantages	Disadvantages
	(windrows type)	▪ Comparatively less technologically involved process ▪ Compost recovery is possible ▪ Cost Economic/ Feasible Solution ▪ Low Maintenance ▪ Easy Management	▪ Heat loss through open windrow surfaces ▪ Open system-Difficulty in operation during rainy season, liable to bad odour, rodent and fly menace, if not operated properly, visible pollution and social resistance ▪ Large land area required
2.	Anaerobic digestion	▪ Energy recovery is possible ▪ Enclosed system - all the gases can be collected for use ▪ Controls green house emissions ▪ Less land area required	▪ Proper segregation of waste required ▪ Proper maintenance of process conditions required
3.	Composting (In-vessel type)	▪ Time of treatment is less, thus large quantity is processed ▪ Not affected by climatic features such as cold temp and rainy period ▪ Less land areas required	▪ High energy involved ▪ High installation cost ▪ Trained manpower requirement ▪ Technologically involved process ▪ Cost intensive in comparison to windrow
4.	Vermi composting	▪ Comparatively less technologically involved process ▪ Compost recovery is possible	▪ No energy recovery ▪ Earthworm culture is required ▪ Open system-Difficulty in operation during rainy season, liable to bad odour , rodent and fly menace , if not operated properly, visible pollution and social resistance ▪ Large land area required
5.	RDF Pellet	▪ More careful segregation of waste leading to less emissions ▪ Energy recovery is possible ▪ Less land area is required	▪ Low moisture content in waste ▪ Drying of waste required ▪ Burning of pellets in controlled conditions with Air Pollution Control Devices installed ▪ Low calorific value of Indian waste ▪ Very low quantity waste is being generated at Durgapur for self sustainable power generation
6.	Pyrolysis / Gasification	▪ High energy recovery ▪ Low land area	▪ Technologically involved process ▪ Low calorific value of Indian fuel

6.7 RECOMMENDATION FOR SETTING UP A WASTE PROCESSING PLANT – WINDROW COMPOSTING AND RDF

Following are the recommendation for setting up a waste processing facility:

- Considering waste quantity and quality windrow composting is techno-economical feasible

- Total waste generation from Durgapur is 247. Therefore, we propose Compost Plant with RDF which can be store and sell to the industries i.e. cement, brick clines etc.
- From the above comparison of different waste processing technologies and considering the constraints as mentioned above at Durgapur, windrow composting method has been proposed for consideration.

6.8 PROPOSED SYSTEM

6.8.1 Design Capacity

The total municipal solid waste generation in is 247TPD for the year 2016 (Refer below **Table 5.9.1**). The biodegradable portion in the waste is 57%. The projected biodegradable waste quantity for the year 2014, 2029 and 2044 is as given below in **Table 6.12**.

Table 6.12: Biodegradable waste generation

Year	Population of Durgapur Planning Area	Total Waste Qty in TPD	Waste for Processing, TPD
Year 2016	611300	247	148
Year 2018	629568	261	152
Year 2023	673163	298	164
Year 2038	786177	422	190

The infrastructure of the plant was constructed for 20 years but the machineries were designed for 7 years

6.8.2 Receipt, Handling and Pre-processing of MSW (Tipping Area)

The waste collected from the city is received through an earthen embankment ramp with a water-bound macadam (WBM) surface by tippers in this area. The waste will be unloaded on an elevated ground (Hopper) in the receipt area. The receiving pit will be constructed of provided in a Reinforced Cement Concrete (RCC) enclosure with a steel bin of 50 MT capacities.

The waste will be segregated manually for foreign materials such as paper, glass, plastic, polythene, etc. Depending on the quality of the material, it will be sent to recyclable units for recovery of to the landfill site for final disposal.

The segregated organic waste will be dozed into a receiving pit through a dozer or front end loader. The waste will then be drawn by a reciprocating feeder (R-feeder) and put on to a conveyor to facilitate removal of inert material/iron and other metallic material.

This segregated material will then be transferred to a surge hopper in the screening plant.

The material from surge hopper is drawn by an R-feeder and put on to a flat picking conveyor that runs at a speed of 0.8 m/sec. The sorting of non-organic material will be done manually by deploying workers on either side of the slow moving picking conveyors.

The sorted out organic material will be sent to a shredder for sizing through.

The rejects from the picking conveyors will be transferred to reject hopper for appropriate disposal.

The shredded material from the shredder yard will be transferred to windrows through front end loaders or through conveyor arrangement and telescopic chute. The additives inoculums etc. will then be added for controlled aerobic treatment.

6.8.2.1 Waste to Compost Plant

The compostable waste primarily comprises of Organic material such as kitchen and yard waste, refuse from vegetable markets, food waste from hotels and restaurants; green & horticultural waste; cow dung and dairy waste etc. Biological treatment of organic material involves using naturally occurring micro-organisms to decompose the bio-degradable components of waste under controlled conditions.

Composting can be achieved using three types of micro-organisms – bacteria, actinomycetes and fungi. In the initial stages, the bacteria, fungi, and protozoa activities cause the temperature in the compost plant to increase to 65-70°C, which is called the thermophilic stage. In this stage, the bacterial and actinomycetes activity causes decomposition, resulting in a fall in temperature, when the fungi activity resumes. This stabilized condition is known as mesophilic stage, when the composting material becomes dark brown due to humus synthesis. In addition to temperature, air supply, moisture content, particle size of MSW, acidity/alkalinity, and chemical characteristics are the other factors which influence the microbial activity in a windrow. Several factors affect the rate of decomposition of the bio-degradable material as described below:

- ***Micro-organisms***: In order to expedite the process, additives such as cellulolitic, lignolytic, or cow dung solution shall be added to the organic waste. Micro-organisms such as azotobactor and phosphorus solubilizing microbes (PSM) will need to be added during the pre-processing stage for initiating the microbial activity.
- ***Moisture content:*** The moisture content of the bio-degradable waste needs to be maintained within the range of 55-60%. Additional water will need to be mixed with the bio-degradable waste, if required, to keep the moisture content within the range of 55-60%.
- ***Air supply:*** Sufficient air supply is required to maintain a high rate of decomposition, removal of carbon dioxide and volatile organic compounds, and buffering of the pH. This can be done manually by regular turning of the windrows. The automated process involves controlled air supply through self propelled windrow turners installed on the ground of the composting area.

- ***Temperature:*** A temperature range of 65-70oC is conducive for sanitization of MSW. In addition, the disease-causing micro-organisms are killed and weeds are destroyed at this temperature. Further, a high rate of decomposition is achieved in the temperature range of 35-45oC.
- ***Particle size of MSW***: Smaller particle size of compostable material provides greater surface area for the micro-organisms to act up on. However, the particle size should not be too small so as to compact the organic matter and reduce void space.
- ***Acidity/alkalinity:*** A pH range of 6.5-7.8 is most suitable for the composting process.
- ***Chemical characteristics:*** A C: N ratio, 20:1 to 25:1 is ideal for maximum decomposition of organic matter.
- ***Waste Densities Adopted:*** For the purpose of design, a density of 0.45 T/m3 is assumed for the incoming waste and 0.60 T/m3 is assumed for the compost (within the range 0.6-0.9 T/m3).

6.8.2.2 Process Design for Proposed MSW Composting Unit

The bio-degradable waste segregated at the source is collected and transported to the Compost Plant. The Process Design for MSW Compost Plant involves various steps as described below

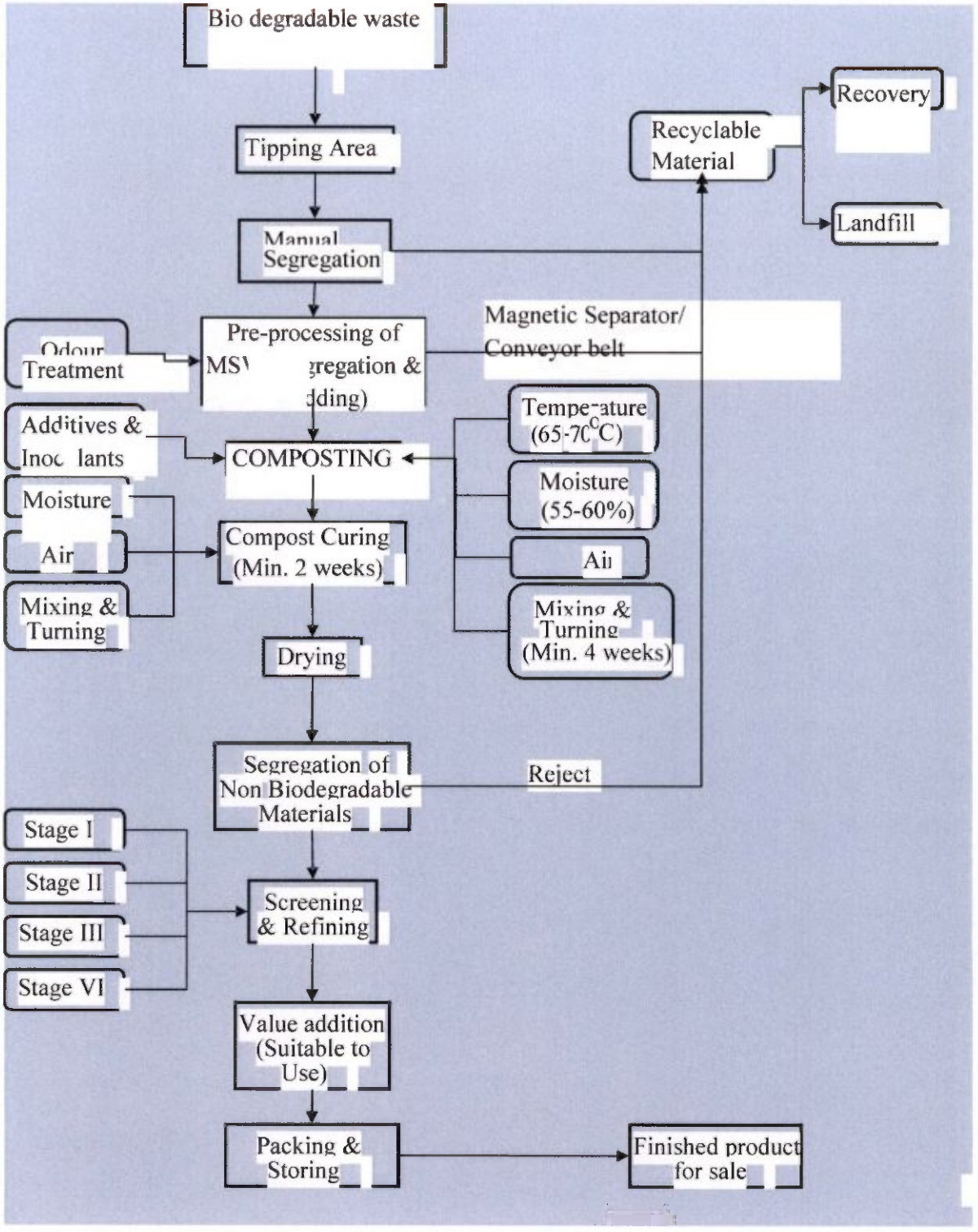


Figure 6.9: Process Design for MSW Composting

6.8.2.3 Waste Receipt and Storage:

The bio-degradable waste from the city is received by Tippers and unloaded on an elevated ground near the Receipt area. At this point, waste segregation is carried out manually. The segregated organic material is

dozed off into the receiving pit through a Dozer or Front-end Loader. It is then drawn by a Reciprocating Feeder (R-feeder) and put on to a Conveyor Belt to facilitate removal of non-biodegradable material such as metal, paper, glass, bricks, stones, etc.

6.8.2.4 Waste Pre-processing:

The segregated organic waste is transferred to a Surge Hopper in the Screening Area. The material in the surge hopper is drawn by reciprocating feeders and put on to flat Picking Conveyors that run at a speed of 0.8m/s. Workers are deployed on either side of the slow moving picking conveyors to sort the non-biodegradable wastes. The rejected material is transferred to a Reject Hopper for appropriate disposal.

The sorted organic refuse is sent to a Shredder in the Shredding Yard for sizing through Loading Conveyors. The size reduction facilitates faster biological decomposition. The shredded material is transferred to Windrows through front-end loaders or through Shuttle Conveyor arrangement and telescopic chute. Additives, inoculants and micro-organisms are added at this stage for controlled decomposition of organic material.

6.8.2.5 Windrow (Mechanical) Composting:

Figure 6.10: Windrow Turner

The pre-processed waste is laid in trapezoidal or triangular heaps in multiple rows for initiating the microbial activity. These waste heaps are periodically aerated through Self-Propelled Windrow Turners which move over the rows and facilitate turning and cropping.

Water is sprayed on the heaps to maintain the desired moisture content. The heaps are covered with a layer of polyvinyl chloride (PVC) sheets to prevent outdoor nuisance and flies and to maintain the required temperature.

As the decomposition progresses, the bio-mass changes color from light green to dark brown humus like substance. Once, this condition is reached, the compost ready for further refinement (separation and grading).At this stage the conversion of organic waste into compost takes approximately 4 weeks.

6.8.2.6 Curing and Drying:

The fully decomposed organic matter will be placed on the curing bed for two weeks and covered with PVC sheets. Water will be sprinkled on a regular basis. This process is done to remove any odor and the microbes present in the compost. The fully matured compost will then be dried in the drying bed under the sunlight.

6.8.2.7 Compost Refinement, Bagging, and Storage:

The compost is passed through a coarse trommel (rotary sieve) to get the compost of desired size. After the mechanical separation, grading and sieving, fully matured and stabilized humus like organic fertilizer/soil enriched is recovered for use in crop production. Quality control is done for the physical, chemical, and biological parameters and the finished product is packed in high density polyethylene (HDPE) bags for sale.

6.8.2.8 Mass balance for Compost and RDF Plant

MATERIAL FLOW OVERALL
300 TPD

	PROCESS		QUANTITY	
PRE-PROCESSING	*I st Stage*			
	Feed Material :	CITY GARBAGE		
	Material Properties :	SEGREGATED / MIXED MSW		
	Tipping	Receiving raw material , hand picking of bulky material .	300 Ton	70 T
	Pre-processing	Mechanical Segregation . (Below 120 m.m.)		
		Oversized Rejection (For RDF Processing)		(RDF Processing)
		Inoculants Addition .		
		Material Shifting on Compost Pad to make windrows		
PROCESSING	**Sanitisation**	I st & II nd Heap / Windrow Formation (Moisture : 55 - 65%)	230 Ton	120 T
	Decomposition	III rd & IV th Heap / Windrow Turning (Moisture : 55%)		(Reject Gas & Moisture)
		Shifting in Rain Shed	110 Ton	10 T
				(Reject Gas & Moisture)
	II nd Stage			
	Feed Material :	Digested Compost (from Yard)		
	Material Properties :	Moist , Lumpy , Heterogenous , Sticky		
	Coarse Segregation	Lump breaking , opening up , segregation and screening	100 Ton	
		of fine material . (Below 35 m.m.)		30 T
		Screening and separation of material .		(Reject)
		(Below 16 m.m.)	70 Ton	(For RDF Processing)
	III rd Stage			
	Feed Material :	Screened Material (Below 16 mm)		
	Material Properties :	Moist , Non Lumpy , Sticky		
	Curing	Shifting of material to Curing section for further digestion	70 Ton	15 T
		/ maturation & moisture management .		(Gases +
		Addition of Rock Phosphate , mixing & turning .	10T	Moisture)
		Shifting of material to refinement line.	65 Ton	
COMPOST REFINEMENT SECTION	*IV th Stage*			
	Feed Material :	Screened Material (Below 16 mm)		
	Material Properties :	Dry , Non Sticky		
	Refinement	Screening and separation below 4 m.m. , Oversized	65 Ton	28 T
		rejections sent for re-sanitisation .		(Reject)
		Separation of heaxy impurities as sand , glass , stones etc.		(For SLF)
	Standardization and	Mixing of additives (Liquid / Granules) to improve	3T	
	Quality control	quality of end products .		
	Storage	Finished goods packing and shifting to storage section .	40 Ton	*Final Compost*
RDF PROCESING	*V th Stage*			
	Feed Material :	Screened Material (Above 120mm,35mm,& 16 mm)	100 Ton	
	Material Properties :	Medium Dry , Non Sticky		15 T
	Drying	Sun / Natural drying by storage in form of heaps		(Moisture Evaporation)
	Sorting / Separation	Removal of heavies by Manual sorting & ADS Unit		25 T
				(Inerts For SLF)
	Shredding & Bailing	Shredding of RDF Material & Bailing final RDF Material		5 T
				(Recyclables Recovery)
	Storage	Finished RDF Bale packing and shifting to storage section .	55 Ton	*Final RDF Recovery*

Table 6.13: Material Flow Sheet

6.8.3 Area Calculation for Waste Processing Plant

Table 14: Area Requirement of Compost Plant

Area required for receiving MSW (A1)		
Incoming waste	=	320
Density from Survey	=	415 Kg/m3
Volume, V	=	771cum
Stored up to height of 0.6 m	=	0.6 m
Area required for storage, A	=	1285sq.m
Add area for vehicular movement side space @ 5%	=	514 sq. m
Total Area, A1	=	1799sq.m
Area required preprocessing plant machineries		250 Sq m
Windrow Platform		10500 Sq M
Covered Shed		3600 Sq m
Preparatory Section M/c		405 Sq m
Curing Area		655 Sq m
Refinement Section		650 Sq m
Godown		500 Sq m
Administrative building & workshop		100 Sq m
Green Belt		**4000 Sq m**
Road =3.5 m		**1.5 km**

Table 6.14: Machineries Requirement

S.No.	EQUIPMENTS	QTY.	COMMENTS
1	**YARDMANAGEMENT-**		
i)	Loader -	3 Nos.	Turning of Windrow
ii)	Backhoe/TurningEquipmentSkidSteerL	4 Nos.	Shifting&FeedingofMaterialFo
iii	oader	5 Nos.	r materialmovement.
)i	Dumper	4 No.	For shiftingmaterial.
v)	TractorwithtippertrolleyWater	2 No.	For sprinkling ofwater&slurryongarbage.
v)	Tanker withslurrypump		
		SectionCapacity:30TPH±10%	
2	**TIPPING&PRE-PROCESSINGSECTION-**	1 No.	Forfeedingmaterialat
i)	Feeder	1 No.	controlledrate.Forscreening.
ii)	120Trommel-	1 No.	Forconveyingmaterialtodumper.
iii	120mmTransferCo	1 No.	Forremoval ofrejectionand transferittosortingbelt.
)i	nveyorRejectionCo		
		SectionCapacity:15TPH±10%	

v)	nveyor		
3	**COARSESEGREGATIONSECTION-**		
i)	Feeder35	1 No.	Forfeedingmaterialat
ii)	Trommel-35	1 No.	controlledrate.Forscreening.
iii	Process-	1 No.	Forfeedingmaterialtonext
)i	35ConveyorReject-	1 No.	Trommel.Forremoval ofrejectionoff-
v)	35ConveyorTrommel	1 No.	line.
v)	-16	1 No.	Forscreening.
vi)	Process-	1 No.	Forfeedingmaterialtonext
viii	16ConveyorReject-16		Trommel.Forremoval ofrejectionoff-
)	Conveyor		**SectionCapacity:9TPH±10%**
4	**REFINEMENTSECTION-**	1 No.	Forfeedingmaterialat
i)	DragChainFeeder	1 No.	controlledrate.Forscreening.
ii)	RotaryScreenFines	1 No.	ForCollectionoffinal compost
iii	ConveyorCoarseC	1 No.	ForCollectionofintermediatecompostFor
)i	onveyor	2Nos.	separationofheavyimpurities.
v)	GravitySeparatorwithAspirator	1 No.	Forremoval ofrejectionoff-line.
v)	RejectConveyor		
vi)			
	PACKAGINGSECTION-	2 Nos.	Forstichingbags.For
5	BagStichingMachineWeig	2Nos.	weighingbags.
i)	hingScale(100	4Nos.	Forstacking&movingpackedmaterial.
ii)	Kg)PelletTrucks		**SectionCapacity:7.5TPH±10%**
iii		1 Nos.	Forfeedingmaterialat controlledrate.
)	**RDFPROCESSINGSECTION-**	2 Nos.	ForseparationofRDFFlufffrom
	ADSFeeder	1Nos.	heavymaterialsForfeedingmaterialat
6	ConveyorAirDensityS	1Nos.	controlledrate.
i)	eparator	1 Nos.	ForcoarseshreddingofRDFmaterialForcol
ii)	ShredderFeeder	2 Nos.	lection&DischargeofRDFFluffForfeedin
iii	ConveyorShredder	2Nos.	gmaterialat controlledrate.
)i	ShredderDischargeConveyor		ForBailingRDF insmall bales of450x450x450
v)	Bailer Feeder ConveyorBailer	4 Set	
v)	unit	6 Set	PushButtonstationalongwithhydraulicsystemtoimproveeffici
vi)			encyandsafetyofequipmentsagainstcontinuouslyfluctuatingl
	CONTROL PANEL		oad.

Table 6.15: Vehicles Requirement

Sl No	Vehicle type	Number
1	Loader cum Backhoe	2
2	Self Propelled Windrow Turner	1
3	Tractor attached loader	2
4	Water tanker with slurry pump	1
5	Tractor with tipping trolly	2
6	Maintenance Vehicles	1

Table 6.16: Man power Details

Sl. No.	Particulars	Nos.
A	**Salary of O&M Staff**	
A.1	Plant Manager (Env. Engineer) - B.E	1
A.2	Supervisor – BSc	1
A.3	Accountant --- B.Com	1
A.4	Chemist - B Sc	1
A.5	Weigh Bridge Operator - H.S.C	1
A.6	Mechanic – ITI	1
A.7	Labourers	12
A.8	Tractor Driver	1
A.9	Tractor Attached Loader Driver	2
A.10	Loader Cum Backhoe Driver	2
A.11	Security Guard	5

6.9 IMPLEMENTATION OF PROCESS FACILITY - MATERIALS RECOVERY (MRF)

The separation of house-hold and commercial waste can be done at the source, at the point of collection by primary waste collectors or at centralized materials recovery facilities or large integrated processing, materials recovery facility (MRF). MRF shall have facility for

- baling of separated materials for shipping; storage of baled materials, manual separation of cardboard and mixed paper; baling of separated materials for shipping;
- storage of baled materials like Mixed plastics, manual separation of PETE, HDPE, and other plastics from commingled mixed plastics; baling of separated materials for shipping;
- storage of baled materials like mixed glass with sorting Manual separation of clear, green, and amber glass;
- storage of separated materials Plastic, aluminum cans, tin cans, sandglass Manual or pneumatic separation of polyethylene eterepholate (PETE), high-density polyethylene (HDPE), and other plastics;
- magnetic separation may occur before or after the separation of plastic; baling of plastic (typically two types), aluminum cans and tin cans, and crushing of glass and shipping;
- storage of baled and crushed materials

A centralized process facility is recommended at Durgapur.

CHAPTER 7 SANITARY LANDFILL FACILITY

Landfill system proposed in compliance to client. Considering techno-commercial feasibility landfill site is proposed at Durgapur town for disposal of domestic solid waste.

7.1 GENERAL

A sanitary landfill is a controlled method of solid waste disposal. The site must be geologically, hydrological, and environmentally suitable. ***It is not an open dump***. The nuisance conditions associated with an open dump, such as smoke, odor, unsightliness, and insect and rodent and seagull and other bird problems, are not present in a properly designed, operated, and maintained sanitary landfill. Professional planning and engineering supervision is required. A well-designed and operated landfill must prevent groundwater pollution, provide gas (methane) venting or recovery, have a leachate collection and treatment system, provide gas and leachate monitoring wells, and be located above the 100-year flood level. A typical cross section through a modern landfill is shown in ***Figure 7.1***.

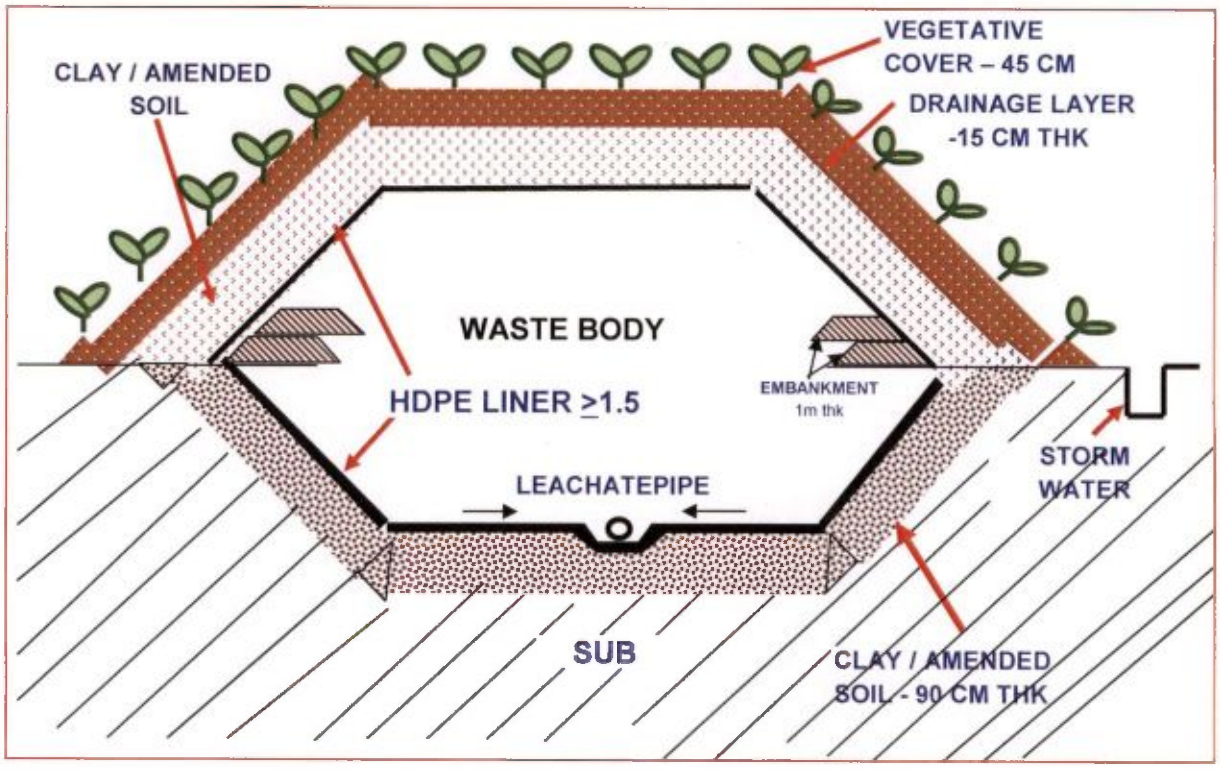


Figure 7.1: A scientifically engineered and designed Landfill Facility

7.2 DETAILS OF PROPOSED SITE

The proposed waste disposal site is located around 10 km from Durgapur. The site is proposed for landfill and processing facilities for Durgapur town only. The land details and NOC of site is yet to be collected.

7.2.1 REGULATORY REQUIREMENTS FOR DEVELOPMENT OF SLFs as per Municipal Solid Waste (Management & Handling) Rules, 2016

As per Schedule-III of MSW (Management & Handling) Rules, 2016, following specifications have been laid down for Sanitary Landfill Facilities (SLFs):

7.2.1.1 Facilities at the Site

1. Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.
2. The landfill site shall be well protected to prevent entry of unauthorized persons and stray animals.
3. Approach and other internal roads for free movement of vehicles and other machinery shall exist at the landfill site.
4. The landfill site shall have waste inspection facility to monitor wastes brought in for landfill, office facility for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipments.
5. Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipments and other facilities as may be required shall be provided.
6. Utilities such as drinking water (preferably bathing facilities for workers) and lighting arrangements for easy landfill operations when carried out in night hours shall be provided.
7. Safety provisions including health inspections of workers at landfill site shall be periodically made.

The above mentioned facilities have been provided in the design of SLF.

7.2.1.2 Specifications for Land Filling

a. Wastes subjected to land filling shall be compacted in thin layers using landfill compactors to achieve high density of the wastes. In high rainfall areas where heavy compactors cannot be used alternative measures shall be adopted.

b. Wastes shall be covered immediately or at the end of each working day with minimum 10 cm of soil, inert debris or construction material till such time waste processing facilities for composting or recycling or energy recovery are set up as per Schedule I.

c. Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. Proper drainage berms shall be constructed to divert run-off away from the active cell of the landfill.

d. After completion of landfill, a final cover shall be designed to minimize infiltration and erosion. The final cover shall meet the following specifications, namely :--

   i) The final cover shall have a barrier soil layer comprising of 60 cms of clay or amended soil with permeability coefficient less that 1 x 10-7 cm/sec.

ii) On top of the barrier soil layer there shall be a drainage layer of 15 cm.

iii) On top of the drainage layer there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

7.2.1.3 Pollution Prevention

1. In order to prevent pollution problems from landfill operations, the following provisions shall be made, namely :-

   a. Diversion of storm water drains to minimize leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;

   b. Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geomembrane, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1 x 10-7 cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;

   c. Provisions for management of leachates collection and treatment shall be made. The treated leachates shall meet the standards specified in Schedule- IV;

   d. Prevention of run-off from landfill area entering any stream, river, lake or pond.

7.2.1.4 Water Quality Monitoring

a. Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 meters of the periphery of landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the Ground Water Board or the State Board or the Committee. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.

b. Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely :-

Table 7.1: Desirable Limit of Constituents of Drinking Water

Sl. No.	Parameters	Desirable limit as per IS 10500: (mg/l except for pH)
1.	Arsenic	0.05
2.	Cadmium	0.01
3	Chromium	0.05

4.	Copper	0.05
5.	Cyanide	0.05
6.	Lead	0.05
7.	Mercury	0.001
8.	Nickel	-
9.	Nitrate as NO_3	45.0
10	pH	6.5-8.5
11.	Iron	0.3
12.	Total hardness (as $CaCO_3$)	300.0
13.	Chlorides	250
14.	Dissolved solids	500
15.	Phenolic compounds (as C_6H_5OH)	0.001
16.	Zinc	5.0
17.	Sulphate (as SO_4)	200

7.2.1.5 Ambient Air Quality Monitoring

a. Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odour generation, prevent off-site migration of gases and to protect vegetation planted on the rehabilitated landfill surface.

b. The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).

c. The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill gas shall be burnt (flared) and shall not be allowed to directly escape to the atmosphere or for illegal tapping. Passive venting shall be allowed if its utilization or flaring is not possible.

d. Ambient air quality at the landfill site and at the vicinity shall be monitored to meet the following specified standards, namely :-

Table 7.2: Specified standards of Parameters of Ambient air quality

Sl. No.	Parameters	Acceptable Levels
(i)	Sulphur dioxide	120 mg/m^3 (24 hours)
(ii)	Suspended Particulate Matter	500 mg/m^3 (24 hours)
(iii)	Methane	Not to exceed 25 per cent of the lower explosive limit (equivalent to 650 mg/m^3)
(iv)	Ammonia daily average (Sample duration 24 hrs)	0.4 mg/m^3 (400 m g/m^3)
(v)	Carbon monoxide	1 hour average : 2 mg/m3 8 hour average : 1 mg/m^3

e. The ambient air quality monitoring shall be carried out by the concerned authority as per the following schedule, namely:-

(i) Six times in a year for cities having population of more than fifty lakhs;

(ii) Four times in a year for cities having population between ten and fifty lakhs;

(iii) Two times in a year for town or cities having population between one and ten lakhs.

7.2.1.6 Plantation at Landfill Site

A vegetative cover shall be provided over the completed site in accordance with the and following specifications, namely:-

a. Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow;

b. The plants grown be such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilized;

c. Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition;

d. Plantation to be made in sufficient density to minimize soil erosion.

7.2.1.7 Closure of Landfill Site and Post-care

The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following, namely :-

a. Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover;

b. Monitoring leachate collection system in accordance with the requirement;

c. Monitoring of ground water in accordance with requirements and maintaining ground water quality;

d. Maintaining and operating the landfill gas collection system to meet the standards.

1. Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis comply with the specified standards.

7.2.2 LANDFILL DESIGN

Planning and design has been made considering waste is being generated in Durgapur city. In view of unavailability of land the conceptual planning has made considering the projected waste for the year base year and proposed design year). The proposed facility comprises Secured landfill (SLF), Leachate Treatment Plant (LTP), Office building, Laboratory, Parking area, MCC Room and other associated facilities. The construction of landfill shall be taken up into six phases. Each phase will serve for approximately 5 years.

After filling of each phase it will be covered with top cover and filling of MSW in the next phase area will be started.

7.2.2.1 Landfill Design

Some of the issues that have direct influence on the design are discussed. They are:

i. Waste to be Handled
ii. Access Road
iii. Land Area
iv. Surface Drainage
v. Operational Plan
vi. Layout of MSW landfill
vii. Completed Waste Fill Features
viii. Estimation of landfill Capacity
ix. Selection of Liner Systems
x. Selection of Leachate Control Facilities
xi. Selection of landfill Gas Control Facilities
xii. Aesthetic Considerations
xiii. Monitoring Facilities
xiv. Determination of Equipment Requirements
xv. Design life
xvi. Post Closure Care

These are discussed in detail as below:

7.2.3 Waste to be handled

Considering the present waste type and proposed collection and processing system the following indicative configuration of waste is considered as landfilable waste. The percentages will vary with increase in awareness level, application of taxes and service charges etc.

- 30% of processing rejects
- 24% of unaccounted waste (will be reduced with efficiency improvements)

The total waste quantity for a period of 30 years including future projection has been taken in the designing of MSW landfill.

7.2.4 Access Road

The proposed landfill shall receive MSW by road from various wards/localities located within Durgapur municipal area; as such the site shall be suitably connected with a good road network. A direct 5.0 m wide road including 1 m shoulders on each side connecting the landfill area is planned to reach the landfill site and within the facility for proper circulation and movement of vehicles.

7.2.5 Land Area

The land has been utilized for MSW landfill so that the landfill holds large amount of waste covering for a disposal period of about 30 years. Around 15 % of the area has been earmarked for green belts, associated facilities and buffer zones in as much as the surrounding environment is not disturbed/effected by noise, odors and defacement (from aesthetic considerations). All services are accommodated within this area.

7.2.6 Surface Drainage Facilities

The storm water routing within the MSW landfill site has been planned to effectively discharge storm water through storm water drains/ control structures effectively discharge to the offsite channels. For this purpose storm water drains, intercepting drains, peripheral drains and toe drains are provided. All these drains shall have masonry construction with lined bottom and sides.

7.2.7 Operational Plan

The facility shall be developed as a MSW disposal facility conforming to the statutory guidelines of MoEF/CPCB/SPCB and CPHEEO Manual with elaborate operation and management (O&M) plans matching to the size and environmental protection requirements. The O&M plan shall ensure operational efficiency and also timely feedback well before onset of any eventuality/emergency.

For this the following areas have been given emphasis:

7.2.7.1 Inventorization and Characterization of MSW

A mechanism shall be established whereby continuous update on MSW inventory in Durgapur is available. Special attention shall be placed in case of entry of any development of new colonies, institutions, mandis, markets etc. A separate cell has been planned to track quantity and characteristics of such MSW. The cell shall comprise of one environmental engineer assisted by a laboratory support. The team shall develop liaison with ULBs, RWAs etc.

7.2.7.2 Change in laws, governing rules/regulations, updates etc.

Conforming to changing scenarios and rulings of the governmental agencies due modifications/improvements shall be implemented. A liaison engineer shall be appointed for monitoring and updating these activities.

7.2.7.3 Operation Manual

An operation manual conforming to the procedures for effective running shall be developed wherein the landfill facility operator, local residents and the government agencies are appraised of their roles and responsibilities.

7.2.7.4 Emergency Management Program

In case of any emergencies like vandalism, fire, floods, earthquake, groundwater and soil contamination, etc. the emergency cell on site shall keep liaison with the concerned agencies such as fire fighting squad, hospitals, police, district administration, local PCB office, etc. for a coordinated timely action.

7.2.7.5 Monitoring Program

Adequate instrumental monitoring systems for knowing the condition of the landfill and the surrounding areas (soil, groundwater, air) covering range of2 km has been planned. These instruments shall be maintained and operated as per the operation manual. A well-equipped laboratory for exercising quality controls is also planned. A monitoring cell shall be responsible for upkeep of the monitoring program. Logbooks and records relating to waste quantities received, disposed in the landfill, etc. shall be maintained in soft and hard copies by this cell.

7.2.7.6 Human Resource Plan

A team shall be created for addressing issues related to environmental concerns, public unrest, grievances, on-site and off-site health hazards, compensations, etc. This team shall make timely and coordinated efforts to sorting out differences, if any.

7.2.8 Layout of the MSW landfill

Considering the broad parameters outlined above conceptual layout has been developed.

These drawings provide detailed description of various supporting and infrastructure facilities. The landfill facility shall have 1.8 m high permanent fencing all along the boundary with one lockable secured gate 3m wide. A complete list of the utilities, services and buildings that are planned in this MSW landfill are given in Table the locations of the facilities are marked in these drawings.

7.2.9 Completed Waste Fill Features

The design of MSW landfill shall be done considering 3 acres of land. The base of landfill i.e., top of liner has been kept at ground level and 5 m high (above GL) earthen embankment has been provided to achieve the required storage capacity within the area available. Top width of the embankment has been kept at 3.0 m. Inner & outer slopes of the embankment have been kept at 1V: 2H for stability of slopes. All around the

landfill site 1.8 m high fencing shall be provided to prevent any unauthorized entry & stray animals. A 3.0 m wide green belt has been provided all along the facility boundary.

The geo-composite liner has been provided on the inner side of the landfill as per the requirement of Central and State Pollution Control board norms. Leachate collection system has been provided at the base of the landfill with 250 mm dia HDPE header and 110 mm dia perforated HDPE lateral pipes. Leachate shall be collected in the Leachate collection sump from where it will be pumped to Effluent Treatment Plant. Leachate transfer pumps shall be provided of adequate capacity.

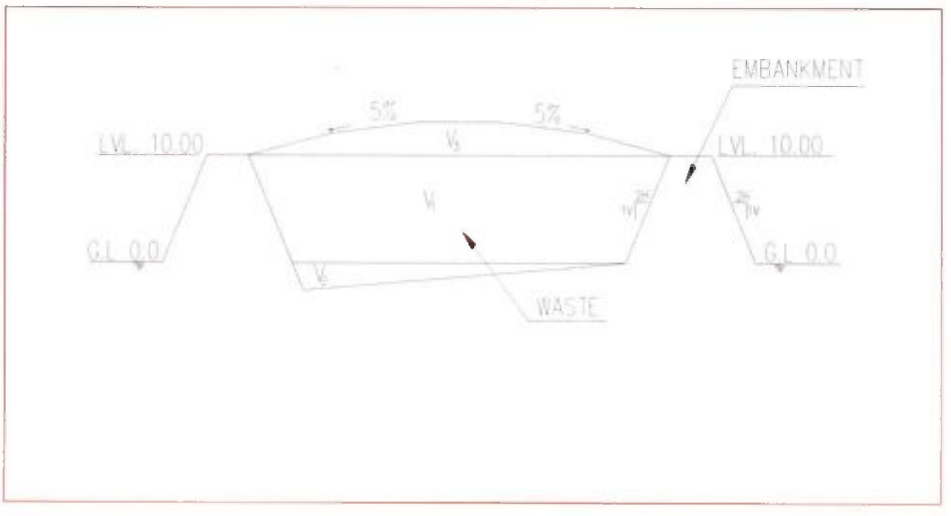
MSW shall be dumped in the landfill by trucks, which shall be further levelled and compacted. Periodic waste audits will ensure that non-conforming waste shall not be dumped at the landfill site. The waste shall be compacted in thin layers using compactors and covered with a daily cover of soil layer or inert waste. After the landfill is filled it will be covered with top cover system with single liner arrangement and on the top 450 mm thick surface layer (Top Soil) shall be provided with vegetation. The slope of top cover shall be kept as 5% to provide quick drainage of rainfall

For ground water monitoring 4 Nos. of wells shall be provided. A suitable ramp to reach the embankment top shall be provided so that truck/ dumper can reach the top of embankment and can directly dump the municipal solid waste in the landfill.

7.2.10 Estimation of landfill Capacity

The sketch showing section of landfill is given below for the estimation of landfill capacity. The capacity of landfill is worked out by considering mainly three parts of landfill which are as follows:

i. Middle part (V_1)
ii. Bottom part in the slope of header pipe (V_2)
iii. Top portion (V_3)



The leachate treatment units, leachate collection sumps, equalization tanks, treatment control room etc. shall be provided outside the embankment. These shall be located 0.5 m above the lowest ground level. Waste conveying facilities are provided for mechanically depositing the residue into the MSW landfill after segregation.

No specific intermediate cover is proposed other than the daily cover. However if the problem of odor persists intermediate cover may also be considered. In that case one intermediate cover of soil of thickness 450 mm may be provided at the mid-level

The top cover shall have the highest point at the center and slopes towards the edges radially with around 5 % slopes (after pre-grade settlement) towards the embankment. A network of intercepting drains and peripheral drains are provided for quick draining of the rainwater.The facility shall have green belts, trees and turfing on the embankment/ formation slopes as slope protection and to present pleasing appearance.

7.2.10.1 Selection of Liner Systems

The objective in the design of liners is to minimize the infiltration of leachate and gases into subsurface soils below the landfill eliminating the potential for ground water contamination. Composite liner designs employing a geomembrane and clay layer provide more protection and are hydraulically more effective than other types of linings. Liners provide an effective hydraulic barrier beneath the waste to contain the waste and to allow for effective removal of leachate generated during containment.

In the present MSW landfill, single composite liner system shall be provided meet stringent performance criteria that provide a high margin of safety. Each of the liner systems is discussed in more detail in the following sections.

Bottom Liners

The bottom portion of the landfill directly rests on stable compacted specially prepared soil bed. The various layers of liners from bottom to top are:

- 600 mm thick compacted clay/ amended soil (k≤ 10-7 cm/sec.)
- 1.5 mm thick High Density Polyethylene (HDPE) Geomembrane
- 200 thick silty sand protective layer
- 300 mm thick granular soil drainage layer (Leachate Collection Layer)

Side Liners

The side slopes in the soil formation are similarly made on firm compacted specially prepared stable slopes of 2H: 1V. The various layers of side liners from bottom to top are:

- 450 mm thick compacted clay/ amended soil (k≤ 10-7 cm/sec.)
- 1.5 mm thick High Density Polyethylene (HDPE) Geomembrane
- 100 mm thick protective layer (selected soil)

Top Cover Liners

The top cover the landfill directly rests on compacted specially shaped waste surface. The bed shall be laid to 3 to 5 % slope (after allowing for pre-grade settlements of the waste) for providing good natural drainage.The various layers of liners from bottom to top are:

- 450 mm thick granular soil (Gas Collection layer)
- 600 mm thick compacted clay/ amended soil (k≤ 10-7 cm/sec.)
- 300 mm thick topsoil /Sweet earth laid to 5 % slope

7.2.11 Selection of Leachate Control Facilities

The leachate collection layer is proposed in the granular soil (drainage) layer of the bottom liner system. The collection layer shall comprise of a network of perforated HDPE lateral pipes laid at a slope of 1% and 20 m c/c spacing. These laterals collect leachate and transfer it to the HDPE header pipe, which is laid at a slope of 1%. The header pipe ultimately transfers the leachate into the Leachate collection sump. The general arrangement of header and laterals is proposed in the layout plan of MSW landfill.

The sizing of laterals and headers is given in Annexure.

The landfill receives municipal solid wastes only. All operations are planned in such a way that generation of liquid waste is minimum and the leachate directly reaches the leachate collection sump for treatment. Apart from the leachate generated as a result of inflow of rainwater into thelandfill, the seepage from the moisture content present in the solid waste and the moisture present in the daily soil cover are the few sources of leachate generation. As the climate is hot with average temperature around 35° C, evaporation losses could be significant except in winter season hence 10% evaporation has been considered.

Area = 7748m^2

Rainfall max. Daily = 50 mm (Approx)

Total (Max.) Rainfall water =16.14 m^3/hour

7.2.11.1 LTP design basis

Around 16.14 m^3/ hr is generation of leachate in case of 50 mm rainfall. This would only happen when waste in the land retain the moisture upto its maximum retaining capacity. From the time of the rain and based on the experience the leachate keeps on coming out for days even after stopping of rain. On existing landfills experience internationally the equalization tank of one hour capacity can take care of the flow variation and for the downstream unit the design capacity taken is 25% of the average inflow in equalization tank.

The leachate generation will be minimized through:

- Proper run off & soil covers
- Operations during heavy rains to be avoided

- To ensure rain water other of SLF does not enter treatment plant.

Since leachate will be received intermittent by during the rainy season and may also vary in BOD, COD, TSS etc. level the system proposed is simple and with ease of operations and O&M, leachate from the SLF will be collection in equalization tank through collection sump. Aeration will be done through aeration to avoid anaerobic conditions and also to reduce BOD & COD through aerobic bacteria.

The waste water the equalization tank will then be transferred to clarifier for settling suspended impurities. Settled sludge will be drained to drying bed and then to SLF. Clarified waste water will be chlorinated and will be passed through pressure sand filter and activated carbon filter. The outlet from the activated carbon filter will be meeting UPPCB discharge standards for irrigation purposes.

7.2.12 Selection of landfill Gas Control Facilities

The landfill is a secured landfill with single composite liners well in place at bottom, sides and top. The liner system consists of one-layers of geomembrane and one-layers of 2ft. (600mm) thick amended clay as liners whereby the chances of gases escaping from the ground and contaminating the groundwater and soil are remote. The gases developed due to continued confinement of degradable wastes, if any, are released through the gas extraction facilities provided in the landfill. For this purpose GI Vents are planned at 20m x 20m grids.

7.2.13 Aesthetic Considerations

Adequate measures are planned to give a facelift by utilizing the abundantly available on site natural soil for raising buffer zones /embankments.Two rows of vegetative plantation shall be developed along the circumference of the outer embankment along with turfing on the slopes. In addition the top cover shall also be developed as a green belt.

7.2.14 Monitoring Facilities

The soil, air and water in the area shall be continuously monitored for no contamination. Both sampling methods and non-sampling methods are adopted and monitored as per the monitoring plan for timely action to be taken before water contamination and leakage of gases into the soil. The facility is proposed with a minimum four monitoring wells for soil water and gas measurements. The details of the monitoring plan are given in Table, wherein instruments /monitoring areas proposed are listed.

Table 7.3: Monitoring Plan

Monitoring Method	Type of Monitoring	Equipment	Information/data to be recorded
Sampling Monitoring Method (Methods involving collection of samples for laboratory analysis)	Air Monitoring (Collection of Air samples)	Gas Syringes Air Bags	Air quality/analysis of gas
	Ground Water Monitoring (Collection of ground Water)	Monitoring wells (Background wells) – both single depth and multiple depth	Water quality
	(Collection of Ground Water)	Piezometers	Water quality
	(Collection of Leachate samples)	In landfill piezometers	Leachate quality
	Vadose Zone Monitoring	Collection Lysimeters, Soil gas probes & Suction Cup Lysimeters	Analysis of Leachate between, VOC in soil, Gas monitoring, liquid monitoring in Vadose zone
Non-sampling Monitoring Method (Methods involving Physical and Electrical measurements)	Ground water Conductivity	Conductivity cells	Monitor changes in Groundwater Conductivity
	Leachate Monitoring	Inland fill Piezometers	Measure depth of Leachate in landfill
	Temperature	Temperature probes	Measure temperature In land fill
	Vadose zone	Electric probes	Salinity of vadose zone
		Electric Resistance Block	Changes in the water content
		Gamma ray attenuation probes	For monitoring of moisture content
		Neutron Moisture meter	Moisture content in the soil
		Tensiometer	Used to measure negative pressure that exists in soil/landfill
		TDR meter & Thermocouple psychometers	For recording Thermo Dielectric Properties of water and soil – any change in temperature and moisture will be recorded
		Waves Sensing Devices (seismic type)	To identify leak detection

Apart from the above, regular inspection and monitoring of important components of the landfill shall be done as per the schedule given below:

Final Top Cover: Once in a year and after each substantial rainfall it should be checked for any erosion, landslides, movement of soil, slope, etc.

Vegetation: Four times in a year a check should be made for existence of dead plants/trees. Any plant/tree found dead shall be removed immediately.

Final Grade: Twice a year should be checked for ponding/logging of water. If any abnormalities found, slope should be corrected by putting soil.

Surface drains: Four times a year and after each substantial rain should be checked for any blockages. Leaves, debris or any other accumulation found in the drain shall be removed immediately.

Gas Monitoring: As required in the Management Plan it should be checked for strong presence of odor. The gas monitoring equipments (compressor, pipes, flaring stand, etc) should be checked to ensure their workability as they might become inoperable due to high gas generation.

Groundwater Monitoring: As per the Action Plan. A regular inspection shall be done to check for any failures in the monitoring system.

Leachate Management: As required by the plan.

7.2.15 Other Facilities

7.2.15.1 Control Room

The control panel room will consist of an RCC framed structure and will be at a strategic location in the compost plant for supervision and efficient operation on the machinery. A transformer will be located adjacent to this control room.

7.2.15.2 Administrative Building

The administrative building will be a two-storeyed RCC framed structure with facilities for laboratory and conference room. The laboratory will be well equipped with all necessary provisions for monitoring of processes such as oven, muffle furnace, balance, spectrophotometer, different chemical glassware, etc.

7.2.15.3 Roads and Other Facilities

Roads of proper sizes are to be provided. Other facilities such as canteen, toilet, washing place, store-room, dump-yard, supervisor room are to be provided adjacent to the coarse segregation section. Adequate lighting proposed throughout the compost plant. In addition, fire-fighting equipments proposed for safety purposes.

7.2.15.4 Electric Power

A HT/LT electric power connection will be obtained from state electricity boards.

7.2.15.5 Green Belt and Garden Area

A green belt of densely planted, tall growing trees will be developed around the plant. Suitable provision for demonstration plots to ascertain the quality of finished products may be made available at the plant site.

7.3 DESIGN CALCULATION FOR INTEGRATED SOLID WASTE MANAGEMENT FACILITY AT DURGAPUR

The total land area requirement has been worked out on basis of solid waste generated in the Durgapur city, characteristics of the waste etc.

DMC has demarcated 10.12 Acre of land for the construction of the new sanitary landfill site and processing plan .

Approx 7 Arc land will be used for construction of processing facility and only 3 Acre land is available for for landfill. The available land for landfill is small and will work till year 2022.

Table 7.4: Area Requirement for Integrated Solid Waste Management facilities

Sl. No.	Description	Area Requirement (in Acre for the year 2044)
1	Design Area	3.0 Acre

7.3.1 MATERIAL SPECIFICATIONS

7.3.1.1 Bottom Liners

The description is:

90[1] cm thick compacted clay or compacted amended soil (to be laid in 3 layers of thickness 30 cm each), above compacted sub-base, with permeability less than or equal to $1X10^{-7}$ cm/s with the following specifications:

- Permeability would be checked at each layer after laying
- Free of any stones, kankars and any other foreign material
- Moisture content would be maintained at 2 – 3 % more than optimum moisture content (OMC) during laying.
- To be compacted to achieve minimum 95 % Proctor Density.
- Permeability & moisture content has to be checked in each layer.
- To be kept covered during installation so that moisture is not evaporated.

1. HDPE[1] Geo-membrane of minimum thickness 1.5 mm would be laid above compacted clay liner. The HDPE Geo-membrane would meet the minimum technical specification as given in "*Criteria for Hazardous Waste Landfills published by CPCB in 2001*", the same specifications are reproduced below:
   - Tensile strength at yield greater than 18 KN / m.
   - Tensile Strength at break greater than 30 KN / m.
   - Tear Resistance greater than 150 N
   - Puncture Resistance greater than 250 N
2. Geo-textile layer above HDPE layer
   - Type – Non woven
   - Make – HDPE
   - 200 GSM

7.3.1.2 Drainage Layer

The details of drainage layer are described below:

1. 30[1] cm thick Leachate drainage layer having permeability greater than 1 X 10^{-2} cm /sec to be laid on entire bottom surface above geo textile layer laid over HDPE geo membrane, in:3 layers as described below:
   - 10 cm thick layer of gravels of size 22 to 32 mm or any other material laid over geo-textile layer. The gravels would be free of dust and any angular or sharp aggregates.

[1] As mentioned in the MSW (Management& Handling) Rules, 2016.

- 10 cm thick layer of stone chips of size 16 – 22 mm over gravel layer. The chips would be dust free.
- 10 cm thick layer of coarse sand of size 0-5 mm over stone chips layer. The sand should be free of clay sized particles.

2. Geo-textile layer above drainage layers
   - Type – Non woven
   - Make – HDPE
   - 200 GSM

7.3.1.3 Leachate Drain

a. In case if it is felt necessary during laying of leachate collection pipe, a cushion layer of suitable thickness & consisting of sand, cement & bentonite mixture (94 : 3 : 3 respectively) may be provided.

b. Specifications for HDPE pipe
   - Outer Diameter. – 300mm
   - Wall Thickness –9.7-10.9mm
   - Pressure Rating- 4 Kg/cm^2

c. 10 mm diameter holes would be made @ 50 mm c/c staggered spacing in the top 2/3rd of perimeter of leachate collection pipe.

d. The 200 GSM geo-textile has to be laid over HDPE pipe and extended by 1 m in both directions (perpendicular to length of pipe) to prevent clogging of slots by drainage material / other solids.

e. Over HDPE pipe covered with geo-textile, gravels in size of 16 mm to 32 mm to be laid uniformly.

7.3.1.4 Top Liner System

1) 15 cm thick gas collection layer has to be provided, above the waste body, in the form of stone chips of size 16 – 22 mm.

2) Passive Vents of 1.5 m height above top surface of vegetative cover
   - 150 mm diameter HDPE pipe to be laid vertically from the gas collection layer.
   - 75 mm diameter and 50 cm long perforated HDPE pipes (4 nos.) to be connected at right angles (in horizontal plane) at the bottom of 150 mm dia. HDPE pipe (vertical).

3) 60[12] cm thick compacted clay or compacted amended soil (to be laid in 2 layers of thickness 30 cm each), above compacted sub-base, with permeability less than or equal to 1X10^{-7} cm/s with the following specifications:
   - Permeability would be checked at each layer after laying
   - Free of any stones, kankars and any other foreign material
   - Moisture content would be maintained at 2 – 3 % more than optimum moisture content (OMC) during laying

[2] As mentioned in the MSW (Management& Handling) Rules, 2016.

- To be compacted to achieve minimum 95 % Proctor Density
- Permeability & moisture content has to be checked in each layer.
- To be kept covered during installation so that moisture is not evaporated.

4) 15^2 cm thick drainage layer consisting of stone chips & coarse sand having a permeability of more than $1x10^{-2}$ cm/s.

5) 45^2 cm, fertile soil cover for vegetation

- To be laid in two layers, the bottom layer to be compacted mildly and the top layer to be kept loose for growing vegetation.
- Vegetation cover with grass, shrubs etc. having root length less than 30 cm

7.4 LIFE OF THE LANDFILL WILL BE: 4 YEARS

Table 7.5: Volume of waste till Year 2022

Year	Design Population	waste generation Rate	Waste generation	yearly waste generation	Year
2018	629568	414.6	261.0		
2019	638524	420.0	268.2	26.8	9787.675
2020	647361	425.4	275.4	27.5	10052.14
2021	656080	431.0	282.7	28.3	10319.97
2022	664681	436.6	290.2	29.0	10591.18
Total					**40750.97**

Table 7.6: Landfill volume calculation

Design Period for ultimate stage per CPHEEO norms	20	years
Total waste generated	40751	Tons
Landfill Grade Density	0.85	T/m3
Total waste volume based on landfill grade density @ 0.85T/m3	47942	m3
Addl vol for daily cover @ 10% of the total volume	4794	m3
Vol. of liner material @ 12.5% of total volume	5993	m3
Total vol of landfill	58729	m3

Table 7.7: Vehicles Requirement Landfill Processing

Sl No	Vehicle type	Number
1	Compactor	1
2	Excavator	1
3	Dozer	1
4	Loader cum backhoe	1
5	Dumper Truck	2
6	Water tanker with pump	1
7	Tractor Tipper	2

Table 7.8: Man power Details

Sl. No.	Particulars	Nos.
1.	Assistant manager – Landfill	1
2.	Supervisor – B.Sc.	1
3.	Laborers	4
4.	Excavator driver	1
5.	Dozer Driver	1
6.	Loader Driver	1
7.	Compactor driver	1
8.	Truck driver / Tractor diver	2

CHAPTER 8 PROPOSED INSTITUTIONAL FRAMEWORK

It is proposed to take steps for institutional strengthening and internal capacity building to ensure that endeavour to improve the existing scenario is successful. Institutional strengthening can be done by adequately decentralizing the administration, delegating adequate powers at the decentralized level, by inducting qualified and competent professionals into the administration and providing adequate training to the existing staff.

Durgapur Municipal Corporation has demonstrated its commitment to developing slums and poor communities. DMC is responsible for the delivery of variety of functions like Water Supply, Sewerage, Sanitation, drainage, solid waste management, roads and transportation to the citizens and has taken long strides in this regard. It has also been dealing with medical relief, preventive medicine, sanitation and conservancy, maternity and child welfare, control of food adulteration and some other functions under the Public Health regulations.

8.1 ADMINISTRATIVE SET UP OF DURGAPUR

The governance structure of DMC is divided into two wings viz. administrative and elected. Durgapur Chairman -in-Council system. Chairman in Council comprises 46 elected members from 46 wards. Chairman is the Chairperson of the Council. Also, there are functional committees on various subjects, namely executive committee, finance committee, health committee, building and works committee, rules and byelaws committee, garage committee, license committee, house tax committee, electric and public lighting committee. The chairman elected by the majority of Councilors is the executive head of the Urban Local Body, presides over the meetings of the DMC Board, and is responsible for the governance of the body.

Mayor
Dy Mayor
Commissioner
Executive Officer
Town Manager
Sanitary Inspector
Office Staff
Supervisor/Assistant
Drivers
Safai Karmacharies

The Municipal Commissioner appointed by the State Government is a whole time principal executive officer of the Corporation, for administrative control of the ULB. Other officers are also appointed to execute specific functions.

8.2 RECOMMENDATIONS FOR INSTITUTIONAL STRENGTHENING

The recommendations for the institutional framework are based on the specific tasks to be carried out under the proposed MSW Project. The activities which need to be focused as per the proposed plan include:

- Segregation of waste at source
- Mechanism of waste collection
  - Primary collection
  - Secondary collection
- Transportation of waste from secondary collection locations
- Development of integrated SWM processing facility
- Operation and maintenance of installed SWM system
  - Landfill
  - Composting
  - Transportation
  - Waste collection infrastructure

In the above listed components, several activities/infrastructure developments are proposed to be taken up for implementation for the first time. The DMC requires capacity building to execute the proposed plan.

In view of successful PPP arrangement in many cities for SWM management; it is proposed to consider the private sector participation for developing and operating new services. Based on analysis of the merits and demerits of the existing system, it is proposed to have responsibility delegation for undertaking each activity under proposed SWM plan as below:

Table 8.1: Roles and Responsibilities for O&M of ISWM

Activities	Organization/ Institution	Scope of work/ Responsibilities
Segregation and collection	Durgapur Municipal Corporation	– Deploy of more sanitary workers – Sensitization of residents/public about segregation. – Provide facilities/bins for segregation – Collection from house holds – Transportation of waste to bins. – Orientation/sensitization of sanitary workers. – Involve NGO's / CBO's in public awareness.

Transportation	Durgapur Municipal Corporation Private agency	– Selection of party/ agencies for procurement and execution – Work out finance model with agency. – Funding – Monitoring and supervision of agency work. – Readdressal of issues. – Monitoring management and coordination. – Procurement of equipments/ facilities. – Installation of facility. – Safety of equipments. – Collection/ lifting of waste from secondary collection points. – Operation and maintenance of vehicles. – Transportation of waste to site
Integrated SWM facility	Durgapur Municipal Corporation	– Selection of agency for execution – Funding – Monitoring of construction and management – Supervision of commissioning.
	PPP	– Design and construction – Commissioning – O&M

The existing staff of DMC shall be adequate for doing monitoring of SWM services by different private operators but require capacity building to undertake this activity efficiently. Therefore in addition to private operator participation, institutional strengthening is required within DMC to ensure sustainability. For institutional strengthening, it is proposed to decentralize the administration, delegate adequate powers at decentralized level and bring accountability at all levels. It is proposed to decentralize SWM functions at three levels:

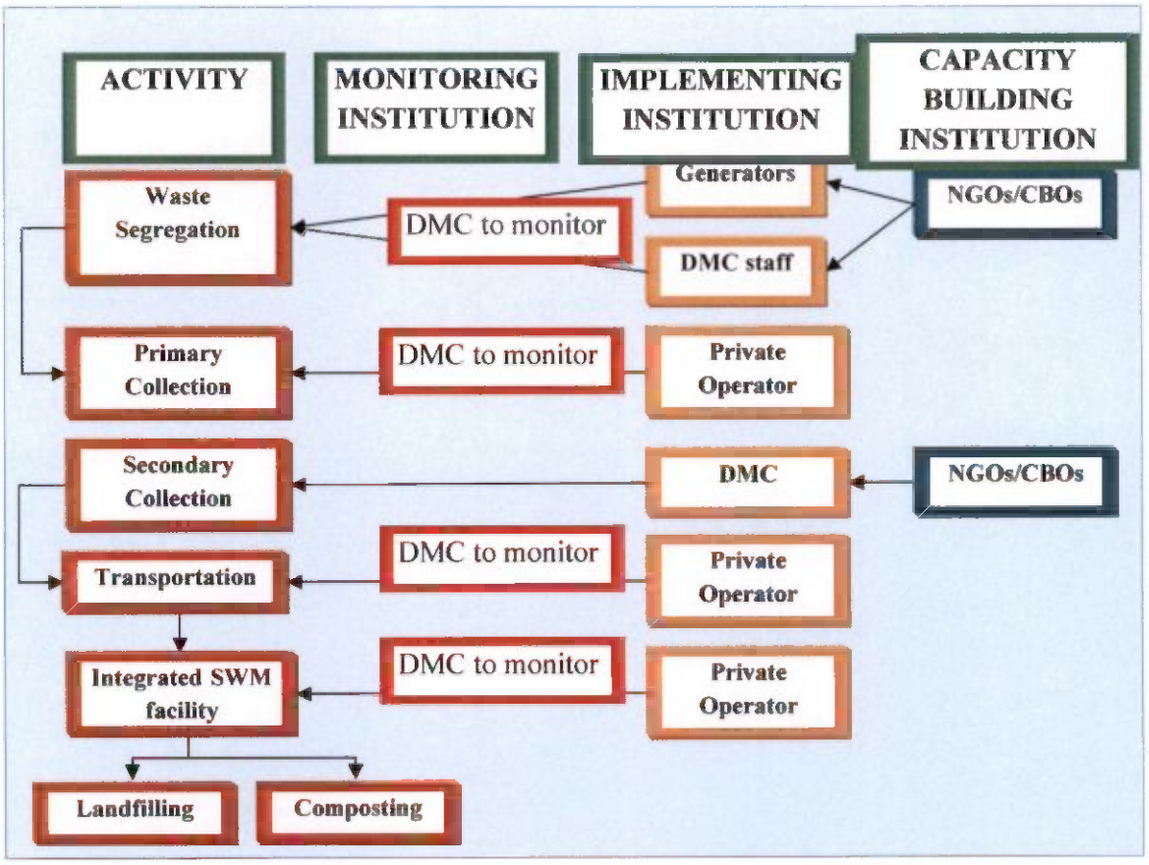
- Election ward level
- Sanitary ward level, and
- City level

8.3 ELECTION WARD LEVEL

The election ward level administration shall be fully responsible for ensuring storage of segregated waste at source, primary collection of waste, street sweeping and transferring waste to bins, cleaning surface drains and public places. The cleaning of each street, lane, by-lane, markets and public places shall be

regularly supervised by the election ward level supervisors. It is proposed to have two wards under one supervisor.

Fig 8.1: Proposed Institutional Framework for SWM



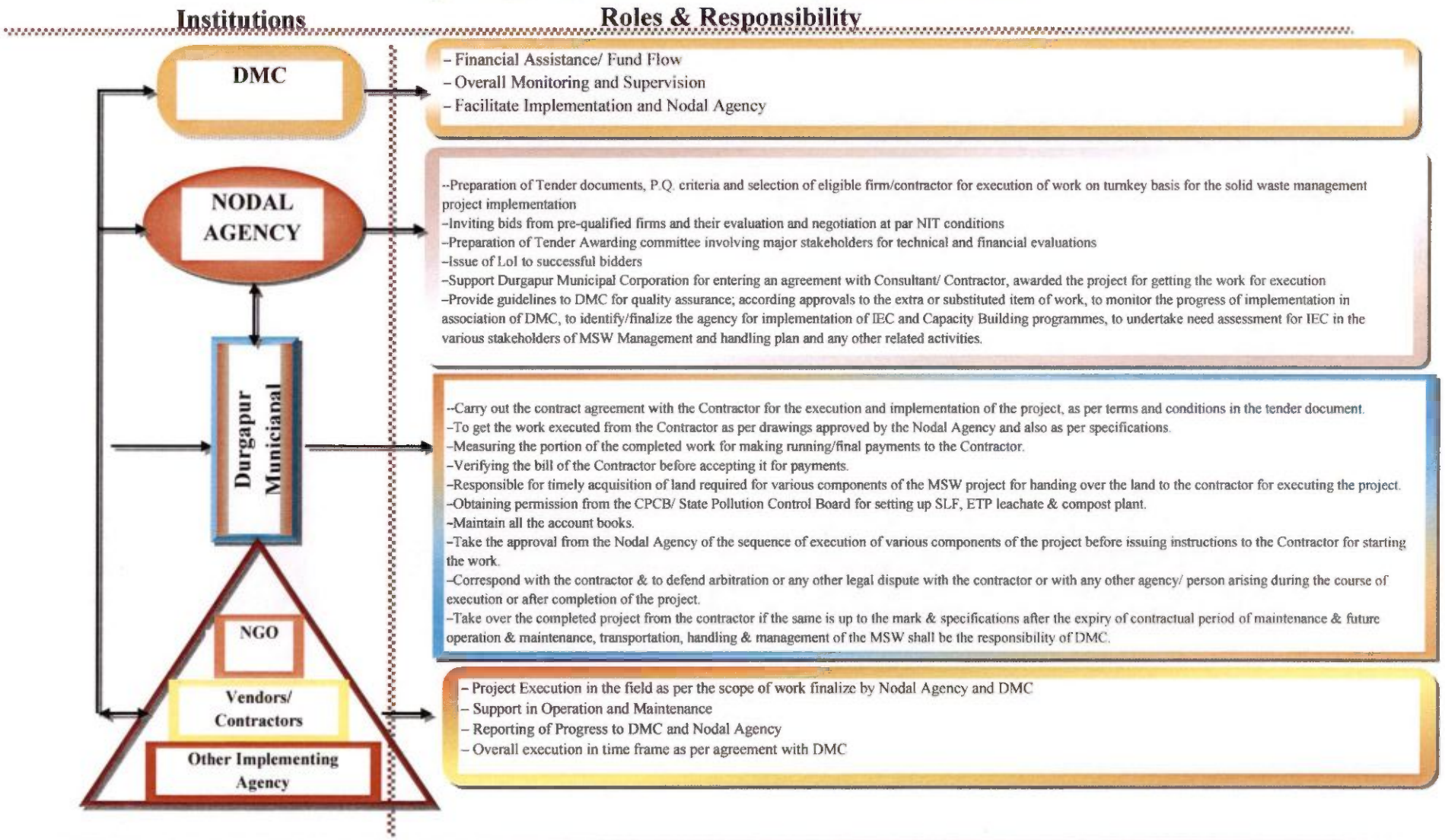
8.4 SANITARY WARD LEVEL

The sanitary ward level administration shall effectively supervise and support the work of sanitary supervisors and also provide due support for upkeep of solid waste collection infrastructure, transportation of waste processing and disposal sites. The sanitary inspector shall ensure that there is adequate coordination between sanitary supervisors of his ward. The fleet of vehicles shall be assigned at sanitary ward level.

8.5 CITY LEVEL

The city level administration shall supervise and support the sanitary ward administration. The city level administration shall monitor daily waste quantities collected and transported from each sanitary ward and enquire if any abnormality is reported. The central department is responsible for monitoring activities at the integrated solid waste management facility. The city level administration shall ensure that private operator is undertaking SWM services as per the contract.

Fig 8.2: Proposed Institutional Framework for Operation and Maintenance



8.6 LEGAL ASPECTS

Solid waste management systems adopted in Indian cities are highly inefficient and outdated, lacking public participation. Overall public apathy is observed in the matter of handling and disposal of municipal waste. A system of throwing garbage on the streets by citizens and local bodies collecting the waste from the streets and disposing of it in the most unhygienic manner is in vogue. These systems can be corrected by taking concerted measures involving the public at large through their active participation in the process, and by corporation performing its duties effectively.

Solid waste management practices can never reach the desired level of efficiency until the public participates and discharges its obligation religiously. The system therefore, can only be improved by modernizing the solid waste management system by the Corporation and ensuring public participation through very serious motivational efforts along with adequate legislative support for taking punitive measures.

For improving solid waste management practices in city, the Supreme Court Committee has given wide ranging recommendations defining the roles and responsibilities of the citizens, NGOs, local bodies, etc. Subsequent to the aforesaid report, the Government of India, Ministry of Environment has notified municipal solid waste (Management & Handling) Rules 2016 under the Environment Protection Act 1986, these rules have clearly laid down the measures to be taken by the Municipal Corporation as well as smaller urban local bodies. Keeping in view both the above report and the rules it is necessary to incorporate suitable provisions in the state law to ensure public participation and for providing for minimum level of service.

Local law also needs to provide for punishment on the spot to those who do not adhere to the directions given for maintaining appropriate solid waste management system in the city giving adequate power to the corporation to punish the offenders.

The following legal provisions may be incorporated by the State Governments in the law-governing corporation.

8.7 LEGAL PROVISIONS

8.7.1 Duty of occupiers of premises to store solid waste at source of generation

It shall be incumbent on the occupiers of all premises to keep two receptacles, one for the storage of food/organic/bio-degradable waste and another for re-cyclables and other types of solid wastes generated at the said premises.

8.7.2 Duty of occupier not to mix recyclable /non-bio-degradable waste and domestic hazardous waste with food waste etc.

It shall be incumbent on the occupier of any premises to ensure that the recyclable waste as well as domestic hazardous waste generated at the said premises does not get mixed with the food/bio-degradable waste and that they are stored separately.

8.7.3 Duty of Societies/Associations/Management to provide community bins

It shall be incumbent on the management of Co-operative Societies, Associations, Residential and Commercial Complexes, Institutional buildings, markets and the like to provide community bin/bins of appropriate size as may be prescribed by urban Corporation, for the temporary collection of waste other then recyclable waste and hazardous waste, to be stored at their premises for its primary collection by the municipal authorities. A separate community bin may also be provided for the storage of recyclable waste where door to door collection of recyclable waste is not practiced.

8.7.4 Receptacles to be kept in good repair

Receptacles as stated in 3 above shall at all times be kept in good repair and condition and shall be provided in such number and at such places as may be considered adequate and appropriate to contain the waste produced by the citizens supposed to be served by the community bins.

8.7.5 Duty of occupiers to deposit solid waste in community bins

It shall be incumbent on occupiers of all premises for whom community bins have been provided as per 3 above, to cause all segregated domestic waste, trade waste, institutional waste from their respective premises to be deposited in the appropriate community bins.

8.7.6 Duty of Corporation to provide bins for Waste storage depots

It shall be incumbent on the corporation to:

Provide and hygienically maintain adequate waste storage bins in the city and place large mobile receptacles at such places for the temporary storage of waste collected from households, shops and establishments as well as from streets and public places until the waste is transported to processing and disposal sites.

8.7.7 Duty of Corporation to collect waste from community bins transport

It shall be incumbent for corporation to remove all solid waste deposited in community bins on a daily basis transport to processing or disposal sites.

8.7.8 Duty of Corporation to clean all public streets, open public spaces and slums

It shall be incumbent on corporation to arrange for cleaning of all public streets having habitation on both or either side, and all slums on all days of the year including Sundays and public holidays.

8.7.9 Prohibition against littering the street and deposit of solid waste

No person shall litter public streets or public places or deposit or cause or permit to be deposited or thrown upon or along any public street, public place, land belonging to the Corporation or any unoccupied land or on the bank of a water-body.

8.7.10 Punishment for littering on streets and depositing or throwing any solid waste

Whosoever litters the street /or public places or deposits or throws or causes or permits to be deposited or thrown any solid waste or construction debris at any place in city would be punished as specified under penalty subsection.

CHAPTER 9 IEC MATERIAL & PUBLIC AWARENESS

To enable people to participate in the development process, it is necessary that people have adequate knowledge about the nature and content of these Programmes. Public Awareness through Information, Education and Communication (IEC), therefore, assumes added significance in the context of the Programmes. Through IEC techniques the stakeholders and local community could be educated and aware about the issues and advantages of existing and implementing system of the solid waste management. The basic approach of IEC plan is to create effectiveness of the Solid Waste Management System. Its operational efficiency can be improved through Information, Education and Communication (IEC) techniques.

Apart from this, to have the municipal solid waste collection in segregated form and adequate handling and processing, the Municipal staff as wall as the other stakeholders/ private operators involved in this process should be properly trained and sensitized. For this purpose need of Information, Education & Communication (IEC) Plan and Training & Capacity Building of DMC staffs responsible for Solid Waste Management have been assessed and are being proposed.

9.1 OBJECTIVE

The major objectives of the IEC and Capacity Building are as follows:

- ✓ Bringing of attitudinal and behavioural changes among the residence about the segregation of waste and sanitation improvement.
- ✓ Public awareness through informing and educating the masses on various aspects of solid waste management and achieve the target of receiving segregated waste from each household.
- ✓ Creating Public Participation in Planning and Management of MSW Activities
- ✓ Capacity Building of the personnel's involved in implementing MSW i.e. Institutional Capacity of Health Department of Durgapur Municipal Corporation for Improved MSW Management.
- ✓ Integration and involvement of private sweepers and Rag Pickers in improving MSW management

9.2 PUBLIC PARTICIPATION AND AWARENESS THROUGH INFORMATION, EDUCATION AND COMMUNICATION (IEC) PLAN

The success of any solid waste management scheme can be measured through the extent of cooperation and participation of people, effectiveness of the proposed system and operational efficiency. Communication is an integral part of planning for sustained development. The development of human

society has largely been due to its ability to communicate information and ideas with each other and to use such information and ideas for progress.

The Programmes being implemented by the Govt. Departments aim at sustainable holistic development in all development projects. The success of these programmes is critically dependent on the participation of the people, particularly target groups, in the implementation process. The approach should be to emphasize on communication with target groups, local community for the implementing programme of Solid Waste Management in respective areas of Durgapur.

9.3 APPROACH OF IEC PLAN

The basic approach of Information, Education and Communication Plan is to make aware the public about the need of reduction and segregation of waste from the households along with the collection system of waste to take public cooperation to make hygienic structure of the area.

- Focus Group Discussions
- Inter personal communications
- Creating watchdog committees comprising of local influential people and important stakeholders, societies
- Printed materials and Audio-visual aids
- Other locally popular media.

The entire implementation shall be designed to cover entire Municipal area of the city in a very planned and strategic way for the efficient implementation and for the success and sustainability of the MSW management.

9.3.1 Communication:

Communication Planning is an integral part of planning for sustained development. The development of human society has largely been due to its ability to communicate information and ideas with each other and to use such information and ideas for progress. First attempt would be a public campaign, which is the objective of the IEC Plan, will be launches to raise awareness about cleanliness.

i). Door to Door Campaign:

For door to door information spreading, involvement of health workers (Sanitary staff) would be easy and speedy along with the volunteers. It will also create a platform for a better communication management among public and sanitary staff. The volunteers and health workers will lead to spread the project information with the help of support material which will be helpful for providing effective information along with time saving.

ii). Public Address Meeting:

Interpersonal and community meeting is a great tool to share the information, views and direct interaction for the effective involvement and awareness among the residents. The message and information and people commitment can be taken for the segregation and better management for the Segregated Solid Waste Management Scheme. Some workshop and seminars will also lead to inform the stakeholders at a time with proper preparation and communication and their participation and cooperation for sanitary improvement.

iii). Media Support:

Media support is essential and a very important part of IEC programme to inform, educate and aware the masses. Media support includes the use of television, radio, print media and folk theatre therefore, accords priority for the promotion of non-formal sanitary improvement education and creation of awareness among all sections of the society through diverse activities using traditional and modern media of communication. The media should be informed and involved for each programme which would be conducting according to the IEC plan.

iv). Folk Programme:

Street play which is an important tool for creating entertained information, education and basically aware the lower income group and lower middle income group residents. The street play theme should be to the point on the IEC plan and in local point of view to realize the residents as of their part. Mass media should also be encouraged for their support in public awareness program.

9.3.2 Social Mobilization:

For the social mobilization, attitudinal and behavioral changes of the residents' involvement of major and social stakeholder are essential. For this purpose institutional and other organizations involved in social activities are a great awareness center for the social mobilization and public awareness as indicated below:

Educational Institutions (Schools and Colleges etc.)

NGOs/ CBOs/ Societies Support

Sr. Officials/ Administration Officers / Sr. Citizens

Ministerial Supports etc.

9.4 IDENTIFICATION & ACTION

Identification and selection of target groups plays a key role in creating effective awareness in residential. For solid waste management, it becomes more important as the source of MSW starts from

houses due to which target starts from household female head, youths and children who requires some form of role model or different methods to influence their behaviour. It is a very important aspect which could be at waste generators level and may reduce, reuse and recycle their waste. The other part of target groups may be waste collector and waste managers. These types of target groups are directly involved with the solid waste management. Along with this, there are other groups which can be helpful for the better management of MSW segregated waste collection, operation, handling and proper disposal. The major target groups are as following:

Table 9.1: IEC action Identification

Sl. No.	Target Groups	Target Group Details	Action Plan
1	Waste Generator	• Residential Areas (Women (household), Maids, children and Youths) • Commercial Areas (Shopping areas, Vegetable markets, Offices, Hotels, Restaurants) • Institutional Areas (Jr. High Schools, Colleges)	– Holding locality-wise meetings, seminars, targeted community meetings with self help groups, through street plays, technical and pictorial presentation along with aware them about health hazards and remedial measures and sanitation improvement. – Informing and suggesting them about the segregated waste management and their important role.
2	Waste Collector	• Sweepers • Rag pickers • Waste loaders • Truck drivers • Landfill supervisors	– They all should be involved and sensitize about the need of segregated waste collection and sanitation improvement. – The waste collection, transportation and disposal of the waste in proper timing so that waste could not be overflow. – The waste collector should be trained about the collection of segregated waste.
3	Waste Managers	• Administrators and supervisors • Control and monitoring team • Complaint handlers • Computer software operators and specialists	– Presenting them about the Rules and Regulation and updating them about the ongoing activities and techniques for MSW management. – Training programmes for the technical staffs

			– Providing the reviews of progress and monitoring activities
4	Leaders	• Political Leaders (Local MLA, MP) • Religious Leaders • Community Leaders	– These leaders can be motivated to participate actively in promotional efforts of community involvement in segregated solid waste management.
5	School Teachers and Students	• Primary Schools • Jr. High Schools • Public Schools	– School teachers can be informed and involved in the segregated solid waste management scheme and can be motivated to educate the children for the sanitary improvement. – The students can be educated and trained for the segregated waste management system and they can be great awareness creators for the societies. – Some groups of students can be created as monitoring and awareness team for sanitation improvement which will make a great impact on societies and communities.
6	Media	• Print Media • Electronic Media	– Launching mass campaign for educating and motivating local communities and families about the need of segregation of Solid Waste and its management for sanitation and hygienic improvement.
7	Elite groups or social organizations	• NGOs, Societies • CBOs • Sr. citizens Association • Rotary Clubs/ Lions Club	– Sensitize and motivate local influential people like Sr. citizens, leading businessmen, social club members, NGOs and CBOs etc. to undertake or sponsor such activities for solid waste management for effective strategy of public participation and awareness.

Once the target groups have been identified, the responsibility lies in developing the approach for educating these groups. For successful implementation of any program involving public at large, it is

essential to spell out clearly and make them know the manner in which the problem is proposed to be tackled to keep area clean and improve the quality of life.

The communication material should be developed and must be utilized in public awareness program through the tools of publicity. The use of various publicity tools as public address meetings, workshops, School Activities, Street Plays, Distribution of Handbills, Pamphlets and Handbills etc. can be used.

This professional work be outsourced to Event management Companies/ NGOs etc who will carry out all programmes for not less than six months through:-

- Mobile Campaign;
- Leaflets;
- Cinema Slides;
- Arranging Hoardings & Banners;
- Holding Seminars and Workshops;
- Locality wise general Campaign for awareness;
- Involving schools and their students for ***"Keep Your City Clean"*** Campaign;
- Holding Exhibitions;
- Importing Trainings to workers for cleaning works in Public and Community Toilets;
- Record Consultations, suggestions and general feedback from the people and deliver to ULB for planning and mitigating redressal issues of complains.

9.4.1 Quantification of Works

9.4.2 Subject Matters (Seminar, Workshops)

9.4.3 Activities Covered in Leaflets, Hoardings and Banners, Campaign and Exhibitions


HOARDINGS
&
BANNERS
"KEEP YOUR CITY CLEAN"
Citizen shall Do
Citizen shall not Do
Handover your waste to BMC waste collector;
Do not throw your waste into drains and on roads/ open spaces;
Segregate your waste and keep it in separate bins;
Do not mix your all wastes;
Get your toilet connected to sewer system;
Do not let your sewage into drains or into ground;
Keep your waste into litter bins;
Do not litter in open space, on buildings etc;
Point out insanitary condition of your area to BMC staff;
Do not allow insanitary condition in your area;
Use public toilets wherever there is.
Do no defecate in open areas.

Table 9.2: Proposed Financial Budget for IEC

Sl. No.	IEC materials and methods for one year budget	Quantity	Approximate Cost (Rs.)
1.	Sanitation Booklet (4page)	2,00,000	Rs 10,00,000
2.	Sanitation Leaflet (One page)	4,00,000	Rs 8,00,000
3.	Banner (4'-0"x2'-0") flex	500 nos	Rs 8,00,000
4.	Hoarding (20'-0"x10'-0"x6'-0") for one year	100 nos	Rs 16,00,000
5.	Advertisements to Newspaper TV & Other Media	L.S	Rs 10,00,000
6.	Workshop, Seminars	100 nos	Rs 10,50,000
7.	Niking 10 sets (Weekly one year)	520 times	Rs 24,00,000
8.	Student Rally Each Month	12 nos	Rs 8,50,000
Total			Rs 95,00,000
Total (say)			**Rs 95,00,000/-**

CHAPTER 10 ENVIRONMENTAL AND SOCIAL ASPECTS

10.1 ENVIRONMENTAL AND SOCIAL ASPECTS

Present environmental situation is not monitored. It is considered that due to inadequate basic sanitation facilities, pollution of air and water is prevailing. There is no activity undertaken by the ULB for mainstreaming the rag pickers and work is to planned for their resettlement.

10.2 SOCIAL ISSUES OF RAGPICKERS AND RESETTLEMENT PLAN

Mainstreaming activity will be taken up by the ULB by employing the rag pickers in waste processing plant and sanitary landfill site. Free medical checkup can be taken up by ULB for all their SWM workers & other manual workers.

It is observed that near about 150 rag pickers involved in segregation and reselling goods from the waste in the Durgapur city. For rag pickers the reselling of goods is the livelihood. Therefore, to ensure living wage for rag pickers it is proposed to educate them and involve in waste management system in due course of project implementation.

10.3 ENVIRONMENTAL ISSUES AND THEIR MITIGATIONS

During execution of projects of sewer line, there will be environmental hazards in air, water and river construction activity shall be planned for minimization of all hazards by following standard methods of mitigation.

Major environmental issues involved in MSW management system are given below:

Table 10.1: Environmental Issue and Action Plan

Sl. No.	SWM Management System	Major Issues Involved	Action Plan
1	Primary Collection	Primary Collection of solid waste is not appropriate resulting accumulation of solid waste on roadsides and vacant plots and in low lying areas and storm water drains.	Door-to-door waste collection service has to be provided to households. The roadside waste collected by street sweepers must be directly dumped into a separate bin at the secondary waste collection point.

2	Secondary Storage of Solid Waste	In the absence of secondary storage facility for MSW, it is dumped at any location in the vicinity – drains, vacant plots, street corners, low lying areas, and other open areas. Heaps and stretches of un-segregated waste in open areas is an eyesore, thereby causing environmentally hazardous & unhygienic conditions across the city, thus, creating conditions for breeding of mosquitoes, grazing by cattle	Separate colored bins must be provided at the secondary storage location for biodegradable and non-biodegradable, and recyclable wastes. The bins must be covered and cleared at the scheduled time to prevent storage of waste for a long time and littering of waste outside the bins
3	Solid Waste Transportation	It is observed that transportation vehicles are overloaded with waste, resulting in road littering during transportation. The loading and unloading of waste is done manually and safai karamcharis involved in this activity do not use any Personal Protection Equipment (PPE) for their protection.	The waste transportation vehicles must be covered at all times expect while loading and unloading activities and the loaded waste should not exceed the capacity of these vehicles.
4	Collection and disposal of construction waste	The construction/ demolition waste generated by local residents is transported in tractor trolleys and disposed off in open/ low-lying areas in the vicinity, privately	The construction and demolition waste must not be dumped in any open areas in an unorganized manner.
5	Disposal of solid waste	The solid waste collected from various sources is disposed off in open dumpsites indiscriminately without segregation or preprocessing. There is no engineered sanitary landfill site for safe disposal of solid waste.	According to MSW Rules, 2016, biodegradable waste shall be processed and converted into compost or used for power generation; recyclables shall be segregated and sold to recyclers; no hazardous waste be dumped along with MSW; construction waste to be segregated and used for filling low lying areas and only remaining waste shall be dumped into engineered landfill facility.

Municipal Corporation should have strict initiative for proper implementation of action plan to avoid environmental and social nuisance.

10.4 ENVIRONMENTAL SCENARIO

Due to growing prosperity and changing lifestyle of people, communities are getting increasingly oriented towards consumerism. They are guzzling resources in a wasteful manner and in the process, generating a variety of wastes, a bulk of which is in the form of solid waste. Consequently, a sea change has occurred lately in both quantum and composition of solid waste. In many cities, the rate of generation of solid waste has increased so much that the civic agencies responsible for the collection and disposal of wastes are unable to deal with the total quantity produced every day. As a result, a major part of the waste remains uncollected and accumulates in the form of heaps at various locations within the inhabited areas. Inefficient and improper methods of disposal result in scenic blights and create serious hazards to human health. These include pollution of air and water resources, accident hazards and an increase in rodent and insect vectors of disease.

The composition of solid waste has changed in such a manner that, today, a major proportion of the waste is composed of non-biodegradable materials such as plastics, iron, glass and other metals. The Indian Cities generate about 110,000 tonnes of garbage in one day of which around 44,000 tonnes are organic and 66,000 tonnes are inorganic. This type of waste can only be recycled or disposed of through special processes. Due to these reasons, the task of handling solid waste has become a highly specialized managerial task.

In most of the Indian cities, waste comprises mainly of not easily combustible vegetable and meat wastes, since the more easily combustible substances such as cardboard, paper, cloth, and plastics are already eliminated at source or by rag pickers for sale to 'kabariwalas'. Even with the implementation of waste reduction, recycling, and transformation technologies, disposal of solid waste in landfills remains a significant component of an integrated waste management strategy. Contrary to what its name suggests, the method of landfilling, till now, has been operated in an unsanitary manner. Most landfill sites give an unhygienic look. Not only this, the consideration of the environmental parameters in designing and developing these projects has been neglected.

The recent directions of the Supreme Court of India to the various municipalities and states' departments of Urban Development to ensure compliance with the Municipal Solid Waste Rules, 2016(MSW Rules), have brought municipal solid waste management (MSWM) issues under the spotlight. Municipalities have thus started to address the MSW issue, for a number of reasons, including citizen concern and recent mandates from the Supreme Court.

The addressal of the solid waste management issues is particularly significant in cities like Jamshedpur, with population up to 13 lakhs. The city of Jamshedpur generates about 350 metric tons of solid waste per day.

In line with such requirements, Purnia has decided to go for Integrated Municipal Solid Waste management and Sanitary Landfill facility (SLF) for MSW disposal. According to legislation on municipal solid waste formulated and enacted by the Union Ministry of Environment and Forest as empowered under the Environment Protection Act of 1986—the submission of an environmental impact assessment prior to the designing and development of any landfill facility in the country has been made mandatory.

10.5 ENVIRONMENTAL MANAGEMENT PLAN

10.5.1 Environmental Monitoring

Environmental monitoring has to be conducted at MSW landfill and composting facility to ensure that no contaminants that may affect public health and surrounding environment are released from the environment. The monitoring required is divided in to three categories:

1. Vadose zone monitoring for gases and liquids
2. Ground water monitoring and
3. Air quality monitoring

10.5.1.1 Vadose Zone Monitoring

The vadose zone is defined as the zone from the ground surface to where the permanent ground water is found. An important characteristic of the vadose zone is that the pore spaces are not filled with water, and that the small amounts of water that are present coexist with air. Vadose zone monitoring at landfills involves both liquids and gases.

10.5.1.2 Liquid Monitoring In the Vadose Zone

Monitoring for liquids in the vadose is necessary to detect any leakage or leachate from the bottom of a landfill. In the vadose zone, moisture held in the interstices of soil particles or within porous rock is always held at pressures below atmospheric pressure. To remove the moisture it is necessary to develop a negative pressure or vacuum to pull the moisture away from the soil particles. Because suction must be applied to draw moisture out of the soil in the vadose zone, convention wells or other open cavities cannot be used to collect samples in this zone. The sampling devices to be used for sample extraction in the unsaturated zone are suction lysimeters.

The most commonly used class of lysimeter used for obtaining samples of moisture in the vadose zone is the ceramic cup sampler, which consists of a porous cup or ring made or ceramic material that is attached

to a short sections of nonporous tubing (e.g. PVC). When placed in the soil, because of its pores it becomes extension of the pore space of the soil. Soil moisture is drawn in through the porous ceramic element by the application of a vacuum. When a sufficient surface through a narrow tube by the application of vacuum or is pushed up by air pressure.

10.5.1.3 Gas Monitoring In the Vadose Zone

Monitoring for gases in the vadose zone is necessary to detect the lateral movement of any landfill gases. Vadose zone gas monitoring probe is to be used for monitoring of land gases. Gas samples are to be collected from multiple depths in the vadose zone.

10.5.1.4 Ground Water Monitoring

Monitoring of the ground water is necessary to detect changes in water quality that may be caused by the escape of leachate and landfill gases. Both down and up gradient wells are required to detect any contamination of the underground aquifer by leachate from the landfill. To obtain a representative sample, the liquid in permanent sample collection tubing, where used, must be purged before the sample is collected.

10.5.1.5 Landfill Air Quality Monitoring

Air quality monitoring in landfills involves:

(i) The monitoring of ambient air quality at and the Landfill and composting facility.

(ii) The monitoring of landfill gases extracted from the landfill and

(iii) The monitoring of gases from any gas processing or treatment facility.

1.) Monitoring Ambient Air Quality

Ambient air quality is to be monitored at landfill site to detect the possible movement of gaseous contaminants from the boundaries of the landfill site and emission from the composting plant.

2.) Monitoring Extracted Landfill Gas

Landfill gas is to be monitored to assess the composition of the gas, to determine the presence of trace constituents that may pose a health or environmental risk.

3.) Monitoring Off-Gases

Monitoring of-gases from landfill and composting facilities is to be done to determine compliance with the local air pollution control requirements.

CHAPTER 11 COST ESTIMATION

11.1 CAPITAL COST OF THE PROPOSED SCHEME

The implementation of the scheme is scheduled to complete by year 2018 after which commercial production of integrated facility will commence.

Table 11.1: Primary Collection System

Sl. No	Description	Equipment Numbers	Already Exist	Additional Requirement	Unit Rate	Total Rate
1	House Household Bin	265874	-	265874	250	66468500
2	Tri- cycle Cart- 6 nos. 50 lit bin	333	194	139	2500	347500
3	Handcart with 4 nos. of 60 lit bin (Street Sweeping)	324	-	324	15000	4860000
4	Auto tipper	27	3	24	950000	22800000
5	Compactor Garbage Bins 1100 lit	813	-	813	45000	36585000
6	Movable Compactor	12	2	10	3700000	37000000
7	hook loader	3	-	3	3500000	10500000
8	Compactor station construction	6	-	6	3000000	18000000
9	Stationary compactor container - 10 m3	12	-	12	180000	2160000
10	Wheel barrow for Drain Cleaning	296	-	296	15000	4440000
Total						**203,161,000**

Table 11.2: PPP Equipments

Sl. No.	Equipments / Implements	Annual Requirement	Unit Rate	Amount
1	Long hand brooms	816	285	232560
2	HPE Pans	816	250	204000
3	HDPE Plates	816	200	163200
5	M. S. Shovel	136	350	47600
6	Gloves	6762	250	1690500
7	Mask	14352	55	789360
8	Apron	1196	450	538200
9	Gum boot	326	350	114100
10	Cap	2392	100	239200
Total				**4018720**

Table 11.3: Capital Cost for Construction of Processing Plant (Compost Plant and RDF Plant)

Sl. No.	Items	Description of Items	Unit	Total Quantity	Total Amount (INR) in Figures
1	**Preliminaries**				
1.1	Temporary Office	Provide temporary office for the PMU including furniture, electricity, water supply, consumables, maintenance during the Project, etc.	LS	LS	3,00,000.00
1.2	Topographical Survey	Conduct topographical survey for all the sites to recognize the current condition of the sites for detail design.-	LS	LS	50,000.00
1.3	Geotechnical Survey	Conduct geotechnical survey for all the sites to recognize the soil condition for the detail design.	LS	LS	1,00,000.00
1.4	Detail Design	Prepare detail design on the basis of topographical and Geotechnical survey date {Report of geotechinical and topographical survey carried out by KMDA is attached for reference. The survey report (KMDA and contractor) which show worst condition will have be considered for design purpose} meeting the requirement and specification. The design includes drawings, shop drawings, construction planning (methodologies and schedules), etc. for all the structures and facilities.	LS	LS	10,00,000.00
2	**Land Preparation**				
	Shifting of Waste	Shifting of garbage to new location		55415	99,19,285.00

2.5	Earth /Sand Fill	Filling of earth or any approved material after removing all garbage within the site and below the structure upto design ground level (approx. 0.5m above the existing road level in front of site) in layers including watering, ramming and consolidation of sub grade in layers at OMC to required dry density including filling the depressions which occurred during the process using vibratory rollers all complete as per instruction of Engineer-In-charge	LS	LS	184,82,400.00
3	**Buildings and Structures**				
3.1	Compost Plant				
3.1(a)	Foundation	Designing, providing & constructing Compost Pad area* with detail foundation design, R.C.C foundations, concrete works, anti-termite treatment, DPC, etc all complete including filling of sand as per approved design.	LS	LS	1664,20,000.00
3.1 (b)	Concrete platform	Designing, providing & constructing Compost Pad area with detail foundation design, sand filling as per design with min 200 mm thick Impermeable reinforced cement concrete floor min M25 grade (as per approved drawing) and maintaining proper slope of 1.5% in transverse direction, earthworks, concrete works, masonry works, finishing works etc all complete.	LS	LS	
3.1(c)	R.C.C column	Designing, providing & constructing R.C.C column over concrete platform upto min height of 1.5m above top of concrete floor level as per approved drawing.	LS	LS	
3.1(d)	Steel/Tubular Truss with G.I & Fiber Glass Sheet	Designing, providing & constructing Steel/tubular truss with min 0.63 mm thick G.I sheet (of approved make like Everest etc) & min 1.2 mm fiber glass Sheet (of approved make etc) at the roof top including R.C.C (M 25) column over entire compost pad area * .	LS	LS	

3.1(e)	Brick Work at Compost Pad Area	Brick wall with cement plaster all around the compost plant area (1.0m height), quality control area (3.0m height), godown (3.0m height), 2m height wall between Windrow platform and Monsoon shed etc all complete.	LS	LS	1,05,489.30
3.1 (f)	Leachate Drain	Designing, providing & constructing R.C.C Leachate drains of Impermeable cement concrete including plaster, all complete over all around the compost pad area. This leachate should connect to leachate collection tank.	LS	LS	4,36,611.56
3.1 (g)	Sprinkling System	Sprinkling system: Designing, providing & constructing R.C.C sump of 7500 lit capacity with water proofing compound to prevent the leakage and R.C.C slab cover at the top with manhole of 0.75m x 0.75m, the manhole has to be covered with hinged steel gate in order to avoid the entry of rain water into the sump all complete. Including 1Hp pump and piping arrangement to spray water on MSW heap at windrow.	LS	LS	5,00,000.00
3.2	Leachate Sump	Designing, providing & constructing R.C.C leachate collection sump (effective capacity min $8m^3$) of with R.C.C slab cover at the top. Water proofing compound and epoxy paint is to be provided inside the tank. The R.C.C slab is to be provided with manhole of 1m x 1m, the manhole has to be covered with hinged steel gate in order to avoid the entry of rain water into the sump.	LS	LS	8,00,000.00
3.3	Administration Building	Designing, providing & constructing Administrative building (14.25m x 8.5 m c to c) which have office for plant manager 4.5m x 4.5 m, engineer room 3.75mx 3.5m, clerk office 3.0 m x 3.5 m, lab 2.75 m x 3.5 m, conference hall 7.0mx 3.5 m, staircase, toilet 2.0m x 4.5m with including earthworks, sand filling, foundations, concrete works, masonry works, anti-termite treatment, DPC, Roof treatment, Finishing works, fittings, electric works, plumbing, drainage, HVAC, furniture, painting etc. all complete	LS	LS	24,22,500.00

3.6	Weighbridge Cabin & Weighbridge Foundation	Designing, providing & constructing Weigh bridge cabin, internal dimension should be 3.5 m X 2 m and 'Designing providing & constructing Weighbridge foundation and cabin including earthworks, sand filling foundations, concrete works, anti-termite treatment, DPC, Roof treatment, masonry works, finishing works, fittings, electric works, earthing, plumbing, drainage, HVAC, furniture, painting etc. all complete	LS	LS	5,00,000.00
3.7	Guard Room	Designing, providing & constructing Guard room of internal dimension should be 2.0 m X 2.0 m including earthworks, sand filling foundations, concrete works, masonry works, anti-termite treatment, DPC, Roof treatment, finishing works, fittings, electrical works, furniture, painting etc all complete.	LS	LS	3,00,000.00
4	**Infrastructure**				
4.1	Road and Pavements	Design & Construction of Roads and Pavements for both flexible pavement and rigid pavement as per IRC applied for all the internal roads, parking area, connection with the existing road in front of entrance, etc. including earthworks, sand filling, sub-base, base course, wearing course, shoulders, barriers, road signs, road marking, etc. as per approved drawing.	LS	LS	67,78,800.00
4.2	Water Supply	Road width Should varies from 7m (at entrance and ramp of TS &CP) to 3.5 m (Internal road).	LS	LS	8,00,000.00
4.3	Drainage	Necessary approval, Designing & Construction of water supply system for the facility including connection, storage tank, piping, valves, pumps, etc. as required. As per necessary approval.	LS	LS	54,63,000.00
4.4	Sewerage	Construction of storm water drainage system in the site to drain and discharge the surface water to the existing drains out of the site, including earthworks, piping, open ditches and gutters, manholes, catch basin, etc. as required.	LS	LS	15,00,000.00

4.5	Power Supply	Provision of Electricity connection, necessary approval, for permanent connection for electricity board including connection charges, earthworks, cabling, inspection chambers, fittings, equipment, devices, etc. all complete.	LS	LS	8,00,000.00
4.6	D.G Set Room	Designing, providing & constructing D.G set area (4m x 5m), covered from top, open from side including 'earthworks, anti-termite treatment, DPC, sand filling connection, cabling, supports, inspection chamber, distribution boards, panels, switchboards, transformer, etc. as required.	LS	LS	12,00,000.00
4.7	Lighting Works	Design & Construction of indoor and outdoor lighting facilities (Average Level of Illumination on Road Surface should be 4 Lux) all over the site and with in all structures (TS&CP, Admin building, workshop, parking etc) including earthworks, foundations, lighting post, lights, switchboard, etc all complete.	LS	LS	18,00,000.00
4.8	Telecommunication	Provision of telecommunication system necessary for operation including connection, earthworks, cabling, inspection chambers, fittings, equipment, devices, mobile phones, etc.	LS	LS	20,000.00
4.9	Boundary Walls and Gate	Design & Construct Boundary wall (approx. 525 m) all around the plant site upto 2.7 m height (2.1 m brick work and 0.6 m barbed wire fencing) above design ground level with R.C.C pillar at every 3.0 m and expansion joint at 12-15 m. Including earthworks, sand filling foundations, masonry works, anti-termite treatment, DPC, steel works, finishing works, boundary stones, name plate, fittings, plaster etc. all complete. Contractor has to supply and install 1 nos of sliding gate of 8m width.	LS	LS	68,51,161.25
4.10	Parking area (covered from top)	Construction of Paved covered parking area of required size (180 m^2 for Compost plant and Transfer station vehicle and 100 m^2 near Admin building) , including earthworks, sand filling sub-base, base course, wearing course, etc. as per approved drawing.	LS	LS	9,00,000.00

4.11	Buffer Zone and Landscaping	Development of Green Belt including providing, sowing and maintaining (for whole time limit of contract) small flowering non flowering plants, big trees on peripheral area, lawns including cost of plants, trees, lawns, necessary excavation for sowing, fertilizer, manure, watering, insecticide, etc. As per list of plants approved by Engineer-In-charge.	LS	LS	25,00,000.00
5.0	**Mechanical Works and Equipment**				
5.1	**Equipment Transfer Station**		LS	LS	
a)	Pushcart with 4 nos. of 50 lit bins	As per Standard Specifications approved by Engineer-In-Charge	Nos.	6	1,50,000.00
b)	M.S Containers with wheel	Provide M.S containers with tyres ($3.0m^3$) approved by Engineer-In- Charge for storage of recyclables	Nos.	6	3,00,000.00
5.2	**Equipments at Compost Plant**				
a)	**Waste receiving platform**				
1)	Pushcart with 4 nos. of 50 lit bins	As per Standard Specifications approved by Engineer-In-Charge	Nos.	6	1,50,000.00
b)	**Quality Control cum Packing Section**				
1)	Bag Stitching Machine	As per Standard Specifications approved by Engineer-In-Charge	Nos.	1	5,000.00
2)	Weighing Scale	As per Standard Specifications approved by Engineer-In-Charge	Nos.	1	5,000.00
3)	Wheel Barrow	As per Standard Specifications approved by Engineer-In-Charge	Nos.	6	30,000.00
4)	Moisture Probe with Digital Indicator	As per Standard Specifications approved by Engineer-In-Charge	Nos.	1	1,000.00

5)	Temperature Probe with Digital Indicator	As per Standard Specifications approved by Engineer-In-Charge	Nos.	1	1,000.00
6)	Pellet Trolley	As per Standard Specifications approved by Engineer-In-Charge	Nos.	2	30,000.00
5.3	**Weighbridge**				
1)	Weighbridge	Supplying and Installing fully electronic weigh bridge of Pit-less type with digital indicator of 30 MT capacity with testing erection alignment and presenting the same to the weight & measures department for verification and stamping including design, fabrication including all civil works Measuring method : Loading cell method, Maximum load : 30t, Minimum load : 10kg, Size of Loading area : 3m x 8m	Nos.	1	10,00,000.00
2)	Indicator	Digital indicator	Nos	1	1,00,000.00
3)	Desktop Computer	Processor : Core i3, Memory : 1GB, HDD : 512 GB, Display : SAMSUNG 17" LCD Color Monitor, Optical Device , DVD--RW, Operating System : Pre-Installed Windows 7 with License, Operating soft ware	Nos.	1	30,000.00
4)	Dot Matrix Printer (EPSON)	Pins-9, 337cps (High speed draft 12cpi), 64kb input buffer, usb interface and copy facility (1 original & 4 duplicate)	Nos	1	60,000.00
5.4	**Administration Building**				
1)	Desktop Computer	Processor : Core i3, Memory : 1GB, HDD : 512 GB, Display : SAMSUNG 17" LCD Color Monitor, Optical Device , DVD--RW, Operating System : Pre-Installed Windows 7 with License, Operating soft ware	Nos	2	60,000.00
2)	Laser Printer cum Scanner cum Copy Machine	Paper Size : A4 (Black), Resolution : 600 x 600 dpi (for print), 600x400 dpi (for Xerox), 1200dpi (for scan), Memory : 16 MB RAM, Xerox zoom facility 30% to 400% and scan output facility in pdf,tiff,bmp jpg, gif format.	Nos	1	40,000.00

3)	Furniture	2 nos of Cupboard, 3 office tables (1.5m x 0.6m), 3 nos of Executive chair, 6 Nos Normal Chair, Meeting table – 4 m x 1.5 m and 8 Nos of Executive chair.	Set	1	2,50,000.00
4)	Laboratory Equipment	Laboratory must be well equipped with Furniture and all necessary provision for monitoring of the process, as oven, muffle furnace, balance, different chemicals required for testing of NPK value of manuare, glassware etc. (Contractor will provided list of equipments for approval before procurement)	Set	1	10,00,000.00
5.5	**Workshop**				
1)	Maintenance Tools	As per Standard Specifications approved by Engineer-In-Charge	Set	1	10,000.00
2)	Furniture	2 nos of Cupboard, 1 No office tables (1.5m x 0.6m), 1 nos of Executive chair, 2 Nos Normal Chair.	Set	1	70,000.00
5.7	D.G of capacity (50 KV)	As per Standard Specifications approved by Engineer-In-Charge	Nos	1	10,00,000.00
5.8	**Sign Board**	Construction and erection of permanent sign board 10'x 6' with M.S framework as approved by Engineer-In-Charge	Nos	1	3,00,000.00
5.9	**Project 3D Scale model**	Construction project 3D model of size mentioned in Technical Specification and as approved by Engineer-In-Charge	Nos	1	80,000.00
Grand Total					**2346,21,247.11**

Table 11.4: Vehicle Cost for Compost Plant

Sl No.	Vehicle type	Number	Unit cost	Amount
1	Loader cum Backhoe	2	2200000	4400000
2	Self Propelled Windrow Turner	1	3200000	3200000
3	Tractor attached loader	2	1100000	2200000
4	Water tanker with slurry pump	1	900000	900000
5	Tractor with tipping trolly	2	90000	180000
6	Maintenance Vehicles	1	850000	850000
Total				**11730000**

Table 11.5: Construction Cost of Sanitary landfill

Items	Description	Unit	Quantity	Local Currency (INR)	
				Rate	*Amount*
Preliminaries					
Land Preparation and Landfill Area					
Excavation	Cutting and excavation down to the required level and shapes for the site including landfill area and water treatment ponds. The work includes storage, leveling, compaction, slope formation, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	12026400
Filling up the Site and Construction of Embankment with Impermeable Clay	Filling up the site up to the required level as well as to form dikes with impermeable clay (k not greater than $1x10^{-7}$ cm/sec) born from the cutting mentioned above. The work includes haulage from the storage, leveling, compaction in layers, slope formation, testing, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	6764850
Sanitary Landfill					
Designing, Providing & Constructing Liner System	Supplying and Laying 900mm Clay or amended Soil of permeability $1x\ 10^{-7}$ cm/sec in accordance with MSW Rules 2016, all complete and approved by Tender Accepting Authority	LS	1	N.A.	9470790
	Supplying and Laying 400 GSM Non Woven Geo-textile or Equivalent. Laying in two layers beneath the HDPE Geo-membrane at the base and in One layer beneath the HDPE Geo-membrane on the slopes, as shown in the drawing. Geo-textile shall be Standard Make and approved by the Tender Accepting Authority.	LS	1	N.A.	2570643
	Supplying and Laying 1.5mm HDPE Geo-membrane of Standard Make Approved by the Tender Accepting Authority.	LS	1	N.A.	5141286

	Supplying and Laying 400 GSM Non Woven Geo-textile or Equivalent. Laying in two layers above the HDPE Geo-membrane at the base and in one layer above the HDPE Geo-membrane on the slopes as shown in the drawing. Geo-textile shall be Standard Make and approved by the Tender Accepting Authority.	LS	1	N.A.	2570643
	Sand	LS	1	N.A.	2029455
Drainage Layer	Designing, providing & constructing 300 mm thick granular drainage layer at the bottom of landfill area. The size of the metal stone for drainage layer is of 30-50mm diameter. All complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	4870692
Leachate Collection System	Designing, providing & constructing leachate collection system for sanitary landfill area including perforated HDPE pipes surrounded with gravel or crushed stone, connection pits, collection pit, leachate collection and conduction pipe, protection, etc. as required. All complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	555800
Leachate Collection Sump	Designing, providing & constructing receiving sump pit made of RCC to receive leachate from the Landfill. The work includes excavation, concrete works, waterproofing, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	600000
Gas Removal System	Designing, providing & constructing gas collection system for sanitary landfill area including gas vent pipes of perforated U-PVC pipe surrounded with circular gabion filled with crushed stones, provisions for extension required during operation, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	764883
Leachate & Septic Tank Sludge Treatment Plant					
Facultative Aerated Lagoon I	Designing, providing & constructing Aerated Lagoon-I lined concrete lining of 150 mm thick over and below 1.5 mm HDPE Geo-membrane liner sheet and necessary provisions for Aerators, Equipments, Piping, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	15405000
Discharge Facility	Provide discharge facility from the facultative pond to (Canal) including necessary piping and facilities all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	456973

Substation Building	Designing, providing & constructing Substation Building including earthworks, foundations, concrete works, masonry works, finishing works, fittings, electrical works, HVAC, furniture, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	878424
Pump house	Designing, providing & constructing Pump house including earthworks, foundations, concrete works, masonry works, finishing works, fittings, electrical works, plumbing, drainage, HVAC, furniture, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	387539
Electrical Work for Treatment Plant	Supply and installation of all electrical appliances required for proper functioning of Leachate and Septic Tank Sludge Treatment Plant all complete as specified in Tender Document and the Basic Design Report. (Provide the list of electrical appliances along with specification and numbers required and quote the rates accordingly)	LS	1	N.A.	500000
Buildings and Structures					
Equipment Storage	Designing, providing & constructing Equipment Storage rooms of Size (c/c dimension) 29.0m x 10.5 m for bulldozer, wheel loader, excavator, water tanker, 2 nos. of dump truck, maintenance vehicle including earthworks, foundations, concrete platform, structural frame, roof shed, masonry works, finishing works, etc. all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	3942600
Car Wash	Designing, providing & constructing Car Wash facility including earthworks, foundations, concrete platform, finishing works, plumbing, drainage, etc all complete as specified in Tender Document and the Basic Design Report.	LS	1	N.A.	711994
Infrastructure					

Road and Pavements	Designing, providing & constructing Roads and Pavements for both flexible pavement and rigid pavement applied for all the internal roads, parking area and approach road connection with the existing Delhi road in front of entrance, Bituminous pavement shall be designed as per IRC: 37-1984 "Guidelines for the Design of Flexible Pavements and for Concrete pavement shall be designed as per IRC: 58-2002 "Guidelines for the Design of Rigid Pavement. The tentative thickness of the layers for Bituminous pavement are 75 mm Brick soling, 300 mm upper GSB, 100 mm WBM, 75 mm DBM, 35 mm SDBC. including earthworks, sub-base, base course, wearing course, shoulders, barriers, road signs, road marking, etc. all complete as specified in Tender Document and the Basic Design Report. (area where bituminous pavement and concrete pavement is to construct is marked in the Drawings)	LS	1	N.A.	500000
Monitoring Well	Designing, providing & constructing monitoring well to examine the groundwater quality including boring, PVC pipes, strainers in aquifer, etc. all complete as specified in Tender Document and the Basic Design Report.	Nos.	4	77132.5	308530
Mechanical Works and Equipment					
Convey Pump	Supply of Convey Pumps to pump Leachate from Leachate Sump to Facultative Aerated Lagoon - I, (approximate water head 12 m) all complete as specified in Tender Document and the Basic Design Report.				
	Capacity: 30 m^3/hr	Nos.	2	104900	209800
	Capacity: 60 m^3/hr	Nos.	2	174319.5	348639
	Capacity: 100 m^3/hr	Nos.	3	87931	263793
Aerators		Nos.	16	120000	1920000
Weighbridge		Nos.	1		650000
Car Wash		Nos.	1		120000
Steel Plates	3 m x 1.5 m - 20 mm thick	Nos.	120	45000	54,00,000.00
Gas meter		Nos.	1	72000	72,000.00

Laboratory equipments		Nos.			1,00,000.00
Total					**795,40,734.00**

Table 11.6: Vehicle Cost for Landfill Processing

Sl No	Vehicle type	Number	Unit cost	Amount
1	Compactor	1	5500000	5500000
2	Excavator	1	5200000	5200000
3	Dozer	1	12500000	12500000
4	Loader cum backhoe	1	2200000	2200000
5	Dumper Truck	2	1800000	3600000
Total				**29000000**

Summary of Total Project Cost

Estimated Cost for SWM System	
A. Collection System	
Procurement of vehicles for Primary Collection & Secondary Transportation	203161000
Procurement PP Equipments for primary collection	4018720
	207179720
B. Processing Plant	
Construction of Compost Plant and RDF Plant	2346,21,247
Procurement of Machineries for the plant	557,75,000
Procurement of vehicles for Operation of the plants	117,30,000
	3021,26,247
C. Sanitary Landfill	
Construction of Sanitary Landfill	795,40,734
Procurement of Vehicles for Operation of the landfill	290,00,000
	1085,40,734
D. Social Awareness Program (Per Year)	6550000
Sub Total	6243,96,701
Contingency – 3%	187,31,901
Administrative Expenses – 1%	62,43,967
Total	**6,493,72,569**

CHAPTER 12 OPERATION AND MAINTENANCE ARRANGEMENT AND COST

12.1 O&M ARRANGMENTS

S.W.M will be under a separate department in the ULB. It is considered as emergency department and round the year service shall be rendered. For Sundays and holidays, additional staff at 20% has been considered.

There Asst. Engineers will be in charge of

a) Landfill Site Manager
b) Waste Processing Unit Manger
c) City Conservancy service Manger.

They will be supported by two SAE each. Other category staff shall be placed according to the necessity from manpower strength. Monitoring cell headed CEO and City Manager will daily monitor S.W.M. Services for the ULB and will prepare reports in the report format (Daily/Monthly/Quarterly/Annually) and publish annual administrative report along with preparation of draft SWM budget & Schedule of fees and charges.

Table 12.1: Manpower requirement for Primary Collection, Road Sweeping and Drain Cleaning

Sl No.	Equipments	Nos.	Waste cum Sweeper Collector	Drivers	Helpers
1	Tri- cycle Cart- 6 nos. 50 lit bin	333	367		
2	Handcart with 4 nos. of 60 lit bin (Street Sweeping)	324	357		0
3	Drain Cleaning - Wheel Barrow	296	326		
4	Auto tipper	27		27	54
5	Movable compactor	12		12	36
6	hook loader	3		3	3
7	Compactor station	6			12
Total			**1050**	**42**	**105**

Apart from the above following Manpower required

- Supervisor @1 per ward = 43
- Sanitary Inspector = One for each Borough – 5 Nos.
- Assistant Engineer - 1 No.
- Health Officer = 1 No.

12.1.1 Monitoring Cell as Sanitation Cell

Maintaining the sanitary condition of a town is one of the crucial aspects of sanitation apart from creating basic infrastructure. A successful operation requires a threefold attention for all the time as noted below.

A Strong 'Sanitation Cell' in the ULB comprising of.

- Municipal commissioner/ CEO;
- Environmental Engineer with his team sanitary Supervisory engineers;
- Municipal Health officer with his team of health inspectors and sanitary workers;
- Ward wise sanitary inspectors and general sanitary inspectors;
- A sub-cell of monitoring and grievance redressal system management professional team of at least 5 persons.

City Sanitation Task Force for taking monthly situation analysis on the city sanitation

- This task force shall take note of sanitation situation of the town once a month under chairmanship of Mayor/ Chairman of the ULB.

An informal body administering all day to day support in

- Awareness and Campaign;
- Indentifying the violators of sanitation rules;
- Institutional support services from

    a. State Govt.
    b. Civil Societies
    c. Local NGOs
    d. Elected representatives
    e. Urban departments of the State Govt.
    f. National Govt. (CPCB, CPHEEO)

District Magistrate or his representative shall sit quarterly with all the members and overview the sanitation situation. All dept shall provide all manpower & expertise with special assistance to sanitation and O& M where possible.

12.1.2 Annual Operation and Maintenance Cost

The objective of a good maintenance programme is to keep the system in a good operating condition so that it can function efficiently throughout its design life. Lack of maintenance can have health implications as well as cause damage to properties when things go wrong. It is important that the operation and maintenance personnel continuously monitor the condition of the sanitation system to ensure proper functioning thereof. Inspection and testing provide the means for the monitoring activity. Table 7.0.3.1.0 shows cost for manpower for operation of vehicles and equipments.

Table 12.2: Cost requirement of manpower for operation of Vehicles and Equipments

Sl No.	Equipments	Waste cum Sweeper collector			Drivers			Helper		
		Nos.	Salary	Amount	Nos.	Salary	Amount	Nos.	Salary	Amount
1	Tri- cycle Cart- 6 nos. 50 lit bin	367	3000	1101000						
2	Handcart with 4 nos. of 60 lit bin (Street Sweeping)	357	3000	1071000				0		
3	Drain Cleaning - Wheel Barrow	326	3000	978000						
4	Auto tipper				27	9000	243000	54	7000	378000
5	Movable compactor				12	12000	144000	36	7000	252000
6	hook loader				3	12000	36000	3	7000	21000
7	Compactor station						0	12	7000	84000
Total		**1050**		**3150000**	**42**		**423000**	**105**		**735000**

Table 12.3: Structure of Manpower of Plant

Position	Nos.	Salary	Amount
Supervisor	43	10000	430000
Sanitary Inspector	5	15000	75000
Assistant Engineer	1	35000	35000
Health Officer	1	35000	35000
			575000

Table 12.4: Operation & Maintenance Cost of Primary collection Equipments & Vehicles

Sl. No	Description	Equipment Numbers	Operation Cost	Total	Maintenance Cost	Total
1	Tri- cycle Cart- 6 nos. 50 lit bin	333	0	0	500	166500
2	Handcart with 4 nos. of 60 lit bin (Street Sweeping)	324		0	500	162000
3	Auto tipper	27	16200	437400	1620	43740
4	Compactor Garbage Bins 1100 lit	813			500	406500
5	Stationary compactor container - 10 m3	12			800	9600
6	Movable compactor	12	32400	388800	3240	38880
7	hook loader	3	32400	97200	3240	9720
8	Compactor station maintenance	6	0	0	3000	18000
9	Wheel barrow for Drain Cleaning	296			500	148000
			81000	**923400**	**13400**	**854940**

O & M cost of Primary waste collection

- **O & M Cost = 3150000+ 423000+ 735000+ 575000+ 923400+ 854940 = 6661340 per Month**

O & M cost of Compost Plant, RDF Plant and landfill

Table 12.5: Manpower Details

Sl. No.	Position	Nos.	Salary	Amount
1	Plant Manager (Env. Engineer) - B.E	1	60000	60000
2	Assistant Pant Manager- Compost plant	1	30000	30000
3	Assistant Pant Manager – RDF and MRF plant	1	30000	30000
4	Assistant manager – Landfill	1	30000	30000
5	Supervisor – B.Sc.	3	18000	54000
6	Accountant --- B.Com	1	16000	16000
7	Chemist - B Sc	1	20000	20000
8	Weigh Bridge Operator - H.S.C	1	12000	12000
9	Mechanic - ITI	1	16000	16000
10	Laborers	16	7000	112000
11	Tractor Driver	1	9000	9000
12	Tractor Attached Loader Driver	2	10000	20000
13	Loader Cum Backhoe Driver	2	15000	30000
14	Excavator driver	1	20000	20000
15	Dozer Driver	1	18000	18000
16	Loader Driver	1	15000	15000

17	Compactor driver	1	20000	20000
18	Truck driver / Tractor diver	2	12000	24000
19	Security Guard	10	7000	70000
				606000

Table 12.6: Operational Cost Analysis for Compost Plant, RDF Plant and Sanitary Landfill

Sl. No.	Particulars	Amount (INR)
A	**Salary of Staff**	606,000
B	**Utilities, Consumables & Miscellaneous Supplies- per day**	
B.1	Fuel (Diesel)	424970
B.2	Inoculants (Bio-culture)	39000
B.3	Electricity - machine operation daily	116,410
	Utilities, Consumables & Miscellaneous Supplies Per Day	**580,380**
C	**Other Expenses**	
C.1	Repair and Maintenance of CP Machinery	80,000
C.2	Repair and Maintenance of T/S & CP Vehicles	74,340
C.3	Plant & Office Running Expenses	40,000
C.4	Marketing & Promotional Expenses	40,000
C.5	Insurance premium of the plant	10,000
C.6	Quality check	16,667
C.8	Miscellaneous	16,667
	Other Expenses Per Year	**277,673**
D	**TOTAL (A+B+C)**	**1,464,053**
E	**Contingency 3%**	**43,922**
F	**Contractors Profit - 15%**	**219,608**
	TOTAL MONTHLY COST FOR OPERATION OF PLANTS	**1,727,583**

Table 12.7: Operational Monthly Expenditure

Sl. No.	Revenue Generation (per month)	Amount (INR)
1	O & M cost of Primary collection and Secondary transportation	6,661,340
2	O & M of Processing plant and Sanitary landfill	1,464,053
	Total (INR)	**8,125,393**

Table 12.8: Operation and Maintenance Charges calculation for 10 Years

O & M Cost per month - **8,125,393 (INR)**
O & M Cost per year – **97,504,716 (INR)**
Escalation of O&M Cost per year after full utilization - 7.50%
Escalation Factor - 1.075

Expenses	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
O&M cost for the project	79936080.00	90477261.60	97504716.00	104817569.70	112678887.43	121129803.98	130214539.28	139980629.73	150479176.96	161765115.23
Total	**79936080.00**	**90477261.60**	**97504716.00**	**104817569.70**	**112678887.43**	**121129803.98**	**130214539.28**	**139980629.73**	**150479176.96**	**161765115.23**

12.1.3 Operation and Maintenance (O & M) Cost Recovery

To make the system of cleaning the whole city on regular basis, the residential as well as commercial waste collection method has to be implemented. To make system self sustainable, there is requirement of revenue collection by selling out recyclable items (non-biodegradable) and biodegradable wastes and by collecting user charges.

12.1.3.1 Proposed User Charges for sanitation Services

Table 12.9: Proposed user Charges for sanitation services

Items		Nos.	Unit Rate	Amount per month
Household		122260		
	Slum	31788	5	158940
	Normal	90472	40	3618880
Market -shops		3686	50	184300
Institution	Higher Secondary School	23	500	11500
	Secondary School	9	300	2700
	Primary School	104	200	20800
	Sishu Shikka kendra	78	100	7800
	Research Institute & Engg. College	22	500	11000
Restaurants & Hotel	Hotels	125	600	75000
	Restaurants	34	300	10200
Health Center	Hospital	43	600	25800
	Regional Diagnostic Center	2	200	400
Community Hall		31	800	24800
ICDS Center		188	100	18800
Others	Bus Terminus	3	500	1500
	Guest House	9	500	4500
	Public Library	3	300	900

Total	**4177820**

12.1.3.2 Revenue generation from Recyclable Items

Table 12.10: Revenue Generation by recyclable items

Sl no.	DATE / Parameter	AVERAGE % of each Parameter in Total quantity of Solid Waste (7 days)	Quantity in TPD	Unit rate per Ton	Total Amount	Amount Per Month	Per Annum
			261				
1	**Metals**	1.17%	1.5	10500	16031.925	416830.05	5001960.6
2	**Glass & Ceramics**	4.01%	5.2	9000	47097.45	1224533.7	14694404.4
3	**Leather**	0.70%	0.9	8500	7764.75	201883.5	2422602
						1843247.25	**22118967**

12.1.3.3 Revenue generation from plant

Table 12.11: Revenue Generation by Biodegradable items

Sl. No.	Type	Unit Rate/Ton	Quantity (TPD)	Total Amount	Per Month	Per Annum
1	Compost	1800	26.7	48,000.00	**1,248,000.00**	**14,976,000.00**
2	RDF	2000	33.3	66,666.67	**1,733,333.33**	**20,800,000.00**

Table 12.12: Total Revenue Generation

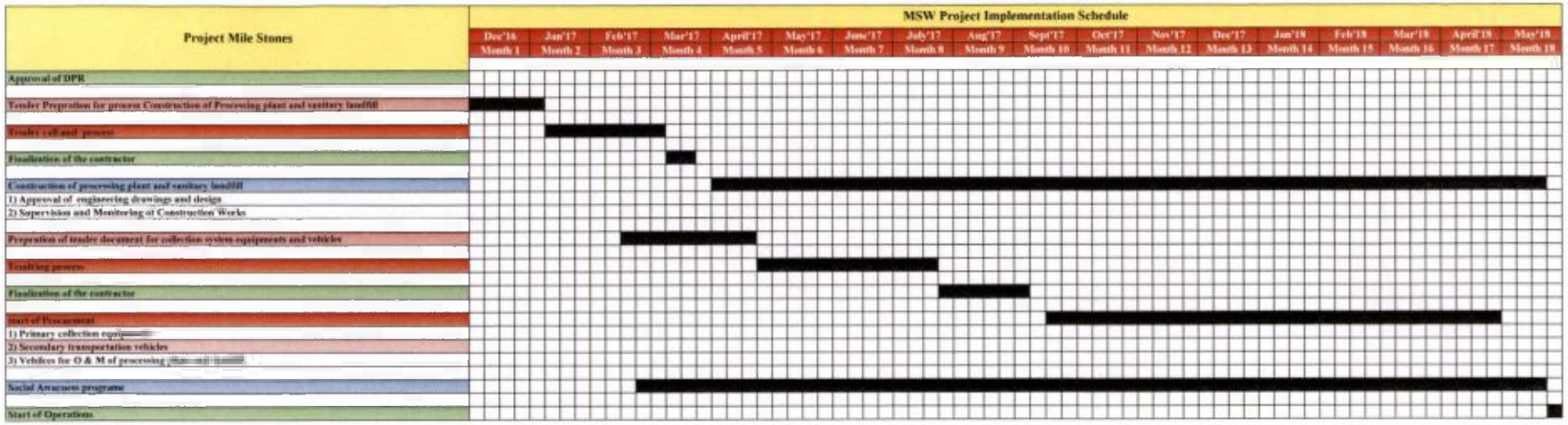
Sl. No.	Revenue Generation (per month)	Amount (INR)
1	Revenue from Proposed User Charges	1843247
2	Revenue from selling out the recyclable items	1248000
3	Revenue from Compost	1733333
4	Proposed user Charges for sanitation services	4177820
Total Revenue (INR)		**9002400**

Total monthly Revenue generation = **9002400 (INR)**

Total yearly Revenue generation = **108028800 (INR)**
Escalation of Revenue after every 3years after full allocation - 15%
Escalation factor - 1.15

Table 12.13: Total Revenue Generation calculation for 10 years

Year	1	2	3	4	5	6	7	8	9	10
TOTAL REVENUE	501,33,840.00	848,70,816.00	1080,28,800.00	1242,33,120.00	1242,33,120.00	1242,33,120.00	1428,68,088.00	1428,68,088.00	1428,68,088.00	1642,98,301.20
Total Revenue	**501,33,840.00**	**848,70,816.00**	**1080,28,800.00**	**1242,33,120.00**	**1242,33,120.00**	**1242,33,120.00**	**1428,68,088.00**	**1428,68,088.00**	**1428,68,088.00**	**1642,98,301.20**


Project Mile Stones
MSW Project Implementation Schedule
Dec'16 Month 1
Jan'17 Month 2
Feb'17 Month 3
Mar'17 Month 4
April'17 Month 5
May'17 Month 6
June'17 Month 7
July'17 Month 8
Aug'17 Month 9
Sept'17 Month 10
Oct'17 Month 11
Nov'17 Month 12
Dec'17 Month 13
Jan'18 Month 14
Feb'18 Month 15
Mar'18 Month 16
April'18 Month 17
May'18 Month 18
Approval of DPR
Tender Prepration for process Construction of Processing plant and sanitary landfill
Tender call and process
Finalization of the contractor
Construction of processing plant and sanitary landfill
1) Approval of engineering drawings and design
2) Supervision and Monitoring of Construction Works
Prepration of tender document for collection system equipments and vehicles
Tendring process
Finalization of the contractor
start of Procurement
1) Primary collection equi
2) Secondary transportation vehicles
3) Vehikes for O & M of processing
Social Awacness programe
Start of Operations

ANNEXURES

1. Population Data
2. Survey and Data Analysis

Population Projection of Durgapur City

Population Projection

Census Year	Population	Increase	Growth Rate
1961	41696		
1971	206638	164942	3.956
1981	311798	105160	0.509
1991	425836	114038	0.366
2001	493405	67569	0.159
2011	563557	70152	0.142
Total		**521861**	
Average Increase per Decade		**104372.2**	

Analysis of Data

The population figures show that the population actually started increasing at huge rate after 1961. This may be because of the status being changed from a village to a town. Therefore population figures after 1961 only are considered in the following analysis.

Arithmetical Progression Method

Population in current year = Population in previous year + n*x
Where, n = no. of decades = (current year – previous year) / 10
X = average increment per decade

Increase in population from 1961 to 2011 (i.e. in 4 decades) - **521861**
Average decadal increase in number - **104372**
Population 2011 - **563557**

Incremental Increase Method

Population in current year = Population in previous year + n*x + (n(n+1)y)/2
Where, n = no. of decades = (current year – previous year) / 10
X = average increment per decade
Y = average of incremental increase

Population in 2001 = 493405
X (Average) = 104372
Y (Average) = (-23698)
Population in 2011 = 563557

Geometrical Progression Method

Geometric Mean = Rg = $\sqrt[n]{R1 \times R2 \times R3 \times R4 \times R5 \times \ldots\ldots\ldots \times Rn}$

Rg = 0.441
Population in 2009 = P1 x (1 + Rg) (Average Increase for 0.8 Decade)
Population in 2019 = P1 x (1 + Rg) (Average Increase for 1.8 Decade)
Where P1 is Population Figure of Latest Census

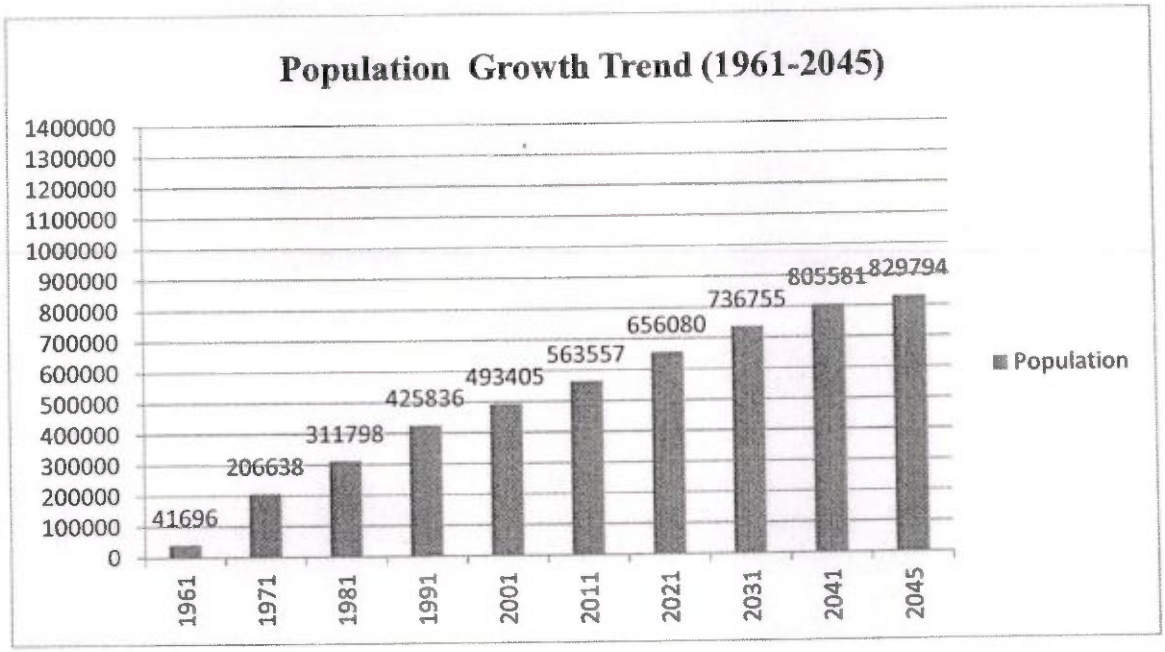
Population in 2011 = 563557
Average decadal increase (Rg) = 0.441

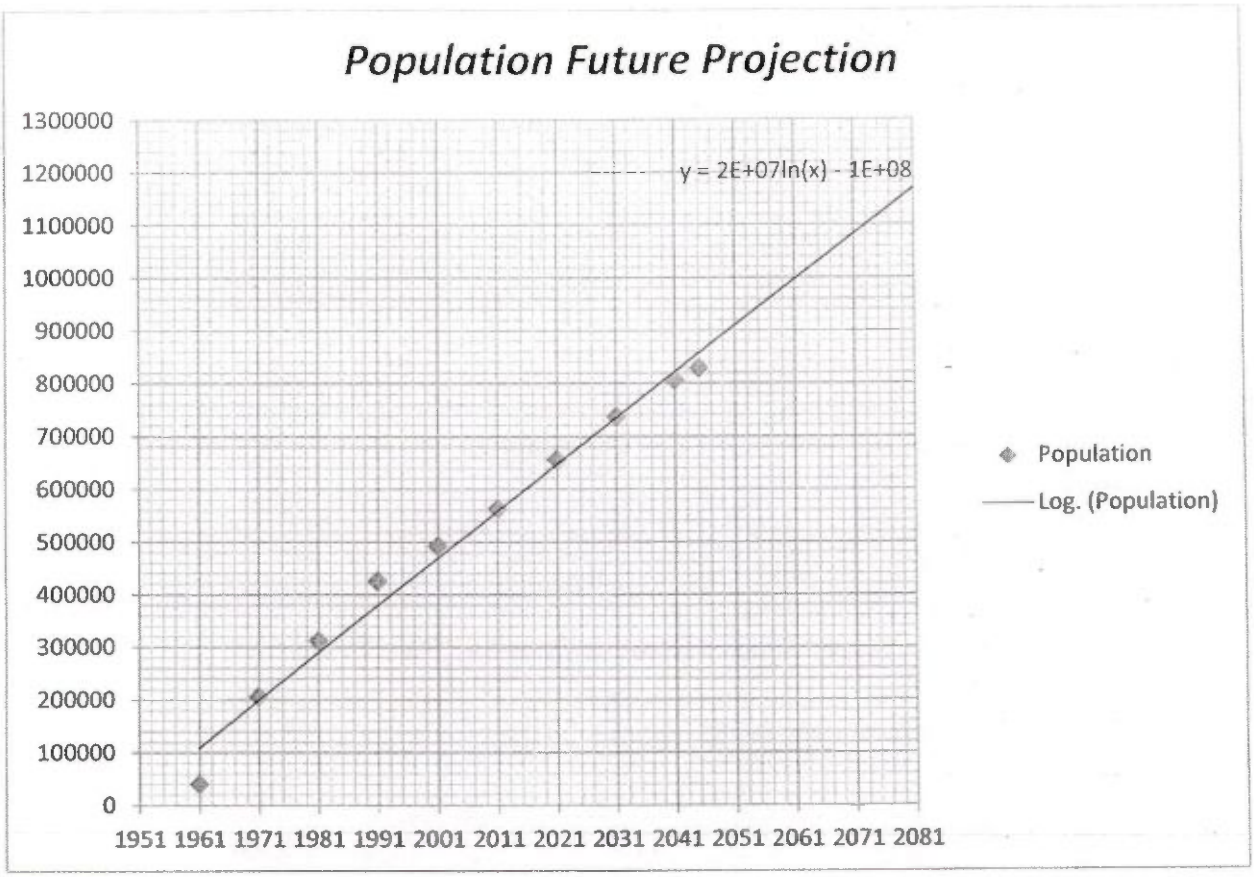
Population Projection

Year	Arithmetic Increase	Incremental Increase	Geometrical Increase Method	Design population
2012	573994	572691	584512	573343
2013	584431	581588	606246	583010
2014	594869	590248	628788	592558
2015	605306	598671	652168	601988
2016	615743	606857	676418	611300
2017	626180	614806	701569	620493
2018	636618	622518	727655	629568
2019	647055	629993	754712	638524
2020	657492	637231	782774	647361
2021	667929	644232	811880	656080
2022	678366	650996	842068	664681
2023	688804	657523	873379	673163
2024	699241	663813	905854	681527
2025	709678	669866	939536	689772
2026	720115	675682	974471	697899
2027	730553	681262	1010705	705907
2028	740990	686604	1048286	713797
2029	751427	691709	1087264	721568
2030	761864	696578	1127692	729221
2031	772301	701209	1169623	736755
2032	782739	705603	1213113	744171
2033	793176	709761	1258220	751468
2034	803613	713681	1305004	758647
2035	814050	717364	1353528	765707
2036	824488	720811	1403857	772649
2037	834925	724020	1456056	779473
2038	845362	726993	1510197	786177

2039	855799	729728	1566351	792764
2040	866236	732227	1624592	799232
2041	876674	734489	1684999	805581
2042	887111	736513	1747653	811812
2043	897548	738301	1812636	817924
2044	907985	739851	1880035	823918
2045	918422	741165	1949940	829794

The Result of Arithmetic Progression Method & Incremental Increase Method are more closure to the relevant figure. Therefore, the average of above said methods is considered to be Design Population of Durgapur City.




Population Future Projection
y = 2E+07ln(x) - 1E+08
1300000
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1951 1961 1971 1981 1991 2001 2011 2021 2031 2041 2051 2061 2071 2081
Population
Log. (Population)

PRIMARY WASTE GENERATION SURVEY DATA

Analysis of Household Waste Generation Survey Data

Category – HIG **Name of Waste Handler – Nemai Haldar**

SL NO	WARD NO.	NAME OF THE RESPONDENT	RESIDENTIAL ADDRESS	HOUSEHOLD SIZE			TOTAL QUANTITY OF WASTE PER DAY IN gms							QUANTITY OF WASTE PER CAPITA PER DAY IN gms
				ADULT	CHILD	TOTAL	9/7/2016	9/8/2016	9/9/2016	9/10/2016	9/13/2016	9/14/2016	9/15/2016	
1	22	Dr S .K Dutta	A-4, Nandalal Bithi City Center	3	1	4	1950	3610	845	1690	1490	940	2180	453.75
2	22	Shibnath Mondal	A-5, Nandalal Bithi City Center	3	1	4	1095	660	170	355	280	330	835	133.04
3	22	Green County	Malhar North Avenue,Bengal Ambuja	3	0	3	1600	650	890	1110	1050	755	810	326.90
4	22	Mahantalal Mondol	Bengal Ambuja	2	0	2	310	1390	825	1650	370	570	275	385.00
5	22	N Chatterjee	UCP-001 North Avenue	5	1	6	1395	300	375	750	1810	660	1165	153.69
6	22	Dr A Maiti	Dr. A Maity MNAV-07	4	1	5	2250	850	370	740	0	1010	3365	245.29
7	22		A.D Mediview Health Care	3	0	3	465	500	560	840	630	0	1265	202.86
8	22	Tapan kr Ghosh	MNAV-08 Bengal Ambuja	4	1	5	1800	660	420	825	1130	540	1560	198.14
9	22	Dabdas Maity	UCP- 005	2	1	3	1095	1340	1225	1115	0	1665	0	306.67
10	22		MWA-05,Bengal Ambuja housing	7	0	7	450	4840	825	945	3060	0	3705	282.14
11	22	Arindam Bakshi	.House No- MWAV 07	3	0	3	530	500	600	765	1370	405	1120	251.90
12	22		MWAV 08 Bengal Ambuja	3	1	4	1130	1780	1420	1335	1050	1135	815	309.46
13	22	Mrs Anita Das	MWAV-06, Bengal Ambuja	3	0	3	4060	3800	4240	3915	2880	2650	2610	1150.24
14	22	Ratan Kr Das	5/1 Bengal Ambuja	2	1	3	2535	950	1420	2840	1980	1320	0	525.95
15	22		5/2 Bengal Ambuja	2	2	4	1560	0	2775	2555	2640	1775	3045	512.50
16	22	N G Sarkar	5/3 Bengal Ambuja	3	0	3	960	1320	560	705	3030	805	1230	410.00
17	22	Dr N Maity	M.S 0505, Bengal Ambuja	2	1	3	945	0	2250	1005	2610	1175	1425	448.10
18	22	Sanchit Barnawal	5/4 Bengal Ambuja	5	2	7	610	840	920	1045	320	555	1175	111.53

19	22	Santimay Maywmdar	5/6 Bengal Ambuja	3	0	3	1105	925	1050	895	3020	645	770	400.48
		Manik Majhi	5/7 Bengal Ambuja	4	0	4	1505	2020	1870	3785	5610	1720	0	589.64
20	22	Dr S P Ghosh	M.S 0508, Bengal Ambuja	2	1	3	515	400	405	365	880	490	550	171.67
21	22	B G Datta	5/10 Urvashi,City Center	2	1	3	405	635	910	715	860	0	1355	232.38
22	22	Dr D Ghosal	5/11 Urvashi,City Center	3	1	4	1490	1110	1315	1440	380	835	990	270.00
23	22	Roys	5/9 Urvashi,City Center	7	0	7	605	3090	2125	2095	2870	2110	2310	310.31
24	22	K C Datta	M.S 0515, Bengal Ambuja	2	0	2	290	100	210	115	400	335	630	148.57
25	22	Bhanu Shome	5/14 Bengal Ambuja	3	1	4	2810	3210	3230	2665	1760	0	1915	556.79
26	22	Nemai siaha Roy	M.S 7/15 Bengal Ambuja	3	1	4	1325	370	1820	770	530	440	0	187.68
27	22	Manideepa Biswas	M.S 7/13 Bengal Ambuja	3	1	4	250	440	155	520	320	175	295	76.96
28	22	Kushal Dhar	M.S 7/14 Bengal Ambuja	4	1	5	1065	1105	2125	2915	950	1525	915	302.86
29	22	Sukumar Nayak	M.S 7/11 Bengal Ambuja	6	2	8	2505	1190	3745	2240	2330	1005	1510	259.38
30	22	Abdul Latif Midya	M.S 7/9 Bengal Ambuja	2	0	2	1595	2870	2005	10770	1340	890	2505	1569.64
31	22	Dr. Mallik	M.S 7/8 Bengal Ambuja	2	0	2	680	1000	980	1330	440	620	1005	432.50
32	22	B.D Mukherjee	7/7 Bengal Ambuja	4	0	4	125	2480	1920	10620	1450	1330	655	663.57
33	22	Talukdar	7/6 Bengal Ambuja	3	1	4	1275	200	835	1670	1570	765	825	255.00
34	22	Subrata Kr. Das	7/3 Bengal Ambuja	2	1	3	1925	1650	1270	2300	1440	1345	2035	569.76
35	22	Mr Dilip Kr. Paul	7/4 Bengal Ambuja	2	1	3	840	1840	770	7270	2600	870	3275	831.67
36	22	Ramlal Dutta	7/5 Bengal Ambuja	2	0	2	215	200	385	770	220	550	0	167.14
37	22	Manas Senapati	7/2 Bengal Ambuja	3	1	4	1650	1900	1445	4940	1960	1225	3105	579.46
38	22	Chandan Chatterjee	MWAY 13 Bengal Ambuja	3	1	4	1410	3110	770	1540	3210	625	4410	538.39
39	22	Ratan Sen	WMAV-12 Bengal Ambuja	3	0	3	560	2410	1395	2990	1220	0	1660	487.38
40	22		MS 06-02, Bengal Ambuja	3	0	3	810	260	1425	880	1060	995	830	298.10
41	22	Hasim Mondal	MS 06-01, Bengal Ambuja	3	0	3	830	620	735	1470	0	1655	1210	310.48
42	22	Rashin Mondal	MS 06-01/01, Bengal Ambuja	2	0	2	1130	1410	1225	1365	1050	705	2275	654.29
43	22	A.K Mukherjee	MS 06-02/1, Bengal Ambuja	2	1	3	220	310	480	520	430	300	1315	170.24
44	22	B. Basu	MS 06-03, Bengal Ambuja	2	0	2	230	280	525	225	280	495	565	185.71
45	22	Mr. S.K Dey	MS 06-04, Bengal Ambuja	3	0	3	1340	1140	1410	1005	1860	1050	750	407.38
46	22	Shibani Saha	MS 06-06, Bengal Ambuja	3	1	4	1765	1460	1555	2115	3010	1105	1590	450.00

47	22	Raman Sen	MS 06-05, Bengal Ambuja	5	2	7	2265	1430	1885	1365	0	1015	2095	205.20
48	22	Rabi Sasmal	6/7 Bengal Ambuja	4	0	4	1235	1830	1335	1220	0	1020	1090	276.07
49	22	Jibanananda Roy	6/8 Bengal Ambuja	2	1	3	390	1030	825	1650	800	1000	1300	333.10
50	22	Chatterjee	6/10 Bengal Ambuja	3	2	5	1330	960	1110	945	910	865	1175	208.43
51	22		6/12 Bengal Ambuja	5	2	7	195	210	210	155	200	0	965	39.49
52	22	Manish Singh	6/14 Bengal Ambuja	2	1	3	725	740	825	775	1300	1520	1430	348.33
53	22	Dr. Himadri Chattopadhay	MS 06/22, Bengal Ambuja	3	1	4	730	1180	990	1125	270	805	1560	237.86
54	22	Sandip Kr. Saha	6/26 Bengal Ambuja	5	1	6	965	390	525	605	1140	300	1475	128.57
55	22	Ajanta Goswami	6/23 Bengal Ambuja	3	1	4	805	655	1470	710	600	505	425	184.64
56	22	Mr. Shyamal Sen	MS 06/18, Bengal Ambuja	6	1	7	590	2110	790	1595	1980	1060	1550	197.45
57	22	A.K Mukherjee	6,Street Bengal Ambuja	2	1	3	310	510	1155	425	660	285	360	176.43
58	22	Dr. Surya Sen	MS 6/15, Bengal Ambuja	2	0	2	1705	1010	420	805	320	470	0	337.86
59	22	Sanmbhu Shaw	MS 6/17 Bengal Ambuja	6	0	6	1365	1290	1455	1020	820	1550	970	201.67
60	22	N.C Ghosh	4/7 Bengal Ambuja	3	0	3	1150	1070	1365	940	870	790	840	334.52
61	22	Nilanjana Roy	MS 04/06, Bengal Ambuja	2	2	4	1665	1450	1335	1420	1550	1310	2590	404.29
62	22	A. Ghosh	MS 04/05, Bengal Ambuja	4	0	4	1460	3510	1780	3560	2180	1655	1585	561.79
63	22	P. Chakroborty	Bengal Ambuja	3	2	5	980	1360	1665	1075	0	2330	0	211.71
64	22	A.K Paul	5/13 Bengal Ambuja	2	1	3	415	350	205	425	0	505	0	90.48
65	22	Bina Kushari	7/16 Bengal Ambuja	3	1	4	830	1080	970	1375	640	920	0	207.68
66	22		7/1 Bengal Ambuja	4	1	5	1645	2060	2375	2750	0	2650	3300	422.29
67	22	Dulal Kr. Mitra	MWAV 11 Bengal Ambuja	3	1	4	395	520	1050	880	940	820	1540	219.46
68	22		6/21 Bengal Ambuja	2	1	3	435	580	2380	690	0	500	980	265.00
69	22		6/16 Bengal Ambuja	4	2	6	1895	2730	1550	0	2230	1305	0	231.19
70	22	Subrata Addi	6/19 Bengal Ambuja	2	1	3	1775	2080	2510	1420	1300	995	415	499.76
71	22	Dr. Kanika Biswas	MS 04/05 Bengal Ambuja	2	2	4	890	1050	825	1650	0	1010	0	193.75
72	22		MS 04/07 Bengal Ambuja	3	1	4	665	830	955	1910	1850	910	0	254.29
73	22	Sadhir Gupta	MS 04/01 Bengal Ambuja	2	0	2	1010	1780	2255	1710	1200	1310	915	727.14
Total														**25983.02**

Per Capita Waste Generation = 355.93

Analysis of Household Waste Generation Survey Data

Category – MIG **Name of Waste Handler – Tapash Barui**

SL NO.	WARD NO.	NAME OF THE RESPONDENT	RESIDENTIAL ADDRESS	HOUSEHOLD SIZE			TOTAL QUANTITY OF WASTE PER DAY in gms							QUANTITY OF WASTE PER CAPITA PER DAY in gms
				ADULT	CHILD	TOTAL	07-09-2016	08-09-2016	09-09-2016	10-09-2016	13-09-2016	14-09-2016	15-09-2016	
1	22	S.K CHATTERJEE	3/5 UDAY SHANKAR BITHI,CITY CENTER	4	1	5	2500	1550	1275	950	1320	980	1075	224.64
2	22	S.C NAG	3/3 UDAY SHANKAR BITHI,CITY CENTER	3	0	3	3645	2285	3615	2015	4005	1955	4215	847.86
3	22	S.CHATTERJEE	3/3 UDAY SHANKAR BITHI,CITY CENTER	3	1	4	2765	1675	1200	1150	635	825	720	258.13
4	22	ASHOK MUKHOPADHYA	D/3 UDAY SHANKAR BITHI, CITY CENTER	2	0	2	1795	845	795	625	585	625	540	331.61
5	22	ASTORAG	D/3 UDAY SHANKAR BITHI, CITY CENTER	7	4	11	7960	3300	1425	1245	1225	965	1440	167.01
6	22	M.ALI	C/11 UDAY SHANKAR BITHI, CITY CENTER	14	6	20	4365	1050	1255	1290	1295	850	1285	61.18
7	22	A.N ROY	C/13 UDAY SHANKAR BITHI, CITY CENTER	3	1	4	2655	890	1095	990	1645	1070	925	267.14
8	22	SANTANU BISWAS	15 UDAY SHANKAR BITHI, CITY CENTER	4	1	5	3770	1025	2295	0	1040	1095	1945	237.50
9	22		15 UDAY SHANKAR BITHI, CITY CENTER	5	2	7	5210	-1965	0	2010	1130	885	1225	187.91
10	22	BHASKAR MUKHERJEE	15 UDAY SHANKAR BITHI, CITY CENTER	2	2	4	2455	855	930	900	590	535	675	191.96
11	22	PRONOY DUTTA GUPTA	C/25 UDAY SHANKAR BITHI, CITY CENTER	2	0	2	2730	1090	930	835	420	510	715	393.39
12	22	JAYITA DUTTA	C/27 UDAY SHANKAR BITHI, CITY CENTER	2	1	3	220	180	515	225	545	315	315	97.50
13	22		C/29 UDAY SHANKAR BITHI, CITY CENTER	4	0	4	750	315	1390	665	1410	725	1020	192.50
14	22	B.Z ROY	C/33 UDAY SHANKAR BITHI, CITY CENTER	4	1	5	1915	955	0	1035	1820	1010	955	178.71
15	22	L.DUTTA	C/33 UDAY SHANKAR BITHI, CITY CENTER	1	0	1	300	85	0	165	715	255	835	255.36

16	22	SANDHA RANI GHOSH	C/37 UDAY SHANKAR BITHI, CITY CENTER	3	1	4	1600	865	1355	945	740	650	555	201.16
17	22	RANU CHOUDHURY	C/39 UDAY SHANKAR BITHI, CITY CENTER	3	2	5	2000	1005	1765	1085	1440	910	0	205.86
18	22	BIVASH GHOSH	46 UDAY SHANKAR BITHI, CITY CENTER	4	0	4	7100	4065	1305	1110	1625	1005	1555	479.91
19	22	D.HALDER	47 UDAY SHANKAR BITHI, CITY CENTER	5	2	7	2075	1085	725	785	355	420	810	98.21
20	22	D.BHATTACHARYA	49 UDAY SHANKAR BITHI, CITY CENTER	7	1	8	2660	1900	1530	1590	2135	1665	1920	198.39
21	22	S.N.SINGH	2/12 UDAY SHANKAR BITHI, CITY CENTER	10	2	12	19850	11000	8035	8095	7065	6995	6425	646.76
22	22	P.K. CHATTERJEE	5/4 UDAY SHANKAR BITHI, CITY CENTER	3	1	4	750	405	1435	555	815	765	530	164.82
23	22	R. ROYCHOWDHURY	5/34 MAXMULLER PATH, CITY CENTER	2	0	2	350	200	315	375	0	0	0	76.07
24	22	S.B.GOSWAMI	5/35 MAXMULLER PATH, CITY CENTER	4	0	4	1100	350	1025	1085	305	520	905	153.13
25	22	SUBROTO SHOME	5/32 MAXMULLER PATH, CITY CENTER	3	0	3	4260	2000	1180	1240	2830	0	3220	523.33
26	22	N.BHATTACHARJE E	5/30 MAXMULLER PATH, CITY CENTER	3	0	3	2600	400	1575	505	1235	680	1665	310.83
27	22	K.N BOSE	5/31 MAXMULLER PATH, CITY CENTER	2	0	2	875	135	545	240	360	355	525	166.79
28	22	C.R DAS	5/28 MAXMULLER PATH, CITY CENTER	6	2	8	3000	1165	1665	1270	1245	795	795	143.53
29	22	S. BHATTACHARYA	5/26 MAXMULLER PATH, CITY CENTER	4	0	4	2535	1180	1225	1285	1035	890	1120	265.80
30	22	SUJATA GHOSH	5/26 MAXMULLER PATH, CITY CENTER	2	1	3	500	965	320	765	1785	695	565	241.07
31	22	GITA GHOSH	5/24 MAXMULLER PATH, CITY CENTER	10	3	13	2640	1195	1325	1135	1670	1235	1330	93.90
32	22	GANESH MAJUMDER	5/25 MAXMULLER PATH, CITY CENTER	6	2	8	3530	820	1690	910	845	860	950	131.52
33	22	PRITAM SINGH	5/23 MAXMULLER PATH, CITY CENTER	3	0	3	6000	2655	4190	1885	845	980	1125	672.26
34	22	S.K.BARAL	5/20 MAXMULLER PATH, CITY CENTER	5	0	5	1830	640	385	455	1370	680	620	135.86
35	22	P.K.BANERJEE	5/19 MAXMULLER PATH, CITY CENTER	6	0	6	3940	1000	210	280	265	315	440	101.43
36	22	JIBON BISWAS	5/18 MAXMULLER PATH, CITY CENTER	4	0	4	2100	1275	1050	1120	590	630	885	219.91
37	22	ADHARANI SEN	5/17 MAXMULLER PATH, CITY CENTER	2	0	2	2005	480	220	290	260	330	385	198.21
38	22	PARTHA MUKHERJEE	5/16 MAXMULLER PATH, CITY CENTER	5	0	5	2610	705	520	590	980	465	755	141.21
39	22	SUGATA	5/14 MAXMULLER PATH,	2	0	2	1870	0	0	2080	960	875	490	363.93

		CHAKROBORTY	CITY CENTER											
40	22	SOUVIK SORKHEL	5/14 MAXMULLER PATH, CITY CENTER	2	0	2	3940	610	0	0	0	0	740	210.71
41	22	JAHIRUL ISLAM	5/15 MAXMULLER PATH, CITY CENTER	6	0	6	23675	7465	8490	7685	6240	5475	5475	1188.81
42	22	R.N. BANERJEE	5/13 MAXMULLER PATH, CITY CENTER	8	0	8	2150	1435	1315	1335	475	890	975	125.22
43	22	DR. P.K SINGH	5/11 MAXMULLER PATH, CITY CENTER	5	0	5	4400	1970	2075	2095	1675	1565	1830	357.00
44	22	S. HALDER	5/9 MAXMULLER PATH, CITY CENTER	3	0	3	800	460	520	540	1020	210	735	167.50
45	22	S. MODI	5/9 MAXMULLER PATH, CITY CENTER	3	0	3	835	0	795	815	1240	715	1110	216.07
46	22	S. CHOUDHURY	5/10 MAXMULLER PATH, CITY CENTER	2	0	2	3125	1510	1300	1475	845	915	945	577.14
47	22	SILAJIT BHATTACHARYA	5/8 MAXMULLER PATH, CITY CENTER	7	0	7	730	235	625	500	410	365	770	58.88
48	22	S. SARKAR	5/7 MAXMULLER PATH, CITY CENTER	6	0	6	4660	385	385	350	0	0	695	90.42
49	22	RAVINDRA RANACHANDRA	5/6 MAXMULLER PATH, CITY CENTER	4	0	4	5325	885	2125	850	1020	910	815	316.43
50	22	KABITA PATEL	5/6 MAXMULLER PATH, CITY CENTER	4	0	4	2715	0	1445	1505	2080	1210	0	271.34
51	22	JAYANTA NANDY	5/5 MAXMULLER PATH, CITY CENTER	2	0	2	4275	1805	1245	1345	530	630	1330	596.96
52	22	B.N BHATTACHARYA	5/2 MAXMULLER PATH, CITY CENTER	6	0	6	1460	690	420	515	1040	545	820	103.57
53	22	M.C PAUL	5/3 MAXMULLER PATH, CITY CENTER	4	0	4	4420	1200	2135	1655	1035	945	3055	382.41
54	22	N.MAHATO	5/1 MAXMULLER PATH, CITY CENTER	4	0	4	3720	800	2555	0	1425	780	1885	298.66
Total														**14787.43**

Per Capita Waste Generation = 273.84

Analysis of Household Waste Generation Survey Data

Category – LIG **Name of Waste Handler – Tapas Barui**

SL NO.	WARD NO.	NAME OF THE RESPONDENT	RESIDENTIAL ADDRESS	HOUSEHOLD SIZE			TOTAL QUANTITY OF WASTE PER DAY in gms							QUANTITY OF WASTE PER CAPITA PER DAY in gms
				ADULT	CHILD	TOTAL	07-09-2016	08-09-2016	09-09-2016	10-09-2016	13-09-2016	14-09-2016	15-09-2016	
1	22	ACHINTA BHATTYACHARYA	6/19 UDAY SANKAR BITHI	3	1	4	675	750	1090	830	705	1325	775	219.64
2	22	DIPAK MAJUMDAR	6/22 UDAY SANKAR BITHI	2	0	2	1415	1490	0	1110	1410	890	655	497.86
3	22	AVHIGAN DIXHIT	6/17 UDAY SANKAR BITHI	2	1	3	935	1010	560	465	100	355	4545	379.52
4	22	M.M. DATTA	6/11 UDAY SANKAR BITHI	3	0	3	375	450	290	70	110	200	195	80.48
5	22	DAYAMOY DAY	6/12 UDAY SANKAR BITHI	6	0	6	1650	1725	1730	1700	1310	0	1805	236.19
6	22	P.K MAZUMDER	6/10 UDAY SANKAR BITHI	2	0	6	605	680	375	455	120	505	375	74.17
7	22	S.K DAS	6/08 UDAY SANKAR BITHI	3	1	4	1225	1200	1040	0	2930	940	0	261.96
8	22	N.DEV	6/07 UDAY SANKAR BITHI	2	0	2	1335	1310	0	1100	200	820	1015	412.86
9	22	SANKARI BANERJEE	6/6 UDAY SANKAR BITHI	2	0	2	135	110	515	425	385	0	585	153.93
10	22	A.PAL	6/4 UDAY SANKAR BITHI	2	0	2	805	890	360	580	735	625	360	311.07
11	22	SUPRITI PAL	6/02 UDAY SANKAR BITHI	3	2	5	445	530	2560	1260	1120	855	0	193.43
12	22	S.R BHATTYACHARYA	8/02 UDAY SANKAR BITHI	7	0	7	1340	1425	1575	1400	1365	1220	1340	197.24
13	22	SUKALYAN MUKHERJEE	D-8/3 UDAY SANKAR BITHI	5	0	5	1105	1190	1500	225	1150	705	695	187.71
14	22	S. MAJUMDAR	8/5 UDAY SANKAR BITHI	5	2	7	1090	1200	3510	2531	1020	0	1745	226.45
15	22	K.K.MAJUMDAR	8/7 UDAY SANKAR BITHI	5	0	5	1220	1330	905	870	1460	770	1105	218.86
16	22	ARKA	8/9 UDAY SANKAR BITHI	2	2	4	1550	1660	115	0	0	1305	0	165.36
17	22	MOHIT KR. BOHARA	8/13 UDAY SANKAR BITHI	2	2	4	1230	1340	1770	200	1860	690	770	280.71
18	22	BIPPALUNDU BAIWAS	8/12 UDAY SANKAR BITHI	5	1	6	1190	1300	1610	1230	1970	1405	1005	231.19

19	22	C.PALIT	8/14 UDAY SANKAR BITHI	2	1	3	890	2225	960	1090	2450	880	1045	454.29
20	22	MAYA BHATTYACHARYA	8/10 UDAY SANKAR BITHI	4	0	4	220	375	100	435	330	0	585	73.04
21	22	AJOY ROY	8/18 UDAY SANKAR BITHI	5	0	5	1150	1345	2215	1045	1900	0	2310	284.71
22	22	D.N DATTA	8/15 UDAY SANKAR BITHI	4	1	5	720	1110	820	565	500	305	405	126.43
23	22	SUJATA BHATTYACHARYA	8/16 UDAY SANKAR BITHI	2	0	2	665	970	740	890	0	905	0	297.86
24	22	DIPAK RANJAN CHATTERJEE	8/17 UDAY SANKAR BITHI	2	2	4	855	910	1200	795	1609	640	925	247.64
25	22	H.K PALIT	9-S.N. PATH NON COMPANY	4	0	4	265	320	255	70	95	0	175	42.14
26	22	P.C CHATTERJEE	C-16 SARAJANI NAIDU PATH	8	0	8	395	450	2205	415	645	410	575	90.98
27	22	UJJAL DEVNATH	10/3 SARAJANI NAIDU PATH	4	0	4	520	1210	400	320	675	0	815	140.71
28	22	MRINAL DAS	10/9 SARAJANI NAIDU PATH	2	1	3	1040	1130	1470	1420	1210	1105	1000	398.81
29	22	SISIR KU. GHOSH	10/9 SARAJANI NAIDU PATH	2	0	2	220	175	315	395	695	405	135	167.14
30	22	MUKESH RANJAN	10/11 SARAJANI NAIDU PATH	3	2	5	890	1610	410	760	1000	550	675	168.43
31	22	SOMNATH BISWAS	10/11 SARAJANI NAIDU PATH	3	1	4	0	6700	1485	1605	375	825	625	414.82
32	22	PRADYOUT MAJUMDAR	10/13 SARAJANI NAIDU PATH	4	3	7	805	1800	1330	510	1210	0	1070	137.24
33	22	B.BASU	B-34 SUKANTA PALLI	3	0	3	555	750	495	720	1685	560	870	268.33
34	22	S.K.CHOUDHURY	B-38 SUKANTA PALLI	2	0	2	410	595	710	340	600	510	440	257.50
35	22	RANJIT PRASAD	B-36 SUKANTA PALLI	2	2	4	2880	2175	2775	4000	2270	0	3005	610.89
36	22	B.K. DEY	B-34 SUKANTA PALLI	3	1	4	1005	975	1305	855	1150	715	0	214.46
37	22	KIDS LEARNING POINT	B-30 SUKANTA PALLI	4	0	4	575	0	765	415	500	375	610	115.71
38	22	ARUNA BISWAS	B-28 SUKANTA PALLI	1	0	1	820	910	0	1180	1575	1010	840	905.00
39	22	JOYSHREE CHAKRABORTY	B-26 SUKANTA PALLI	2	1	3	205	695	330	630	370	400	390	143.81
40	22	SEFALI KUNDU	B.C.N 26 SUKANTA PALLI	3	1	4	400	315	350	775	550	0	885	116.96
41	22	P.S. GUPTA	19 MAULANA AZAD SARANI	2	0	2	195	315	555	265	1000	340	420	220.71
42	22	BASANTI DEVI JAIN	A-78 MAULANA AZAD SARANI	7	6	13	0	6835	2130	3355	3005	2915	0	200.44

43	22	G.P KUNDU	A-15 MAULANA AZAD SARANI	4	1	5	1040	2075	905	1360	1785	1120	935	263.43
44	22	SAMBHU NATH CHATTERJEE	A-13 MAULANA AZAD SARANI	2	0	2	805	810	0	4725	0	2335	895	683.57
45	22	S.CHOUDHARY	A-9 MAULANA AZAD SARANI	4	0	4	1725	2920	2015	1685	2450	0	1205	428.57
46	22	M.KHAN	A-11 MAULANA AZAD SARANI	19	1	20	1150	1295	2540	2195	4500	0	1725	95.75
47	22	M.ALI	A-5 MAULANA AZAD SARANI	4	0	4	1495	1640	1005	1210	5475	920	0	419.46
48	22	P.K DUTTA	A-1 MAULANA AZAD SARANI	4	0	4	920	1065	3835	2120	2075	1540	1100	451.96
49	22	MONOMAY DEY	A-3 MAULANA AZAD SARANI	3	2	5	2565	2710	2105	3055	1660	0	2320	411.86
50	22	T.SARKAR	A-3 MAULANA AZAD SARANI	3	1	4	625	770	575	710	1135	870	715	192.86
51	22	ASHOKE MUKHERJEE	A-7 MAULANA AZAD SARANI	5	0	5	720	675	1775	715	2425	0	0	180.29
52	22	BIPLAB CHATTERJEE	A-21 MAULANA AZAD SARANI	3	0	3	825	2670	1720	805	765	905	1110	419.05
53	22	AVIJIT MISHRA	A-23 MAULANA AZAD SARANI	5	0	5	0	1975	645	650	1335	545	715	167.57
54	22	KABERI TEWARI	A-25 MAULANA AZAD SARANI	4	0	4	0	3000	925	1000	3100	1210	0	329.82
55	22	A. BISWAS	A-29 MAULANA AZAD SARANI	1	0	1	560	1350	970	685	460	655	700	768.57
56	22	A.K.KHAN	A-33 MAULANA AZAD SARANI	5	1	6	430	330	775	660	1385	1290	0	115.95
57	22	SUBHASISH BANERJEE	A.C-35 MAULANA AZAD SARANI	2	2	4	605	400	1000	1045	990	895	625	198.57
58	22	N.N BHOWMIK	44 SARAJANI NAIDU PATH	5	0	5	210	155	520	345	150	285	120	51.00
59	22	M. CHAKROBORTY	12/16 SARAJANI NAIDU PATH	6	2	8	0	1725	1005	0	1865	1055	0	100.89
60	22	R.N CHAKROBORTY	46 SARAJANI NAIDU PATH	8	0	8	815	1240	1730	715	1815	1020	875	146.61
61	22	DINESH MONDAL	D-48 SARAJANI NAIDU PATH	3	0	3	575	1485	1010	715	425	645	555	257.62
62	22	DEBJANI PANDA	12/14 SARAJANI NAIDU PATH	4	0	4	295	215	245	580	605	0	785	97.32
63	22	SANJIT DAS	12/14 SARAJANI NAIDU PATH	3	0	3	0	1060	140	1435	0	1635	0	203.33
64	22	RANADEVI KESH KUNDU	12/13 SARAJANI NAIDU PATH	4	0	4	430	320	230	1435	245	440	305	121.61
65	22	M. CHAKROBORTY	12/16 SARAJANI NAIDU PATH	3	0	3	605	530	2380	1050	0	805	920	299.52
66	22	INDIRA	12/12 SARAJANI NAIDU	6	0	6	550	500	625	1375	625	550	630	115.60

		CHATTERJEE	PATH											
67	22	SUREN CHAKROBORTY	12/7 SARAJANI NAIDU PATH	4	2	6	1165	1200	1580	1270	1875	1445	1105	229.52
68	22	PULAK MUKHERJEE	12/10 SARAJANI NAIDU PATH	5	0	5	910	1500	1370	1580	820	945	1005	232.29
69	22	B.D PAUL	12/8 SARAJANI NAIDU PATH	2	0	2	225	985	365	145	105	75	170	147.86
70	22	GAUTAM RAY	D-12/5 SARAJANI NAIDU PATH	4	1	5	1220	1780	1365	1120	860	835	675	224.43
71	22	MRINALINY SEN	12/3 SARAJANI NAIDU PATH	5	0	5	2995	3050	3435	1460	1390	990	1140	413.14
72	22	RAS BIHARI BHABAN	12/1 SARAJANI NAIDU PATH	6	0	6	2950	150	0	2130	785	295	1010	174.29
Total														**18369.03**

Per Capita Waste Generation = 255.13

SWM Survey Sheet

Hospital Questionnaire

1	Borough No.		3
2	Ward No.		27
3	Date		9/09/2016
4	Contact Person with Designation		SATADAL DATTA (EXECUTIVE DIRECTOR)
5	Contact No.		03432532430
6	Location / Address of Hospital		BESIDE E.S. I. HOSPITAL . DR. ZAKIR HUSSAIN AVENUE. BIDHAN NAGAR
7	No. of Beds in the Hospital		160 BEDS
8	Quantity of Waste Generated per day in Kg (approx.)		20- 25 KG
9	Type of waste	Bio- Medical Waste	10 KG
		Municipal Solid Waste	15 -20 KG
		Other waste if any	
10	Whether they have any system for collection of Bio-Medical Waste		MEDICENE COLLECT THE BIO-MEDICAL WASTE.
11	Municipal Solid Waste Collection Mechanism		(Into Truck/Trailer/ Open Dump/ Any Other) TRY-CYCLE
12	Solid Waste Collection Frequency		(Daily/after 1 day/after 2 day/after 1 week/any other) DAILY
13	Suggestions/Remarks		DAILY COLLECTION MUST BE REQUIRED.

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	22
3	Date	10/09/2016
4	Contact Person with Designation	BAPPA ROY - MANAGER
5	Contact No.	7602774047
6	Name of Hotel/Restaurant	DHOSA- JUNCTION
7	Location or Address of Hotel/Restaurant	JUNCTION MALL
8	Capacity of Hotel (Total no. of Rooms)	100 SEATS
9	Average Occupancy per day (No. of Guests/Customers)	70
	a) Peak Season	120
	b) Slack Season	50
10	Quantity of Waste Generated per day in Kg (approx.)	10 KG
	a) Peak Season	15 KG
	b) Slack Season	10 KG
11	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) BY TRUCK
12	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) DAILY
13	Suggestions/Remarks	OVERALL GOOD

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	22
3	Date	10/09/2016
4	Contact Person with Designation	TAPAS THAKUR
5	Contact No.	8436005765
6	Name of Hotel/Restaurant	THE CITY PRESIDENCY
7	Location or Address of Hotel/Restaurant	JUNCTION MALL 3RD FLOOR
8	Capacity of Hotel (Total no. of Rooms)	100 SEATS
9	Average Occupancy per day (No. of Guests/Customers)	250
	a) Peak Season	400
	b) Slack Season	200
10	Quantity of Waste Generated per day in Kg (approx.)	10 KG – 15 KG
	a) Peak Season	20 KG
	b) Slack Season	10 KG
11	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) HOTEL CONTAINER - VAT
12	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other)DAILY. AFTER 10:00P.M THEY DUMP THE WASTE OUTSIDE VAT
13	Suggestions/Remarks	VAT CAPACITY NEED MORE CAPACIZED.

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	27
3	Date	15.09.16
4	Contact Person with Designation	NIMAI CHANDRA BERA
5	Contact No.	9434471259
6	Name of Hotel/Restaurant	PARITRIPTI RESTURENT
7	Location or Address of Hotel/Restaurant	SUKUMAR SARANI BIDHANNAGAR , DURGAPUR -12
8	Capacity of Hotel (Total no. of Rooms)	
9	Average Occupancy per day (No. of Guests/Customers)	400 -450
	a) Peak Season	
	b) Slack Season	
10	Quantity of Waste Generated per day in Kg (approx.)	30 -50 KG
	a) Peak Season	
	b) Slack Season	
11	Municipal Solid Waste Collection Mechanism	AUTO TRIPER
12	Solid Waste Collection Frequency	DAILY
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	5
2	Ward No.	34
3	Date	15.9.16
4	Contact Person with Designation	MONIPADA MONDAL (OWNER)
5	Contact No.	8236151464
6	Name of Hotel/Restaurant	MONIPADA HOTEL
7	Location or Address of Hotel/Restaurant	KADA ROAD,TELIJHUPTI
8	Capacity of Hotel (Total no. of Rooms)	30 PERSON AT A TIME
9	Average Occupancy per day (No. of Guests/Customers)	
	a) Peak Season	7 TABLES
	b) Slack Season	150-200 PERSONS / DAY LUNCH, DINNER, TEA ETC.
10	Quantity of Waste Generated per day in Kg (approx.)	10-15 KGS AVG
	a) Peak Season	RICE, LEFT OVER FOOD ,PLASTIC CUPS , THARMOCAL PLATE ETC.
	b) Slack Season	
11	Municipal Solid Waste Collection Mechanism	NOT COLLECTED
12	Solid Waste Collection Frequency	
13	Suggestions/Remarks	PAY THEMSELVES TO A PERSON AND THEN DUMPS IN A PLACE WASTE NOT COLLECTED

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	22
3	Date	10/09/2016
4	Contact Person with Designation	ANIRBANJYOTI MUKHOPADAHYA GENERAL MANAGER
5	Contact No.	9073915049
6	Name of Hotel/Restaurant	HOTEL LUXOR PVT.LTD
7	Location or Address of Hotel/Restaurant	NAJRUL SARANI, CITY CENTRE DURGAPUR -16
8	Capacity of Hotel (Total no. of Rooms)	28 ROOMS 30% OCCUPIED
9	Average Occupancy per day (No. of Guests/Customers)	120-125
	a) Peak Season	40-50%
	b) Slack Season	
10	Quantity of Waste Generated per day in Kg (approx.)	20-25 KG
	a) Peak Season	30 KG MAX
	b) Slack Season	
11	Municipal Solid Waste Collection Mechanism	TRAILER
12	Solid Waste Collection Frequency	SOME TIME DAILY/ SOMETIME 1 OR 3 TIMES IN A WEEK
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	24
3	Date	09.09.16
4	Contact Person with Designation	BIJENDRA ROY - ASSISTANT
5	Contact No.	
6	Name of Hotel/Restaurant	THE SPICE INN
7	Location or Address of Hotel/Restaurant	S.S.B SARANI,DBI HUDCO MORE
8	Capacity of Hotel (Total no. of Rooms)	5 SMALL TABLE X 6 1 BIG TABLE X12
9	Average Occupancy per day (No. of Guests/Customers)	40-50 NOS PER DAY
	a) Peak Season	50-55 NOS
	b) Slack Season	25-30 NOS
10	Quantity of Waste Generated per day in Kg (approx.)	12-15 KG
	a) Peak Season	15 KG
	b) Slack Season	8-10KG
11	Municipal Solid Waste Collection Mechanism	TRI-CYCLE
12	Solid Waste Collection Frequency	DAILY 8:00 -8:30 AM
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	24
3	Date	09.09.16
4	Contact Person with Designation	SANDIP MAITY(LABOUR)
5	Contact No.	9732000786
6	Name of Hotel/Restaurant	KOHINOOR HOTEL
7	Location or Address of Hotel/Restaurant	A1/22,SSB SARANI NEAR PUMP HOUSE, BIDHANNAGAR, DURGAPUR-
8	Capacity of Hotel (Total no. of Rooms)	7 TABLES WITH 4 SEATER
9	Average Occupancy per day (No. of Guests/Customers)	30-35
	a) Peak Season	40
	b) Slack Season	20-25
10	Quantity of Waste Generated per day in Kg (approx.)	10-12 KG DAILY
	a) Peak Season	20 KG
	b) Slack Season	10 KG
11	Municipal Solid Waste Collection Mechanism	TRI-CYCLE
12	Solid Waste Collection Frequency	DAILY SOMETIME THEY PUT THE WASTE IN OPEN DUMP
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	24
3	Date	09.09.16
4	Contact Person with Designation	TUSHAR PAN
5	Contact No.	8926843460
6	Name of Hotel/Restaurant	COMFORT GUEST HOUSE
7	Location or Address of Hotel/Restaurant	A1/7 SSB SARANI, BIDHANNAGAR
8	Capacity of Hotel (Total no. of Rooms)	12ROOM X 12 NOS BIN
9	Average Occupancy per day (No. of Guests/Customers)	ONLY 2 ROOMS PRESENT
	a) Peak Season	7- 8 ROOMS BOOKED MAX
	b) Slack Season	SOMETIME NIL
10	Quantity of Waste Generated per day in Kg (approx.)	5-10 KG
	a) Peak Season	
	b) Slack Season	
11	Municipal Solid Waste Collection Mechanism	TRI-CYCLE
12	Solid Waste Collection Frequency	VEHICLE COME EVERY DAY BUT THEY PUT WASTE AFTER 1 WEEK
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	24
3	Date	09.09.16
4	Contact Person with Designation	CHIRANJIT PAUL (SERVICE MAN)
5	Contact No.	9635567916
6	Name of Hotel/Restaurant	COZYCOM HOTEL C-SQUARE RESTURENT
7	Location or Address of Hotel/Restaurant	BIDHANNAGAR, SECTOR 2A ,SSB SARANI
8	Capacity of Hotel (Total no. of Rooms)	8 TABLEX4 SEATER
9	Average Occupancy per day (No. of Guests/Customers)	40-50
	a) Peak Season	
	b) Slack Season	
10	Quantity of Waste Generated per day in Kg (approx.)	25-30 KG
	a) Peak Season	40 KG
	b) Slack Season	20-22KG
11	Municipal Solid Waste Collection Mechanism	TRI - CYCLE
12	Solid Waste Collection Frequency	DAILY 10 AM-10:30AM
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	22
3	Date	08.09.16
4	Contact Person with Designation	PIYOUS MITRA(FLOOR MANAGER)
5	Contact No.	9332897909
6	Name of Hotel/Restaurant	PATHIK HOTEL
7	Location or Address of Hotel/Restaurant	GANDHI MORE
8	Capacity of Hotel (Total no. of Rooms)	26 ROOMS
9	Average Occupancy per day (No. of Guests/Customers)	50 PERSONS / 10 TABLES
	a) Peak Season	
	b) Slack Season	
10	Quantity of Waste Generated per day in Kg (approx.)	80-100 KG
	a) Peak Season	100KG
	b) Slack Season	70KG
11	Municipal Solid Waste Collection Mechanism	TRI-CYCLE
12	Solid Waste Collection Frequency	DAILY
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	22
3	Date	7.09.16
4	Contact Person with Designation	SUJIT PAL(MAIN PERSON)
5	Contact No.	9832860709
6	Name of Hotel/Restaurant	MA TARA SWEETS
7	Location or Address of Hotel/Restaurant	CITY CENTRE , BUS STAND
8	Capacity of Hotel (Total no. of Rooms)	
9	Average Occupancy per day (No. of Guests/Customers)	550AVG
	a) Peak Season	600 AVG
	b) Slack Season	
10	Quantity of Waste Generated per day in Kg (approx.)	1-1.5 KG
	a) Peak Season	
	b) Slack Season	
11	Municipal Solid Waste Collection Mechanism	TRI- CYCLE
12	Solid Waste Collection Frequency	DAILY
13	Suggestions/Remarks	NOTHING

Signature of Respondent

SWM Survey Sheet

Hotel/Restaurant Questionnaire

1	Borough No.	3
2	Ward No.	22
3	Date	8/9/16
4	Contact Person with Designation	HAMID RAHAMAN (MANAGER POST)
5	Contact No.	8584014253
6	Name of Hotel/Restaurant	PARK PLAZA
7	Location or Address of Hotel/Restaurant	CITY CENTRE , DURGAPUR-16
8	Capacity of Hotel (Total no. of Rooms)	85
9	Average Occupancy per day (No. of Guests/Customers)	30-40%
	a) Peak Season	50-60%
	b) Slack Season	30-40%
10	Quantity of Waste Generated per day in Kg (approx.)	50-80 KG
	a) Peak Season	
	b) Slack Season	
11	Municipal Solid Waste Collection Mechanism	AUTO-TRIPER
12	Solid Waste Collection Frequency	DAILY
13	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

School/Collage Questionnaire

1	Borough No.	02
2	Ward No.	20
3	Date	9/09/2016
4	Contact Person	SUJATA PAL
5	Contact No.	9851420971
6	Designation	HEAD MISTRESS
7	Name of School or Collage	VIDYASAGAR PALLY F.P. SCHOOL
8	Location or Address of School or Collage	VIDYASAGAR PALLY . BANACHITI DURGAPUR-13
9	Total no. of Teachers and Staffs (approx.)	4
10	Total no. of Students (approx.)	29
11	Quantity of Waste Generated per day in Kg (approx.)	20 KG
12	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) TRY-CYCLE
13	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) ONE DAY IN A WEEK
14	Suggestions/Remarks	DAILY COLLETION REQUIRED AND NEED VAT.

Signature of Respondent

SWM Survey Sheet

School/Collage Questionnaire

1	Borough No.	03
2	Ward No.	22
3	Date	7/09/2016
4	Contact Person	JOYENTI BANERJEE
5	Contact No.	9475937457
6	Designation	HEAD MISTRESS
7	Name of School or Collage	BIDYASAGAR F.P. SCHOOL (DMC)
8	Location or Address of School or Collage	4 NO A.K. BITHI DURGAPUR CITY CENTER - 16
9	Total no. of Teachers and Staffs (approx.)	TEACHERS -05
10	Total no. of Students (approx.)	366
11	Quantity of Waste Generated per day in Kg (approx.)	6 KG
12	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) TRY-CYCLE
13	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) WEEKLY
14	Suggestions/Remarks	NEED DAILY COLLECTION . NEED SWEEPER.

Signature of Respondent

SWM Survey Sheet

School/Collage Questionnaire

1	Borough No.	02
2	Ward No.	19
3	Date	9/09/2016
4	Contact Person	DHARMENDRA PASAD
5	Contact No.	9641551638
6	Designation	HEAD MASTER
7	Name of School or Collage	BENACHITI BHARATI HINDI HIGH SCHOOL
8	Location or Address of School or Collage	GURADUWAR BENACHITI DURGAPUR - 13
9	Total no. of Teachers and Staffs (approx.)	TEACHERS -38
10	Total no. of Students (approx.)	3042 (V-XII) 575 (I-IV)
11	Quantity of Waste Generated per day in Kg (approx.)	2-3 KG(PER DAY)
12	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) NO VEHICLE COME.THEY THROW THE WASTE OUTSIDE.
13	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) DAILY
14	Suggestions/Remarks	WATER LOGGED HERE. NEED LOGGING SYSTEM AND WILL BETTER TO COME THE MUNICIPAL TRUCK TO COLLECT THE WASTE.

Signature of Respondent

SWM Survey Sheet

School/Collage Questionnaire

1	Borough No.	2
2	Ward No.	19
3	Date	9/09/2016
4	Contact Person	SHYAMAL PAL
5	Contact No.	9732268866
6	Designation	A.H.M
7	Name of School or Collage	R.P. VIVEKANANDA VIDYAPIT
8	Location or Address of School or Collage	BENACHITI DURGAPUR - 13
9	Total no. of Teachers and Staffs (approx.)	45
10	Total no. of Students (approx.)	2041(H.S) 450(PRIMARY) 200 (KIDS)
11	Quantity of Waste Generated per day in Kg (approx.)	120 KG
12	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) TRY-CYCLE
13	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) WEEKLY ONE DAY OFF
14	Suggestions/Remarks	REGULAR CLEANING REQUIRED. DRINKING WATER PROBLEM.

Signature of Respondent

SWM Survey Sheet

School/Collage Questionnaire

1	Borough No.	3
2	Ward No.	21
3	Date	9/09/2016
4	Contact Person	JOYONTO SINHA
5	Contact No.	7548945615
6	Designation	HEAD MASTER
7	Name of School or Collage	NETAJI NAGAR COLONY HIGH SCHOOL
8	Location or Address of School or Collage	BESIDE S.B.S.T.C. GARRAGE
9	Total no. of Teachers and Staffs (approx.)	T-15/ S-2 /PARATEACHER- 4
10	Total no. of Students (approx.)	520
11	Quantity of Waste Generated per day in Kg (approx.)	6KG
12	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) SEND TO THE SCP AND PIG FOOD
13	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) AFTER 2 DAYS
14	Suggestions/Remarks	NEED MUNICIPAL HELP TO COLLECT THE WASTE REGULARLY.

Signature of Respondent

SWM Survey Sheet

School/College Questionnaire

1	Borough No.	2
2	Ward No.	20
3	Date	9/09/2016
4	Contact Person	SUJATA PAL
5	Contact No.	9851420971
6	Designation	HEAD MISTRESS
7	Name of School or Collage	VIDYASAGAR PALLY F.P SCHOOL
8	Location or Address of School or Collage	VIDYASAGAR PALLY. BANACHITI DURGAPUR -13
9	Total no. of Teachers and Staffs (approx.)	4
10	Total no. of Students (approx.)	29
11	Quantity of Waste Generated per day in Kg (approx.)	20 KG
12	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/Tri cycle/Pushcarts/Any Other) TRY-CYCLE
13	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) ONE DAY IN A WEEK
14	Suggestions/Remarks	DAILY COLLETION REQUIRED AND NEED VAT.

Signature of Respondent

SWM Survey Sheet

School/College Questionnaire

1	Borough No.	01
2	Ward No.	04
3	Date	10.09.16
4	Contact Person	KRIPASINDHU KUMAR
5	Contact No.	9775388987
6	Designation	ASSISTANT PROFESSOR
7	Name of School or Collage	DURGAPUR GOVT. COLLEGE
8	Location or Address of School or Collage	J.N.AVENUE, DURGAPUR -1
9	Total no. of Teachers and Staffs (approx.)	150
10	Total no. of Students (approx.)	4000
11	Quantity of Waste Generated per day in Kg (approx.)	
12	Municipal Solid Waste Collection Mechanism	OPEN DUMPING ONLY / DMC NOT SENDING ANY VEHICLE INTO CAMPUS
13	Solid Waste Collection Frequency	ONE TIME IN 2 OR 3 MONTHS
14	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

School/College Questionnaire

1	Borough No.	03
2	Ward No.	
3	Date	09.09.16
4	Contact Person	ABHIJIT GOSWAMI
5	Contact No.	9434708759
6	Designation	SUPERVISOR
7	Name of School or Collage	HEMSHEEIA MODEL SCHOOL
8	Location or Address of School or Collage	J.N.AVENUE
9	Total no. of Teachers and Staffs (approx.)	175
10	Total no. of Students (approx.)	4500
11	Quantity of Waste Generated per day in Kg (approx.)	50NOS BINS HAND CART -03 WHEEL CART-3 CAKE ,PACKET,BOTTLE+MOSQUITO MEDICINE. 42 STAFF ARE INVOLVED FOR THIS PURPOSE
12	Municipal Solid Waste Collection Mechanism	OPEN DUMPER
13	Solid Waste Collection Frequency	
14	Suggestions/Remarks	

SWM Survey Sheet

School/College Questionnaire

1	Borough No.	03
2	Ward No.	21
3	Date	09.09.16
4	Contact Person	DEBASHIS DATTA
5	Contact No.	9434788074
6	Designation	TECHNICAL ASSISTANT
7	Name of School or Collage	NIT, DURGAPUR
8	Location or Address of School or Collage	M.G.ROAD-713209
9	Total no. of Teachers and Staffs (approx.)	200 (TEACHING AND NON TEACHING) 500X4 NO
10	Total no. of Students (approx.)	5000-6000
11	Quantity of Waste Generated per day in Kg (approx.)	30NOS CONTAINER WITH IN CAMPUS + MADE A HOLE WITHIN CAMPUS AND PUT THERE.
12	Municipal Solid Waste Collection Mechanism	PER CONTAINER PER MOUTH PAID 750 RS VAT-10-15 NOS GARBAGE BIN-10-15 NOS
13	Solid Waste Collection Frequency	
14	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

School/College Questionnaire

1	Borough No.	03
2	Ward No.	22
3	Date	08.09.2016
4	Contact Person	SAMAR DEV/MADHUMITA JAJURIA
5	Contact No.	9679830853
6	Designation	PRINCIPAL
7	Name of School or Collage	DURGAPUR WOMEN'S COLLEGE
8	Location or Address of School or Collage	M.G.ROAD
9	Total no. of Teachers and Staffs (approx.)	60 APPROX
10	Total no. of Students (approx.)	1200 NOS APPROX
11	Quantity of Waste Generated per day in Kg (approx.)	ONE HAND CART PUT INTO OPENDUMP 2-3 TIMES
12	Municipal Solid Waste Collection Mechanism	HAND CART-01 SPOT-3-4 NOS
13	Solid Waste Collection Frequency	NOTHING
14	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

School/College Questionnaire

1	Borough No.	03
2	Ward No.	22
3	Date	08.09.2016
4	Contact Person	J.N.GANGULY
5	Contact No.	9126292348
6	Designation	SECURITY
7	Name of School or Collage	NATIONAL POWER TRAINING INSTITUTION
8	Location or Address of School or Collage	MICHALE FARADEY ROAD DURGAPUR -16
9	Total no. of Teachers and Staffs (approx.)	PARMANENT-10 STAFF-42 + GUAST
10	Total no. of Students (approx.)	300 APPROX
11	Quantity of Waste Generated per day in Kg (approx.)	
12	Municipal Solid Waste Collection Mechanism	CONTAINER SYSTEM
13	Solid Waste Collection Frequency	1 TIME IN A MONTH
14	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	05
2	Ward No.	36
3	Date	10/09/2016
4	Contact Person	AVIJIT DAWN/ SWAPAN DAWN BAZAR HEAD
5	Contact No.	9333730694
6	Location or Address of Market	MAYA BAZAR
7	No. of Shops in the Market (approx.)	200
8	Quantity of Waste Generated per day (approx.)	2 TRY-CYCLE FULL (1.5 TONNE)
	a) Peak Season	2 TRY-CYCLE FULL
	b) Slack Season	1-1.5 TRY-CYCLE
9	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/ Pushcart/ Tricycle/Any Other) TRUCK -407
10	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) MONTHLY
11	Suggestions/Remarks	TRY TO IMPROVE THE DRAINAGE SYSTEM/DRAINAGE SYSTEM IS VERY POOR. DRINKING WATER IS NOT AVAILABLE HERE.

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	05
2	Ward No.	33
3	Date	10/09/2016
4	Contact Person	GIRIDHARI DHIBAR
5	Contact No.	9832779540
6	Location or Address of Market	FARIDPUR VEGETABLE MARKET
7	No. of Shops in the Market (approx.)	25
8	Quantity of Waste Generated per day (approx.)	10 KG
	a) Peak Season	15 KG
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/ Pushcart/ Tricycle/Any Other)NO VEHICLE CAME TO COLLECT THE WASTE. THEY THROW THE WASTE OUTSIDE A VACANT LAND
10	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) NO VEHUCLE COME
11	Suggestions/Remarks	SWEEPING AND LIGHT POST IS REQUIRED HERE.

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	04
2	Ward No.	30
3	Date	10/09/2016
4	Contact Person	RAJEN KR. SHAW
5	Contact No.	8509721342
6	Location or Address of Market	HAT TALA SABGI MARKET DURGAPUR-1
7	No. of Shops in the Market (approx.)	500
8	Quantity of Waste Generated per day (approx.)	2 TRUCK DAILY (4TONNE APPROX)
	a) Peak Season	2.5 FULL TRUCK
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/ Pushcart/ Tricycle/Any Other) BY TRUCK
10	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) DAILY
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	03
2	Ward No.	22
3	Date	08/09/2016
4	Contact Person	LAXMAN MONDAL (FISH SHOP MAN)
5	Contact No.	8926267854
6	Location or Address of Market	DAILY MARKET
7	No. of Shops in the Market (approx.)	100
8	Quantity of Waste Generated per day (approx.)	3 TRY-CYCLE FULL (150KG APPROX)
	a) Peak Season	5 TRY-CYCLE FULL
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/ Pushcart/ Tricycle/Any Other) BY TRY-CYCLE
10	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) DAILY
11	Suggestions/Remarks	CLOSE TO DMC . NO PROBLEM

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	03
2	Ward No.	21
3	Date	09/09/2016
4	Contact Person	UTTAM SARKER
5	Contact No.	9733299182
6	Location or Address of Market	BENACHITI NETAJI COLONY MARKET
7	No. of Shops in the Market (approx.)	60
8	Quantity of Waste Generated per day (approx.)	30 KG
	a) Peak Season	35 KG
	b) Slack Season	20 – 25 KG
9	Municipal Solid Waste Collection Mechanism	(By Truck/Trailer/ Open Dump/ Pushcart/ Tricycle/Any Other) BY TRY-CYCLE
10	Solid Waste Collection Frequency	(Daily/after 1 day/after 2 day/after 1 week/any other) MONTHLY
11	Suggestions/Remarks	REGULAR WASTE COLLECTION REQUIRED.

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	3
2	Ward No.	24
3	Date	8/9/16
4	Contact Person	GORAI STORE/LONHO BIPONI
5	Contact No.	8900396777
6	Location or Address of Market	MAMRA MARKET(SABJI MARKET)
7	No. of Shops in the Market (approx.)	5-6 TONNE
8	Quantity of Waste Generated per day (approx.)	FULL CAPACITY OF ONE DUMPER TRUCK
	a) Peak Season	
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	BY TRUCK - SMALL DUMPER
10	Solid Waste Collection Frequency	AFTER 02 DAYS SUNDAY NOT COME
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	02
2	Ward No.	17,18 BOTH
3	Date	09.09.16
4	Contact Person	TARUN RUIDAS
5	Contact No.	9932147174
6	Location or Address of Market	BENICHITI MARKET,NACHON ROAD
7	No. of Shops in the Market (approx.)	800-1000 NOS , SHOPS 3500-4000 NOS SHOPS ,ALL COMMERCIAL SHOPS
8	Quantity of Waste Generated per day (approx.)	3500-4000 9 TONNE APPROX FRUIT MARKETS 2 TONS
	a) Peak Season	5-6 SOME TIMES NEAR ABOUT 7 TONNES
	b) Slack Season	4-5 TONS
9	Municipal Solid Waste Collection Mechanism	HYVA AND AFTER COMPACTOR AT 9 A.M
10	Solid Waste Collection Frequency	DAILY
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	04
2	Ward No.	30
3	Date	10.09.16
4	Contact Person	SAJAL SEN
5	Contact No.	9474392173
6	Location or Address of Market	SEN MARKET, BANKURA MORE
7	No. of Shops in the Market (approx.)	70-80 NORMAL SHOPS + SABJI MARKET + FISH MARKET – NEAR ABOUT 500-700 SHOPS
8	Quantity of Waste Generated per day (approx.)	8-10 TONNE
	a) Peak Season	
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	HYVA TIMING 8:00AM -8:30AM DURATION 2-2:30 HOURS
10	Solid Waste Collection Frequency	DAILY
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	05
2	Ward No.	42 AND 43
3	Date	10.09.16
4	Contact Person	ASHIM GHOSH /UJJAL GHOSH
5	Contact No.	9564822415
6	Location or Address of Market	SHYMPUR MARKET(SMALL MARKET)
7	No. of Shops in the Market (approx.)	10-12 SHOPS
8	Quantity of Waste Generated per day (approx.)	SMALL AMOUNT OF WASTE GENERATED PER DAY
	a) Peak Season	MORE AMOUNT (10KG)
	b) Slack Season	SMALL AMOUNT
9	Municipal Solid Waste Collection Mechanism	TRY – CYCLE + DUMPER
10	Solid Waste Collection Frequency	AFTER 1 DAY
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	03
2	Ward No.	22
3	Date	10.09.16
4	Contact Person	CHOTTU SINGHA ROY
5	Contact No.	9932119021
6	Location or Address of Market	C-ZONE MARKET OPEN MARKET
7	No. of Shops in the Market (approx.)	15-20 SHOPS APPROX
8	Quantity of Waste Generated per day (approx.)	DSP MADE THIS DUST BIN FOR QUARTER WHICH LOCATED BEHIND THE MARKETBUT NOW BOTH MARKET WASTE AND QUARTER PUT THEIR WASTE IN THE DUST BIN
	a) Peak Season	20-25 KG
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	BY TRUCK - DUMPER
10	Solid Waste Collection Frequency	1 TIME IN A WEEK
11	Suggestions/Remarks	

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	01
2	Ward No.	07
3	Date	10.09.16
4	Contact Person	MORANJAN SARKER
5	Contact No.	
6	Location or Address of Market	CHINDIDAS MARKET
7	No. of Shops in the Market (approx.)	800-1000 APPROX
8	Quantity of Waste Generated per day (approx.)	VEGITABLE MARKET +FISH MARKET 150-200 QUENTITY 50-60 NOS (1-1.5 TONNE)
	a) Peak Season	HUGE QUENTATITY OF WASTE DUMPING IN OPEN LAND
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	HYVA VEHICLE AT 10AM
10	Solid Waste Collection Frequency	1 OR 2 TIMES IN A WEEK
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	01
2	Ward No.	07
3	Date	13.09.16
4	Contact Person	ASHUTOSH KUNDU
5	Contact No.	8436434959
6	Location or Address of Market	NEWTON MARKET
7	No. of Shops in the Market (approx.)	36 NOS (16-17 OPEN DAILY)
8	Quantity of Waste Generated per day (approx.)	EATEN BY COW
	a) Peak Season	25-30 KG
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	NOTHING , HIRE BY MARKET COMMITTEE ONE SWEEPER HAS GIVEN RS- 450-500 AFTER 15 DAYS
10	Solid Waste Collection Frequency	CORPORATION NEVER SEND ANY KIND OF VEHICLE
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	01
2	Ward No.	07
3	Date	13.09.16
4	Contact Person	TAPAS SAHA (SECRETARY)
5	Contact No.	9332612150
6	Location or Address of Market	D- CENTER MARKET
7	No. of Shops in the Market (approx.)	COMMERCIAL-22, FISH-5, VEG-7
8	Quantity of Waste Generated per day (approx.)	DMC VEHICLE DUMPER 2 PER MONTH
	a) Peak Season	(30KG)
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	DUMPER 2 TIMES IN ONE MONTH
10	Solid Waste Collection Frequency	HIRE ONE SWEEPER / RS-50 PER SHOPS
11	Suggestions/Remarks	

Signature of Respondent

SWM Survey Sheet

Vegetable Market Questionnaire

1	Borough No.	01
2	Ward No.	10
3	Date	13.09.16
4	Contact Person	SURAJ NARAYAN SINGH
5	Contact No.	9593791864
6	Location or Address of Market	ASHISH MARKET
7	No. of Shops in the Market (approx.)	300 NOS SHOPS
8	Quantity of Waste Generated per day (approx.)	1.5 TONNE
	a) Peak Season	
	b) Slack Season	
9	Municipal Solid Waste Collection Mechanism	VENDORS HIRE ONE SWEEPER EACH SHOPS GIVEN RS-2 TO HIM PER DAY
10	Solid Waste Collection Frequency	
11	Suggestions/Remarks	

Signature of Respondent

DRAWINGS

MAP

MAP