REPORT ON ASSESSMENT & CHARACTERIZATION OF PLASTIC WASTE



CENTRAL POLLUTION CONTROL BOARD DELHI

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1. Introduction:

India's rapid urbanization, industrialization, and economic growth over recent decades have led to a significant rise in plastic waste generation. This issue is further compounded by a growing population and improved living standards. The extensive use of plastics, especially single-use items, and their improper disposal pose serious environmental challenges.

Plastic production in India has also grown substantially, driven by urbanization and the expansion of plastic packaging across various sectors. While plastic packaging has advantages, its non-biodegradable nature and poor waste management systems often make it a major component of municipal solid waste (MSW). Ineffective segregation at the source leads to contaminated waste that accumulates in landfills, causing long-term environmental harm.

To address this, the Government of India introduced the **Plastic Waste Management (PWM) Rules, 2016**, and subsequent amendments. Key measures include banning identified single-use plastics (SUP) (effective July 1, 2022) and implementing Extended Producer Responsibility (EPR) Guidelines to promote recycling and reduce waste. These initiatives require periodic evaluation to ensure effective implementation and identify areas for improvement. Further, vide Amendment to PWM Rules dated March 14, 2024, the local Authorities have been mandated to assess the quantity of plastic waste generated in their jurisdiction. They are also required to characterise the plastic waste as per the quantity of different Single Use Plastic items as well as categories of plastic packaging present in the waste. The aforementioned information is to be submitted by the Local Authorities in the Annual Report a per the format prescribed in the Report.

CPCB has prepared Standard Operating Procedure (SOP) aligned with the provision of PWM Rules, giving details of the methodology to be followed for assessment and characterization of plastic waste. The same has been uploaded on the CPCB website and is placed at **Annexure K** for reference. CPCB Regional Directorates conducted the assessment & characterization of plastic waste in eight cities namely Bhopal, Vadodara, Mysuru, Vijayawada, Kolkata, Shillong, Pune, and Lucknow. This document, outlining the practical aspects in implementation of the SOP as well as the findings of the Assessment carried out by CPCB, has been prepared to assist the Local bodies in conducting the Assessment in their respective jurisdiction.

2. Overview and Methodology

As per SOP, the following parameters are to be decided prior to initiation of the Waste Characterization:

a. **Number of Vehicles to be sampled (n)**: It refers to the number of vehicles transporting municipal waste from which the waste sample for characterization is to be collected.

b. **Sorting sample size (kg) (s)**: It is the quantum of sample extracted for further analysis, from each vehicle load, using cone and quarter method It is to be in the range of 91-135 Kg

c. **Vehicle load Size (kg) (v)**: It is the quantum of waste which the aforementioned vehicles can transport in one trip. It is four times the size of the sorting samples i.e 360- 540 kg

d. **Duration of sampling (No of Days) (k)**: It is the number of days during which waste samples for analysis have to be collected.

2.1 Equipment Requirements for conducting assessment as per SOP for a typical city

As per the SOP, Cone & Quarter method is to be followed for conducting the assessment. Following are the requirements for conducting the assessment as per SOP for a typical city

(a) **Equipment Required for collection, segregation, and measurement**: Collection bins of 12-80 L capacity are used for storing waste

(b) **Sorting of waste**: Tarpaulin sheets to create clean and designated sorting areas, minimizing contamination and aiding systematic segregation

(c) **Weighing of waste**: Digital weighing machines 25-50 kg capacity with 1-10 gm accuracy ensure precise weight measurements.

(d) **Safety of persons deployed**: Personal Protective Equipment (PPE) kits to be provided to all personnel involved to ensure safety and hygiene during waste handling activities.

The above equipment's required for assessment are illustrated in **Figure 1 to 4** below

Total expenditure for procuring and utilizing the required equipment and materials is estimated at Rs.1,00,000/- (One lac only). Additionally, 50-75 persons have to be deployed for the period of assessment (5-7 days as per the SOP).



Fig 1: Collection bins of different Capacities



fig 2: PPE kits for waste handling



Fig 3: Digital Weighing machine



Fig 4: Tarpaulin Sheets

3.0 City wise Assessment & Characterization of Plastic Waste

Assessment has been conducted in 8 cities namely Vijayawada, Bhopal, Kolkata, Shillong, Vadodara, Mysore, Pune, and Lucknow

3.1 City wise duration, sample sizes, and number of vehicles to be sampled

The details of the aforementioned parameters S, K and n for the eight cities is given in **Table 1.0**

Table 1.0: City wise sample sizes (kg)(s), duration of Assessment (K days) and number of vehicles to be sampled (n)

S.No.	City	Duration of Assessment (K Days)	Sorting Sample Size (s Kg)	No. of Vehicles to be sampled (n)s
1	**Vijayawada**	7	120	30
2	**Kolkata**	6	100-150	48
3	**Bhopal**	5	85-150	45
4	**Vadodara**	2	120-130	6
5	**Shillong**	6	120	45
6	**Mysuru**	4	73-230	54
7	**Pune**	5	140-565	38
8	**Lucknow**	8	100-140	45

3.2 City wise Distribution of Zones & Wards

As per the SOP, a three-stage random sampling method is to be used to cover the city geographically and account for socio-economic variation in waste generation. Stage 1 divides the city into five zones: East, West, North, South, and Central. Stage 2 classifies the wards in each zone into five categories based on socio-economic characteristics: high-income (HI), middle-income (MI), economically weaker sections (EWS) or slums, commercial wards (CW), and mixed commercial-residential wards (MX). One disposal point is to be identified in each zone. Stage 3 distributes the number of vehicle loads to be collected across the wards to ensure all socio-economic categories are adequately represented. The samples from each category and zone will be evenly distributed over the assessment period (k days).

City wise distribution of Zones & Wards is given in **Table 2.0**

Table 2: City wise Distribution of Zones & Wards

S.No.	City	No. of Zones	No. of Wards
1	**Vijayawada**	3	NA
2	**Kolkata**	4	18
3	**Bhopal**	4	35
4	**Vadodara**	NA	NA
5	**Shillong**	4	27
6	**Mysuru**	9	54
7	**Pune**	5	15
8	**Lucknow**	4	14

4.0 City wise Reports

4.1 Vijayawada

The quantity of mixed waste generated in the city is approx. 300000 TPA and the quantity of mixed waste disposed is about 219000 TPA. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total of 3360 Kg of Samples (mixed waste) were collected from generation point and 240 Kg of samples were collected from the disposal point with each sample sorting size of 120 kg. The analysis of plastic waste, plastic packaging & SUP at both generation and disposal points are given in subsequent sections.

- **Plastic Packaging**

The total quantity of Plastic Packaging waste at generation point and disposal point is summarized in **Table 3 and Table 4** respectively.

Table 3: Plastic Packaging Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	3360	
2.	Total Plastic Waste generation	328	29288
3. Plastic Packaging Generated			
3(a)	Category I	52.556	4692.5
3(b)	Category II	132.17	11800.89
3(c)	Category III	62.65	5593.75
3(d)	Category IV	0.87	77.67857143
Total Plastic Packaging Generated		**248**	**22164**

A pie chart representation of the category-wise plastic packaging waste generated in Vijayawada is given in **Fig 5** below.

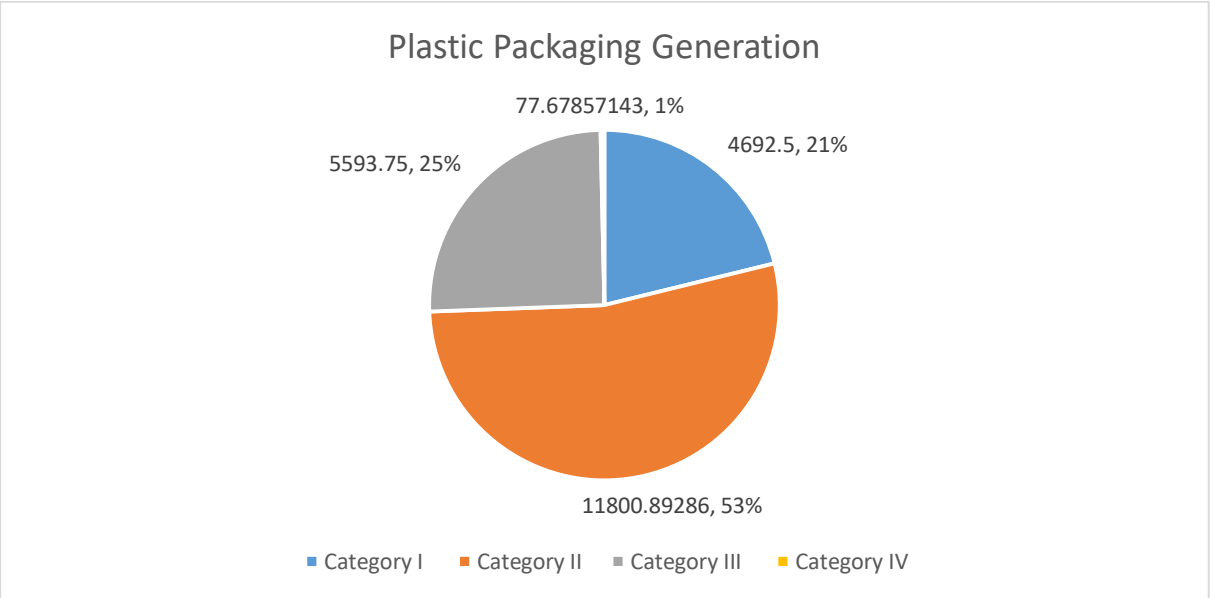


Fig 5: Category-wise distribution of Plastic Packaging generation in Vijayawada

Table 4: Plastic Packaging Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	240	
2	**Total Plastic Waste disposed**	11	9828
3 Plastic Packaging disposed			
3(a)	**Category I**	2.065	1884.3125
3(b)	**Category II**	3.67	3348.875
3(c)	**Category III**	0.58	529.25
3(d)	**Category IV**	0	0
Total Plastic Packaging disposed		**6**	**5762**

A pie chart representation of the category-wise plastic packaging waste disposed in Vijayawada is given in **Fig 6** below.

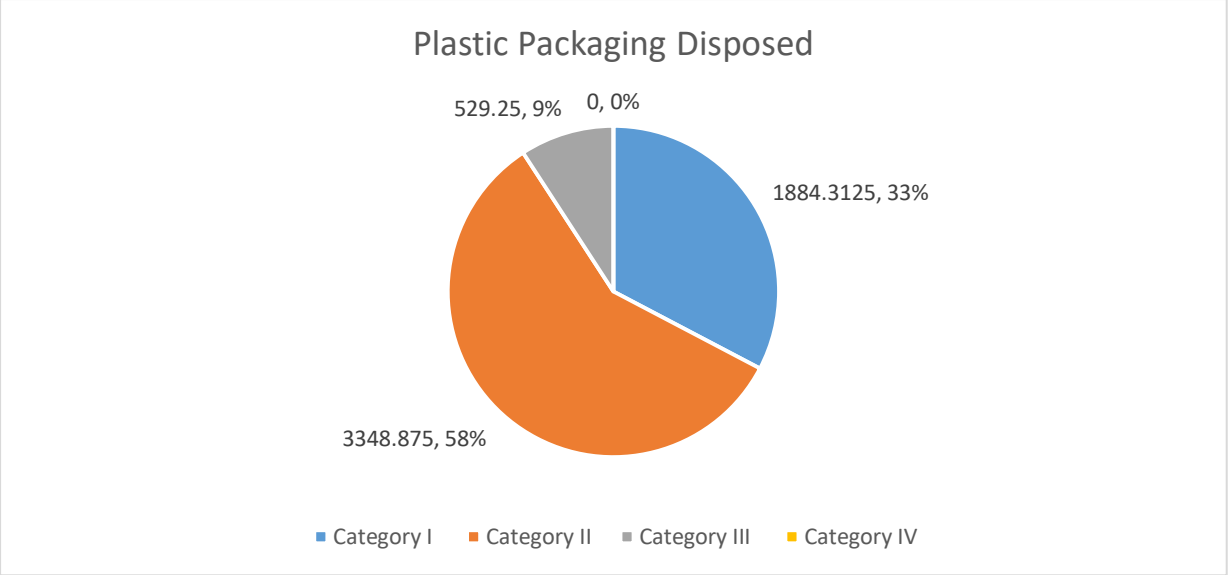


Fig 6: Category-wise distribution of Plastic Packaging disposed in Vijayawada

- **Analysis of Single Use Plastic**

The total quantity of SUP waste at generation point and disposal point in Vijayawada City is summarized in **Table 5 & Table 6** respectively**.**

Table 5: Categorywise SUP Generation in Vijaywada

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	Sample Size	3360	
2	Total Plastic Waste generation	328	29288
3. SUP Generated			
3(a)	Earbuds	0.015	1.339285714
3(b)	Balloons	0	0
3(c)	Candy	0.009	0.803571429
3(d)	Icecream	0.191	17.05357143
3(e)	Straws	0.071	6.339285714
3(f)	Plates	5.077	453.3035714
3(g)	Cups	7.574	676.25
3(h)	Glass	4.103	366.3392857
3(i)	Forks	0.272	24.28571429
3(j)	Spoons	0.432	38.57142857
3(k)	Knives	0.022	1.964285714
3(l)	Trays	1.924	171.7857143
3(m)	Sweet Boxes	4.02	358.9285714
3(n)	Invitation Cards	0.79	70.53571429
3(o)	Cigarette Packets	1.305	116.5178571
3(p)	Carry Bags < 120 microns	50.591	4517.053571
3(q)	Plastic Sheet < 50 microns	2.513	224.375
3(r)	Plastic Flags	0	0

3(s)	**PVC Banners < 100 microns**	0.3	26.78571429
3(t)	**Polystyrene for decoration**	0.185	16.51785714
Total SUP Generated		**79**	**7089**

The category-wise distribution of SUP waste generated in Vijayawada is depicted in the bar graph shown in **Fig 7.**

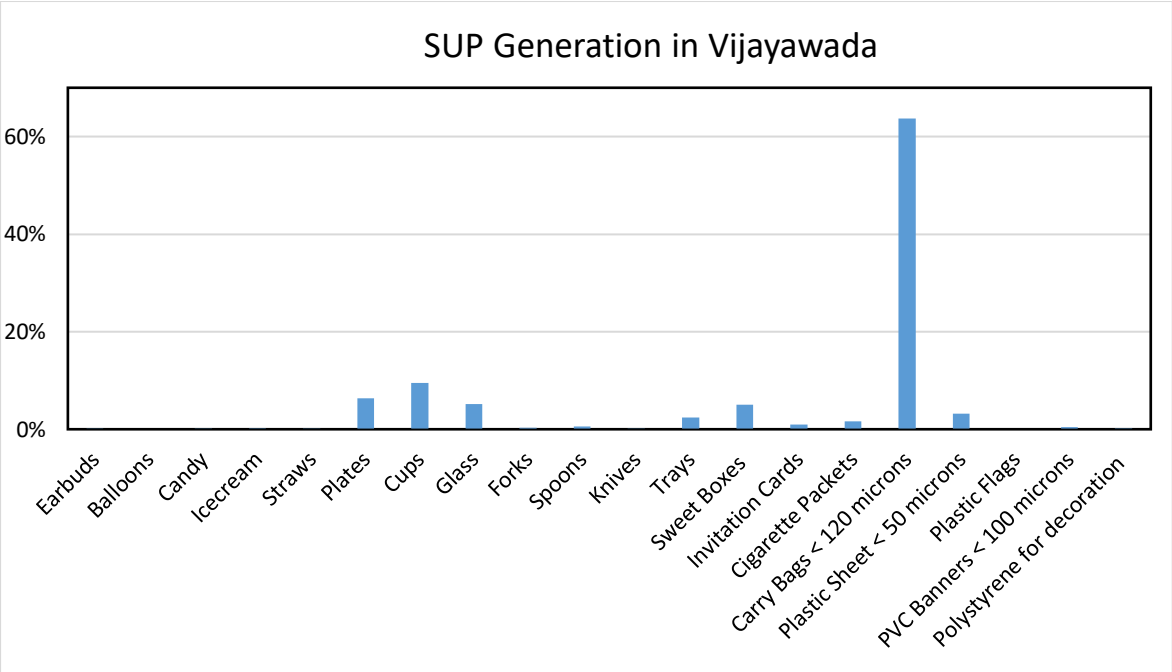


Fig 7: Category-wise distribution of SUP generated in Vijayawada

Table 6: Categorywise SUP Disposal in Vijaywada

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	240	
2	**Total Plastic Waste disposed**	11	9828
3. SUP Disposal			
3(a)	**Earbuds**	0.001	0.9125
3(b)	**Balloons**	0	0
3(c)	**Candy**	0	0
3(d)	**Icecream**	0.006	5.475
3(e)	**Straws**	0.001	0.9125
3(f)	**Plates**	0.17	155.125
3(g)	**Cups**	0.11	100.375
3(h)	**Glass**	0.03	27.375
3(i)	**Forks**	0.013	11.8625
3(j)	**Spoons**	0.004	3.65
3(k)	**Knives**	0	0
3(l)	**Trays**	0.12	109.5

3(m)	**Sweet Boxes**	0.065	59.3125
3(n)	**Invitation Cards**	0	0
3(o)	**Cigarette Packets**	0.007	6.3875
3(p)	**Carry Bags < 120 microns**	3.7	3376.25
3(q)	**Plastic Sheet < 50 microns**	0.055	50.1875
3(r)	**Plastic Flags**	0	0
3(s)	**PVC Banners < 100 microns**	0.1	91.25
3(t)	**Polystyrene for decoration**	0	0
Total SUP Disposed		**4**	**3999**

The category-wise distribution of SUP waste disposed in Vijayawada is depicted in the bar graph shown in **Fig. 8.**

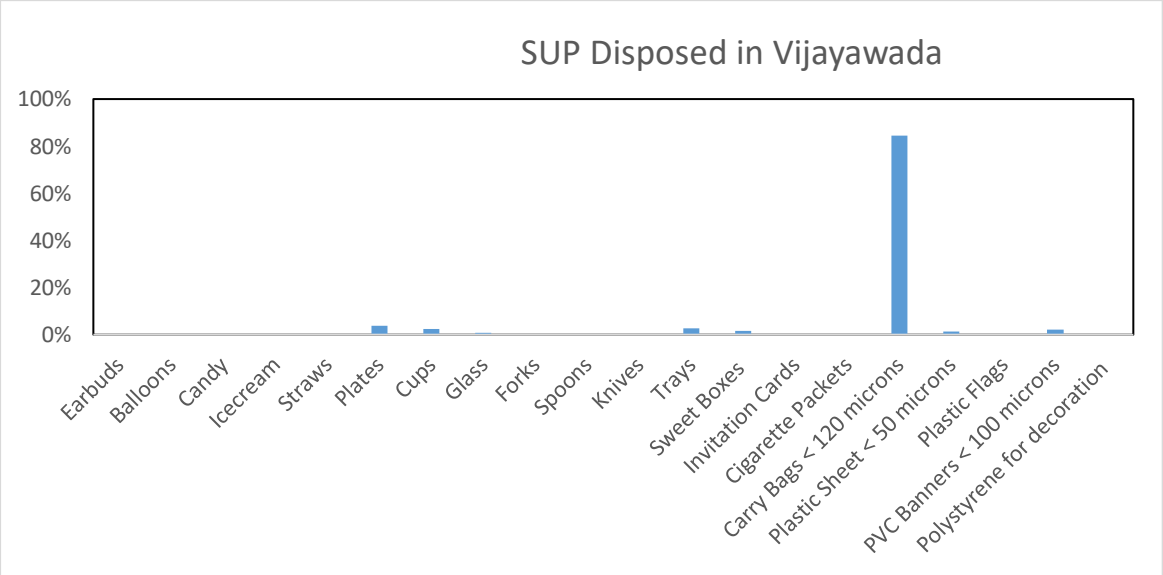


Fig 8: Category-wise distribution of SUP disposed in Vijayawada

- **Overall Analysis**

The Plastic Waste, Plastic Packaging waste & SUP generated, disposed and Segregation with potential for utilization in Vijayawada is summarized in **Table 7.**

Table 7: Plastic Waste Generation, disposal and Segregation with potential for utilization in Vijayawada

Vijaywada	Generated (kg)	Disposal (kg)	Qty Generated (TPA)	Qty. Disposed (TPA)	% Segregation with potential for utilization
Total	**328**	**11**	**29288**	**9828**	**66**
PP	248	6	22164	5762	74
SUP	79	4	7089	3999	44

Others	80	5	7123	4065	43

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in the Vijayawada city is given in **Annexure I**

4.2 Shillong

The quantity of mixed waste generated in the city is approx. 32850 TPA and the quantity of mixed waste which is being disposed in Shillong is 27010 TPA. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total of 2520 Kg Samples (mixed waste) were collected from generation point and 2880 Kg of samples were collected from the disposal point. The analysis of plastic waste, plastic packaging & SUP at both generation and disposal points are given in subsequent sections.

- **Analysis of Plastic Packaging**

The total quantity of Plastic Packaging waste at generation point and disposal point is summarized in **Table 8 and Table 9** respectively.

Table 8: Plastic Packaging Waste Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	2520	
2.	Total Plastic Waste generation	386	5029
3. Plastic Packaging Generation			
3(a)	Category I	102.752	1339.45
3(b)	Category II	111.11	1448.40
3(c)	Category III	35.995	469.22
3(d)	Category IV	0	0.00
Total Plastic Packaging Generated		**250**	**3257**

A pie chart representation of the category-wise plastic packaging waste generated in Shillong is given in **Fig 9** below.

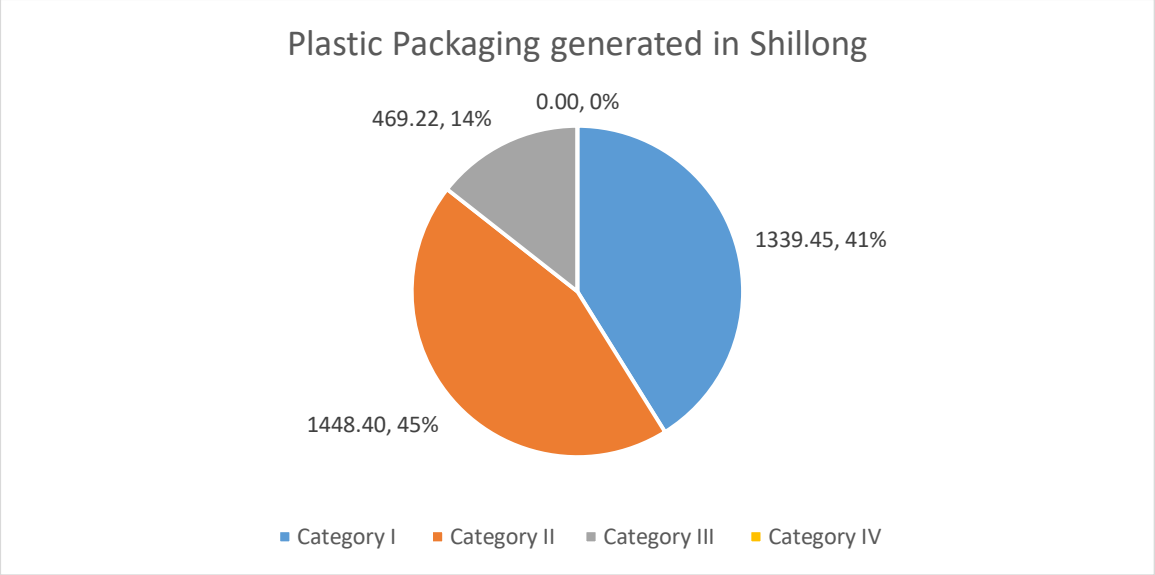


Fig 9: Category-wise plastic packaging waste generated in Shillong

Table 9: Plastic Packaging Waste Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	2880	
2.	Total Plastic Waste disposed	423	3968
3. Plastic Packaging Disposed			
3(a)	Category I	113.05	1060.24
3(b)	Category II	131.4	1232.33
3(c)	Category III	37.16	348.50
3(d)	Category IV	0	0.00
Total Plastic Packaging Disposed		**282**	**2643**

A pie chart representation of the category-wise plastic packaging waste disposed in Shillong is given in **Fig 10** below.

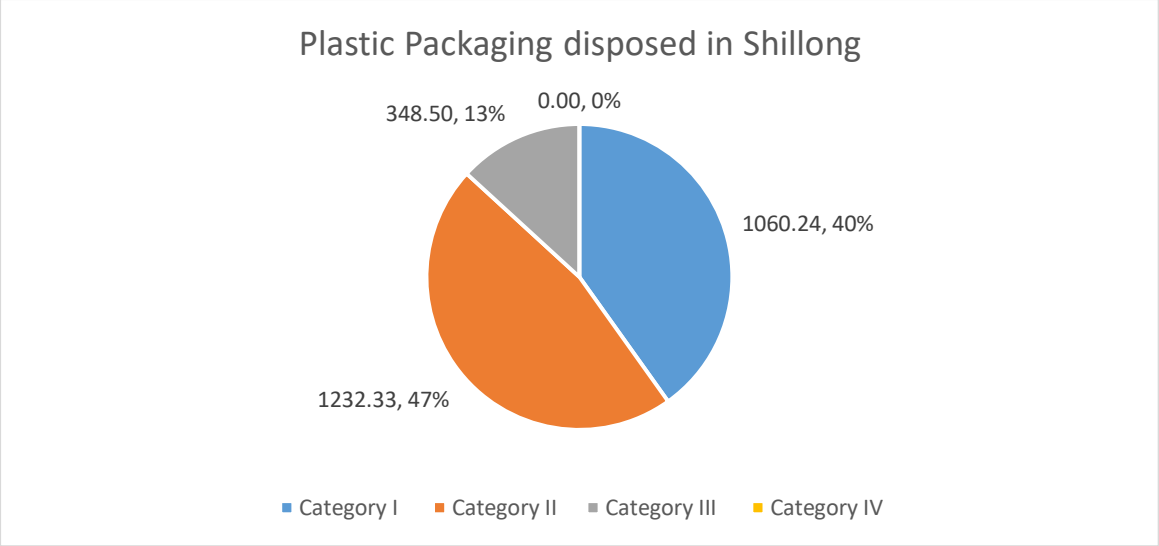


Fig 10: Category-wise plastic packaging waste disposed in Shillong

- **Analysis of SUP**

The total quantity of SUP waste at generation point and disposal point in Shillong City is summarized in **Table 10 & Table 11** respectively**.**

Table 10: SUP Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	Sample Size	2520	
2	Total Plastic Waste generation	386	5029
3.SUP Generated			
3(a)	Earbuds	0.002	0.03
3(b)	Balloons	0	0.00
3(c)	Candy	0	0.00
3(d)	Icecream	0.005	0.07
3(e)	Straws	0.121	1.58
3(f)	Plates	0.29	3.78
3(g)	Cups	1.18	15.38
3(h)	Glass	0.27	3.52
3(i)	Forks	0.417	5.44
3(j)	Spoons	0.79	10.30
3(k)	Knives	0.143	1.86
3(l)	Trays	0	0.00
3(m)	Sweet Boxes	0.11	1.43
3(n)	Invitation Cards	0	0.00
3(o)	Cigarette Packets	0.385	5.02
3(p)	Carry Bags < 120 microns	90.605	1181.10

3(q)	**Plastic Sheet < 50 microns**	39.81	518.95
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	1.802	23.49
Total SUP Generated		**136**	**1772**

The category-wise distribution of SUP waste generated in Shillong is depicted in the bar graph shown in **Fig 11.**

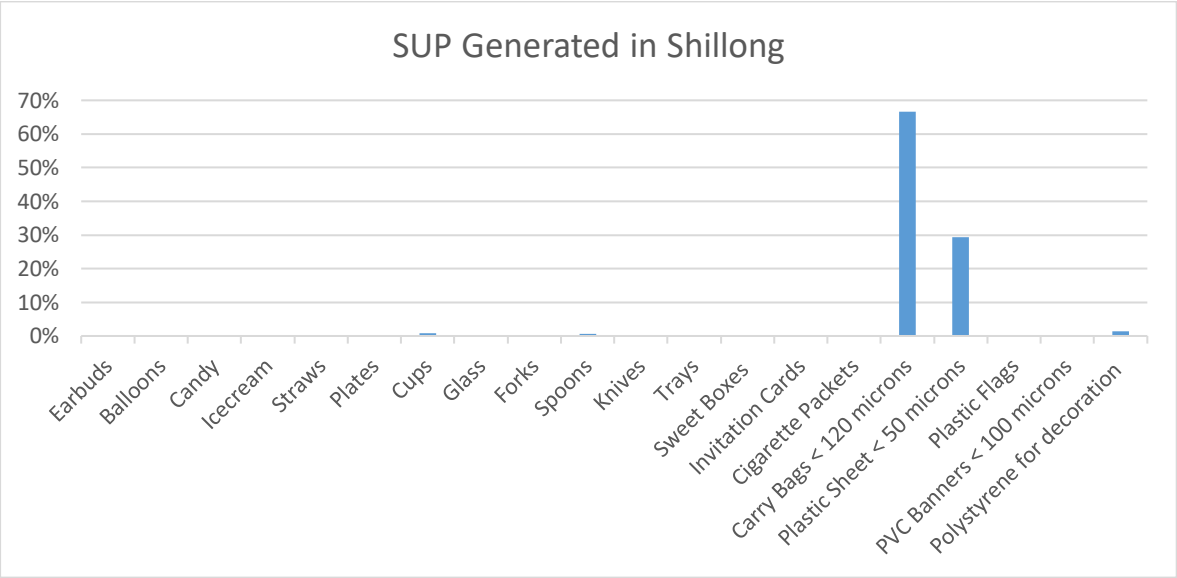


Fig 11: Category-wise plastic packaging waste generated in Shillong

Table 11: SUP Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	2880	
2	**Total Plastic Waste Disposed**	423	3968
3.SUP Disposed			
3(a)	**Earbuds**	0.008	0.08
3(b)	**Balloons**	0	0.00
3(c)	**Candy**	0	0.00
3(d)	**Icecream**	0	0.00
3(e)	**Straws**	0.065	0.61
3(f)	**Plates**	0.66	6.19
3(g)	**Cups**	0.983	9.22
3(h)	**Glass**	0.58	5.44
3(i)	**Forks**	0.518	4.86
3(j)	**Spoons**	1.022	9.58
3(k)	**Knives**	0.085	0.80

3(l)	**Trays**	0	0.00
3(m)	**Sweet Boxes**	0.059	0.55
3(n)	**Invitation Cards**	0	0.00
3(o)	**Cigarette Packets**	0.516	4.84
3(p)	**Carry Bags < 120 microns**	98.528	924.04
3(q)	**Plastic Sheet < 50 microns**	32.345	350.24
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	1.139	10.68
Total SUP Generated		**136**	**1275**

The category-wise distribution of SUP waste disposed in Shillong is depicted in the bar graph shown in **Fig 12.**

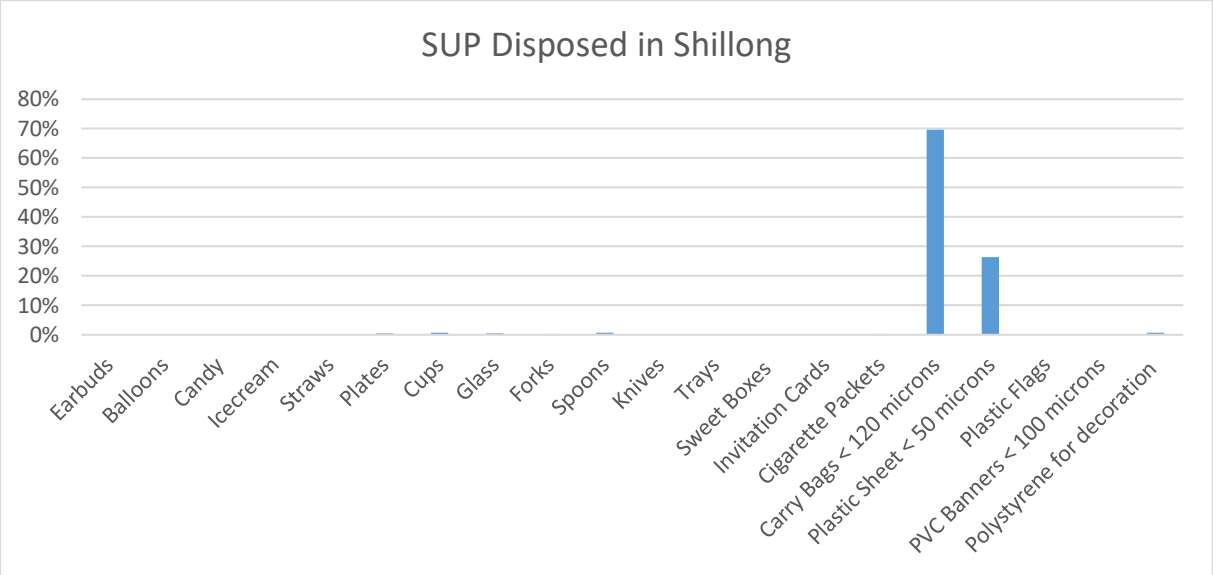


Fig 12: Category-wise plastic packaging waste disposed in Shillong

- **Overall Analysis**

The Plastic Waste, Plastic Packaging waste & SUP generated and disposed in Shillong is summarized in **Table 12.**

Table 12: Plastic Waste Generation, disposal and Segregation with potential for utilization in Shillong

Shillong	Generated (kg)	Disposal (kg)	Qty Generated (TPA)	Qty. Disposed (TPA)	% Segregation with potential for utilization
Total	386	423	5029	3968	21
PP	250	282	3257	2643	19

SUP	136	136	1772	1275	28
Others	136	141	1772	1325	25

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in the Shillong city is given in **Annexure II.**

4.3 Bhopal

The quantity of mixed waste generated in the city is approx. 292000 TPA. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total of 3853 Kg Samples (mixed waste) were collected from generation point and 1080 Kg of samples were collected from the disposal point. The analysis of plastic waste, plastic packaging & SUP at both generation and disposal points are given in subsequent sections.

- **Analysis of Plastic Packaging**

The total quantity of Plastic Packaging waste at generation point and disposal point is summarized in **Table 13 and Table 14** respectively.

Table 13: Plastic Packaging Waste Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	**Sample Size**	3853	
2.	**Total Plastic Waste generation**	530	40166
3. Plastic Packaging Generation			
3(a)	**Category I**	156	11800.48
3(b)	**Category II**	107.33	8134.02
3(c)	**Category III**	187.75	14195.65
3(d)	**Category IV**	3.6	272.83
Total Plastic Packaging Generated		**454**	**34406**

A pie chart representation of the category-wise plastic packaging waste generated in Bhopal is given in **Fig. 13** below.

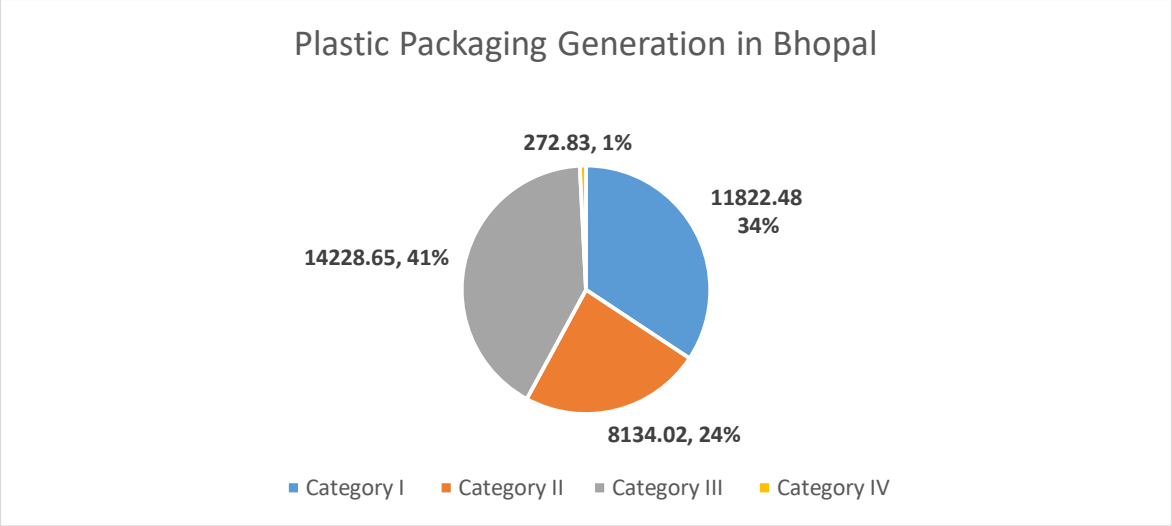


Fig 13: Category-wise plastic packaging waste generated in Bhopal

Table 14: Plastic Packaging Waste Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	1080	
2.	Total Plastic Waste disposed	61	16444
3. Plastic Packaging disposed			
3(a)	Category I	2.81	759.74
3(b)	Category II	14.02	3790.59
3(c)	Category III	33.31	9006.04
3(d)	Category IV	0.08	21.63
Total Plastic Packaging Disposed		**50**	**13578**

A pie chart representation of the category-wise plastic packaging waste disposed in Bhopal is given in **Fig. 14** below.

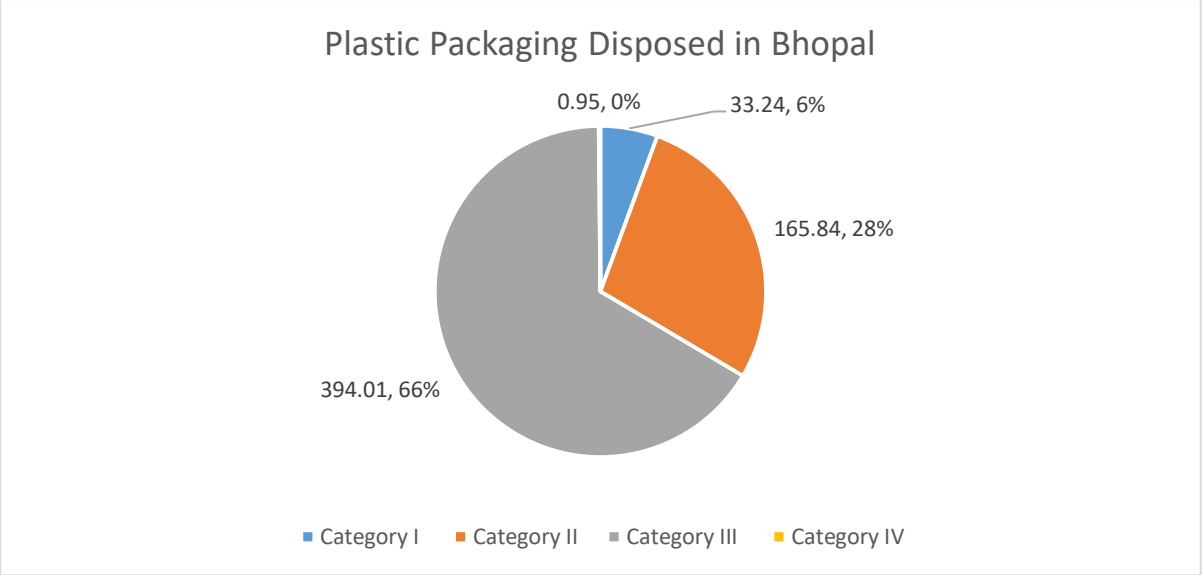


Fig 14: Category-wise plastic packaging waste disposed in Bhopal

- **Analysis of SUP**

The total quantity of SUP waste at generation point and disposal point in Bhopal City is summarized in **Table 15 & Table 16** respectively**.**

Table 15: SUP Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	3853	
2	**Total Plastic Waste generation**	30	40166
3. SUP Generated			
3(a)	**Earbuds**	0.038	2.88
3(b)	**Balloons**	0.065	4.93
3(c)	**Candy**	0.044	3.33
3(d)	**Icecream**	0	0.00
3(e)	**Straws**	0.084	6.37
3(f)	**Plates**	0.35	26.52
3(g)	**Cups**	0.056	4.24
3(h)	**Glass**	1.63	123.53
3(i)	**Forks**	0.145	10.99
3(j)	**Spoons**	0.227	17.20
3(k)	**Knives**	0	0.00
3(l)	**Trays**	0.339	25.69
3(m)	**Sweet Boxes**	0.7	53.05
3(n)	**Invitation Cards**	0	0.00
3(o)	**Cigarette Packets**	0	0.00

3(p)	**Carry Bags < 120 microns**	50.87	3855.19
3(q)	**Plastic Sheet < 50 microns**	20.6	1561.17
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	0	0.00
Total SUP Generated		**75**	**5697**

The category-wise distribution of SUP waste generated in Bhopal is depicted in the bar graph shown in **Fig 15.**

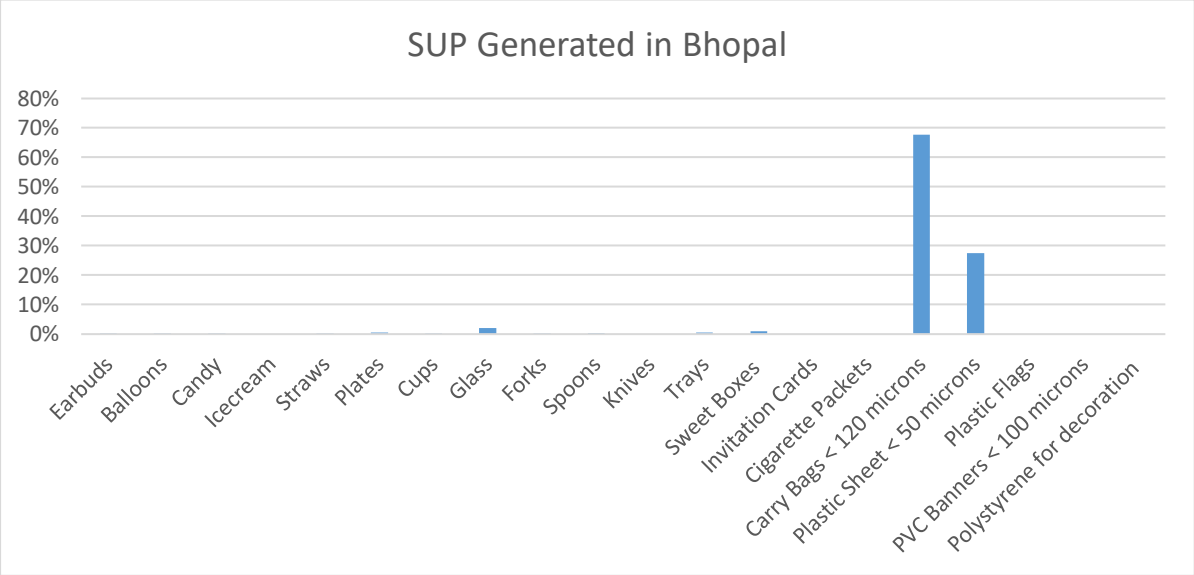


Fig 15: Category-wise distribution of SUP generated in Bhopal

Table 16: SUP Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	1080	
2	**Total Plastic Waste Disposed**	61	16444
3. SUP Disposed			
3(a)	**Earbuds**	0	0.00
3(b)	**Balloons**	0	0.00
3(c)	**Candy**	0	0.00
3(d)	**Icecream**	0	0.00
3(e)	**Straws**	0.006	1.622
3(f)	**Plates**	0	0.00
3(g)	**Cups**	0.011	2.974
3(h)	**Glass**	0.04	10.815
3(i)	**Forks**	0.01	2.704

3(j)	**Spoons**	0.015	4.056
3(k)	**Knives**	0	0.00
3(l)	**Trays**	0.042	11.35
3(m)	**Sweet Boxes**	0	0.00
3(n)	**Invitation Cards**	0	0.00
3(o)	**Cigarette Packets**	0	0.00
3(p)	**Carry Bags < 120 microns**	8.47	2290
3(q)	**Plastic Sheet < 50 microns**	1	270.37
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	0	0.00
Total SUP Disposed		**10**	**2594**

The category-wise distribution of SUP waste disposed in Bhopal is depicted in the bar graph shown in **Fig 16.**

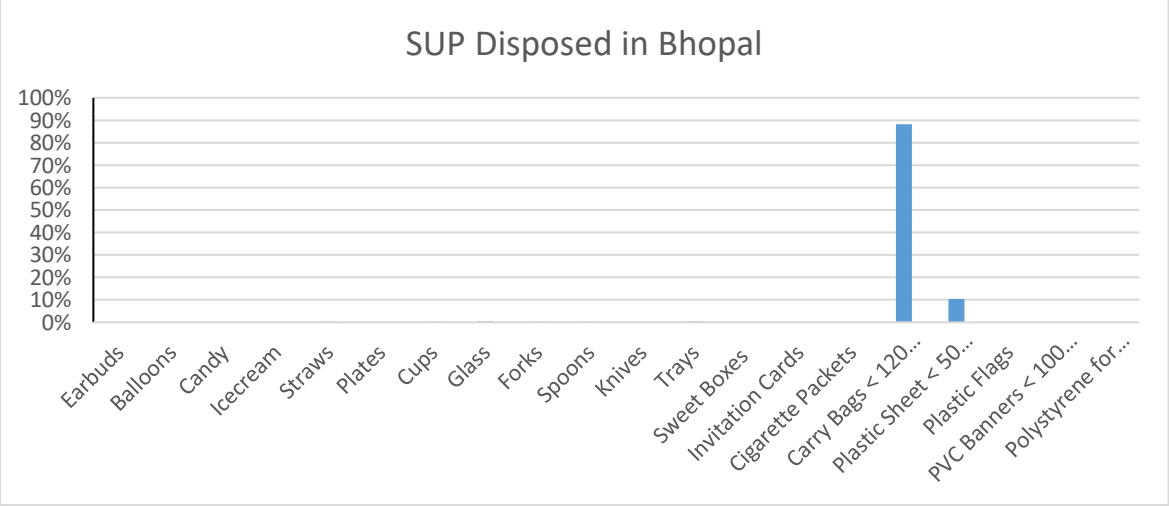


Fig 16: Category-wise distribution of SUP disposed in Bhopal

- **Overall Analysis**

The Plastic Waste, Plastic Packaging waste & SUP generated, disposed and Segregation with potential for utilization in Bhopal is summarized in **Table 17.**

Table 17: Plastic Waste Generation, disposal and Segregation with potential for utilization in Bhopal

Bhopal	Generated (Kg)	Disposal (Kg)	Qty Generated (TPA)	Qty. Disposed (TPA)	% Segregation with potential for utilization
Total	530	61	40166	16444	59
PP	454	50	34406	13578	61
SUP	75	10	5697	2594	54
Others	76	11	5760	2866	50

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in the Bhopal city is given in **Annexure III.**

4.4 Kolkata

The quantity of mixed waste generated in the city is approx. 195030.58 TPA and the same quantity of mixed waste is being disposed in Kolkata. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total of 2115 Kg Samples (mixed waste) were collected from generation point and 2434 Kg of samples were collected from the disposal point. The analysis of plastic waste, plastic packaging & SUP at both generation and disposal points are given in subsequent sections.

- **Analysis of Plastic Packaging**

The total quantity of Plastic Packaging waste at generation point and disposal point is summarized in **Table 18 and Table 19** respectively.

Table 18: Plastic Packaging Waste Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	**Sample Size**	2115	
2.	**Total Plastic Waste generation**	407	37497
3. Plastic Packaging Generation			
3(a)	**Category I**	39.52	3644.26
3(b)	**Category II**	135.53	12497.63
3(c)	**Category III**	73.59	6785.96
3(d)	**Category IV**	0.009	0.83
Total Plastic Packaging Generated		**249**	**22928**

A pie chart representation of the category-wise plastic packaging waste generated in Kolkata is given in **Fig 17** below.

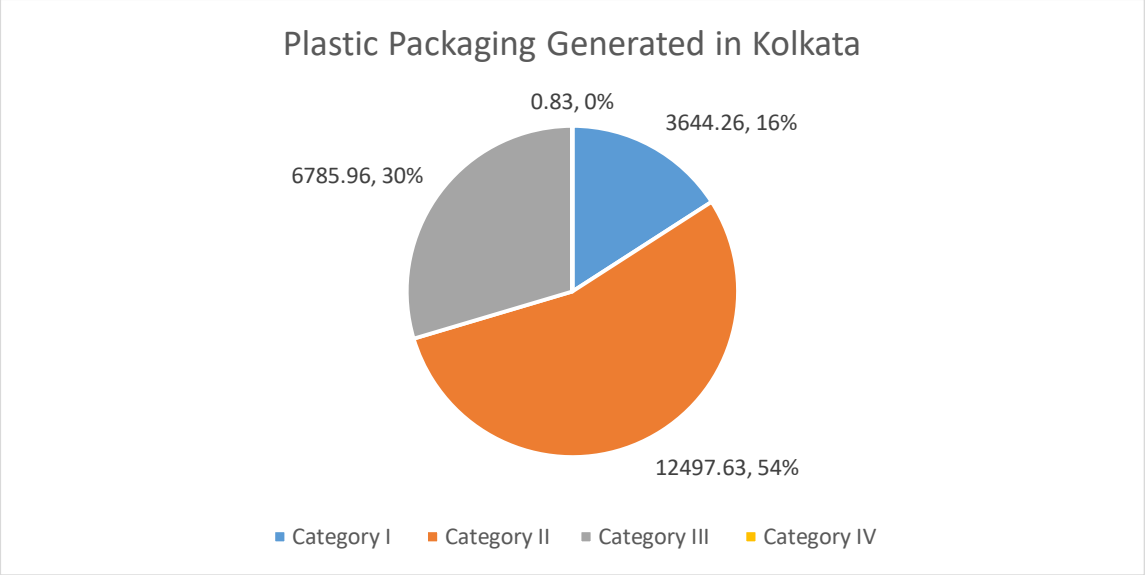


Fig 17: Category-wise plastic packaging waste generated in Kolkata

Table 19: Plastic Packaging Waste Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	**Sample Size**	2434	
2.	**Total Plastic Waste disposed**	424	33960
3.Plastic Packaging Disposed			
3(a)	**Category I**	26.6	2131.39
3(b)	**Category II**	140.82	11283.57
3(c)	**Category III**	94.27	7553.63
3(d)	**Category IV**	0.02	1.60
Total Plastic Packaging Disposed		**262**	**20980**

A pie chart representation of the category-wise plastic packaging waste disposed in Kolkata is given in **Fig 18** below.

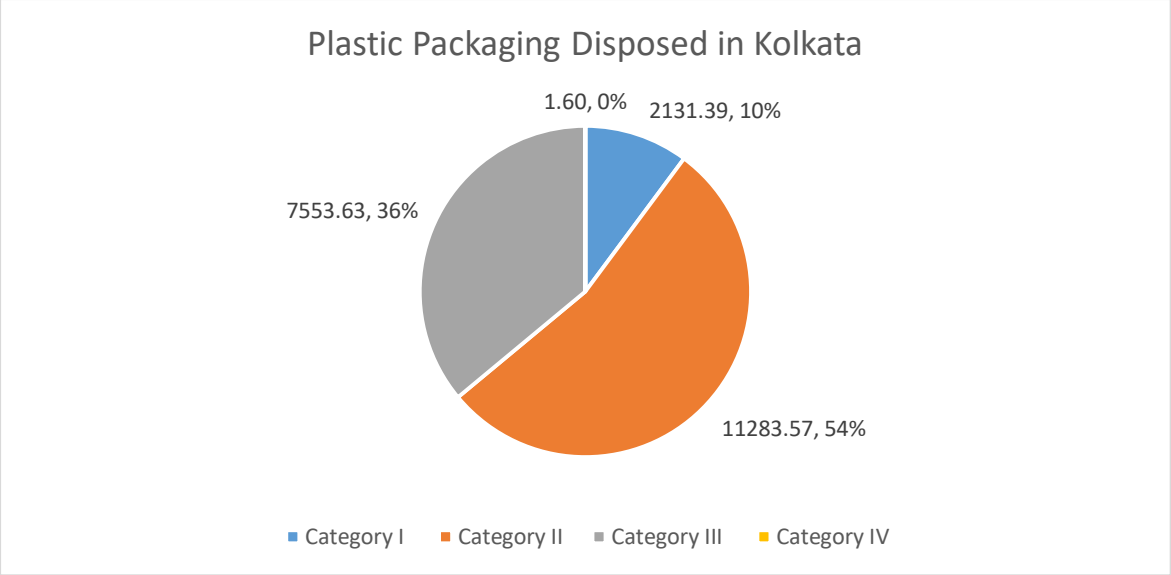


Fig 18: category-wise plastic packaging waste disposed in Kolkata

- **Analysis of SUP**

The total quantity of SUP waste at generation point and disposal point in Kolkata City is summarized in **Table 20 & Table 21** respectively**.**

Table 20: SUP Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	2115	
2	**Total Plastic Waste generation**	248.77	22939.84
3.SUP Generated			
3(a)	**Earbuds**	0	0.00
3(b)	**Balloons**	0	0.00
3(c)	**Candy**	0	0.00
3(d)	**Icecream**	0	0.00
3(e)	**Straws**	0.521	48.04
3(f)	**Plates**	0.983	90.65
3(g)	**Cups**	2.861	263.82
3(h)	**Glass**	2.147	197.98
3(i)	**Forks**	0.075	6.92
3(j)	**Spoons**	0.244	22.50
3(k)	**Knives**	0.12	11.07
3(l)	**Trays**	4.845	446.77
3(m)	**Sweet Boxes**	2.691	248.15
3(n)	**Invitation Cards**	1.757	162.02
3(o)	**Cigarette Packets**	6.771	624.37
3(p)	**Carry Bags < 120 microns**	130.48	12031.96

3(q)	**Plastic Sheet < 50 microns**	2.37	218.54
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	2.062	190.14
Total SUP Generated		**157.927**	**14562.93**

The category-wise distribution of SUP waste generated in Kolkata is depicted in the bar graph shown in **Fig 19.**

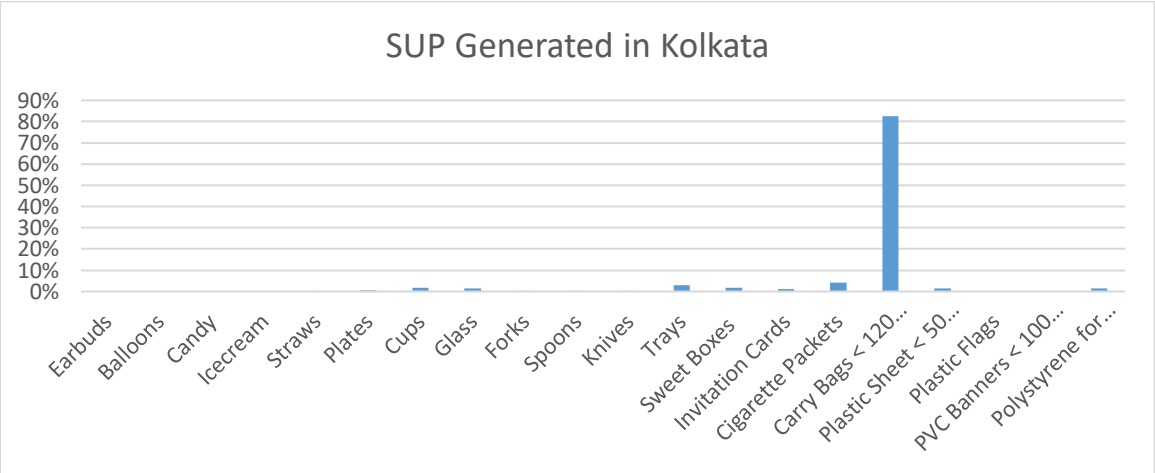


Fig 19: Category-wise distribution of SUP generated in Kolkata

Table 21: SUP Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	2434	
2	**Total Plastic Waste Disposed**	261.83	20979.81
3.SUP Disposed			
3(a)	**Earbuds**	0	0.00
3(b)	**Balloons**	0	0.00
3(c)	**Candy**	0	0.00
3(d)	**Icecream**	0.004	0.32
3(e)	**Straws**	0.115	9.21
3(f)	**Plates**	1.188	95.19
3(g)	**Cups**	2.236	179.17
3(h)	**Glass**	3.246	260.09
3(i)	**Forks**	0.09	7.21
3(j)	**Spoons**	0.367	29.41
3(k)	**Knives**	0.028	2.24
3(l)	**Trays**	3.232	258.97
3(m)	**Sweet Boxes**	3.578	286.70
3(n)	**Invitation Cards**	4.285	343.35
3(o)	**Cigarette Packets**	1.41	112.98

3(p)	**Carry Bags < 120 microns**	141.02	11299.60
3(q)	**Plastic Sheet < 50 microns**	0.662	53.04
Total SUP Disposed		**161.461**	**12937.48**

The category-wise distribution of SUP waste disposed in Kolkata is depicted in the bar graph shown in **Fig 20.**

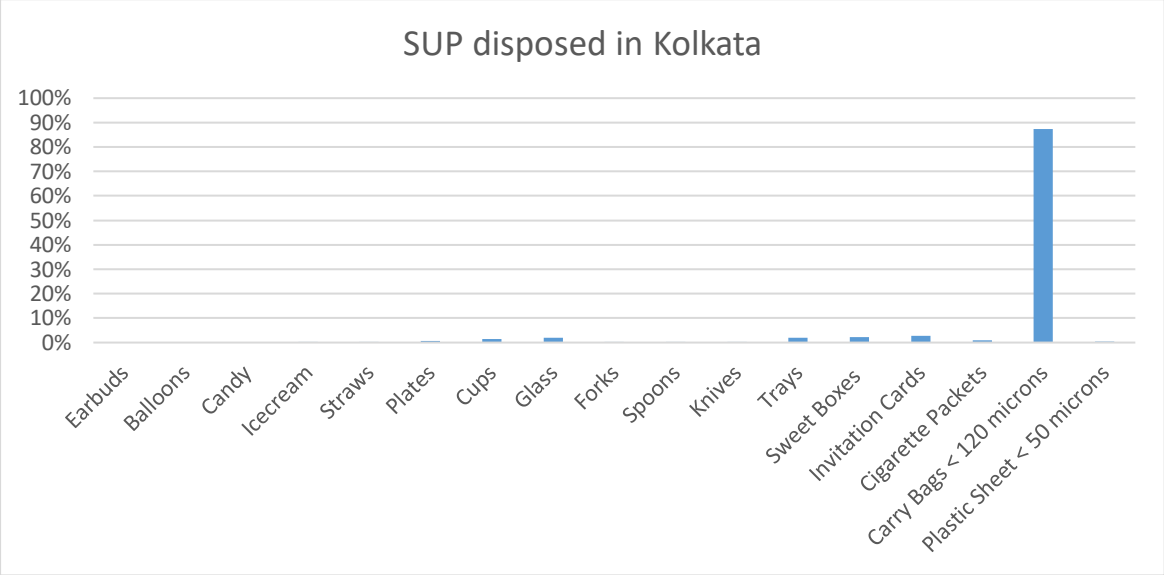


Fig 20: Category-wise distribution of SUP disposed in Kolkata

- **Overall Analysis**

The Plastic Waste, Plastic Packaging waste & SUP generated and disposed in Kolkata is summarized in **Table 22.**

Table 22: Plastic Waste Generation, disposal and Segregation with potential for utilization in Kolkata

Kolkata	Generated (kg)	Disposal (kg)	Qty Generated (TPA)	Qty. Disposed (TPA)	% Segregation with potential for utilization
Total	407	424	37497	33960	9
PP	249	262	22928	20980	8
SUP	157	161	14477	12901	11
Others	158	162	14570	12981	11

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in the Kolkata city is given in **Annexure IV.**

4.5 Pune

The quantity of mixed waste generated in the city is approx. 839500 TPA and 11753 TPA quantity of mixed waste is being disposed in Pune. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total of 5696 Kg Samples (mixed waste) were collected from generation point and 1263 Kg of samples were collected from the disposal point. The analysis of plastic waste, plastic packaging & SUP at both generation and disposal points are given in subsequent sections.

- **Analysis of Plastic Packaging**

The total quantity of Plastic Packaging waste at generation point and disposal point is summarized in **Table 23 and Table 24** respectively.

Table 23: Plastic Packaging Waste Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	5696	
2.	Total Plastic Waste generation	408.44	60197.57
3.Plastic Packaging Generated			
3(a)	Category I	59.73	8803.25
3(b)	Category II	229.045	33757.60
3(c)	Category III	63.41	9345.63
3(d)	Category IV	9.85	1451.73
Total Plastic Packaging Generated		**362**	**53353**

A pie chart representation of the category-wise plastic packaging waste generated in Pune is given in **Fig 21** below.

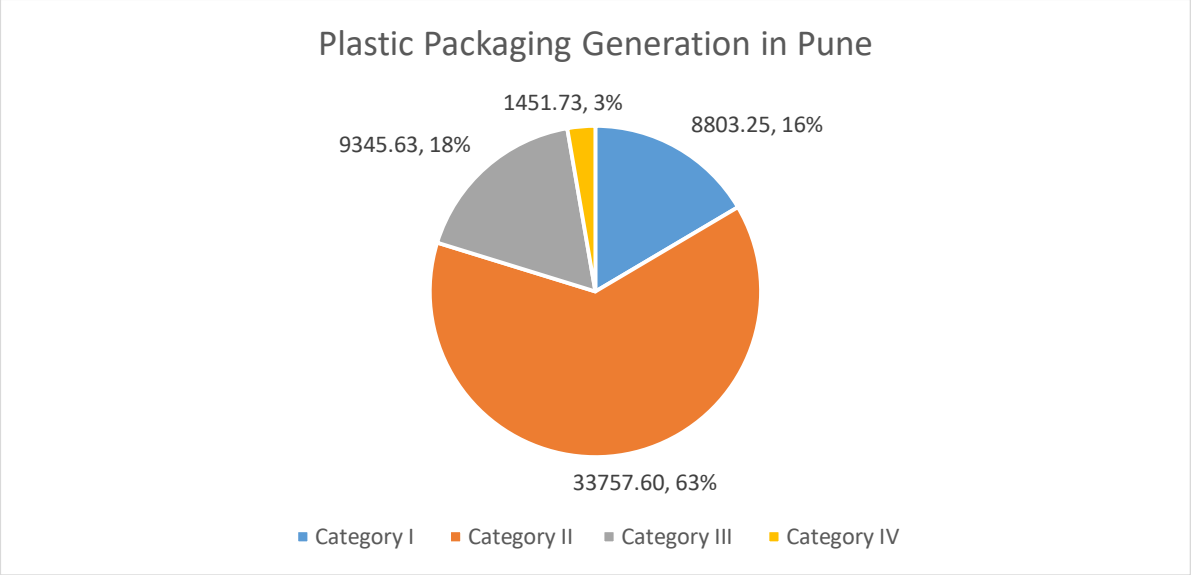


Fig 21: Category-wise plastic packaging waste generated in Pune

Table 24: Plastic Packaging Waste Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	1263	
2.	Total Plastic Waste disposed	89.96	837.13
3.Plastic Packaging Disposal			
3(a)	Category I	11.91	110.83
3(b)	Category II	38.52	358.45
3(c)	Category III	18.49	172.06
3(d)	Category IV	3.375	31.41
Total Plastic Packaging Disposed		**72**	**673**

A pie chart representation of the category-wise plastic packaging waste disposed in Pune is given in **Fig 22** below.

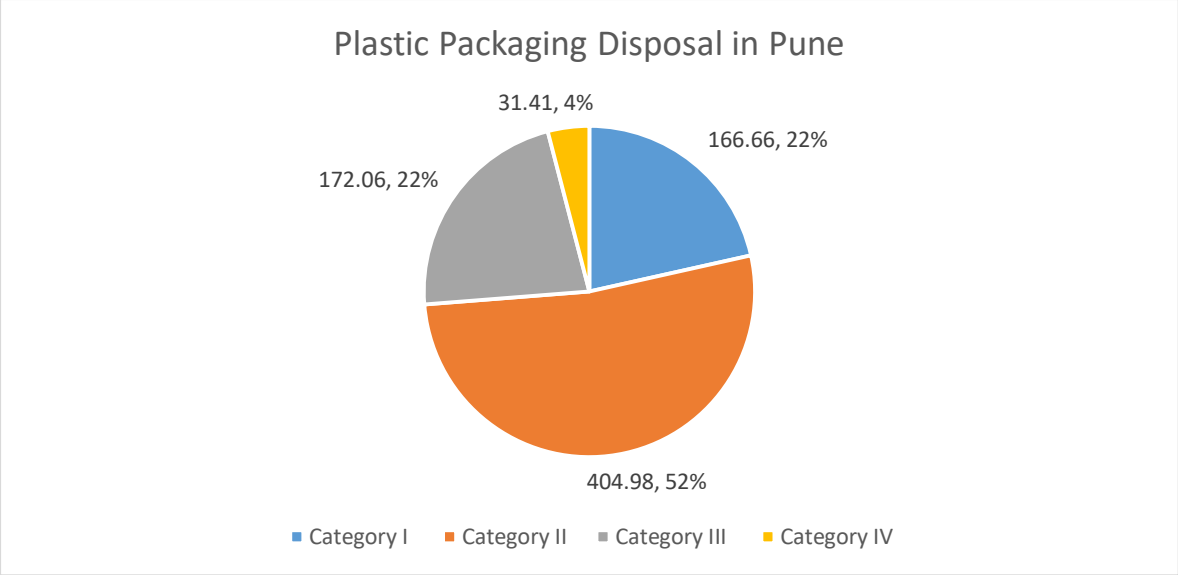


Fig 22: Category-wise plastic packaging waste disposed in Pune

- **Analysis of SUP**

The total quantity of SUP waste at generation point and disposal point in Pune City is summarized in **Table 25 & Table 26** respectively**.**

Table 25: SUP Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	5696	
2	**Total Plastic Waste generation**	408.44	60197.57
3.SUP Generated			
3(a)	**Earbuds**	0.08263	12.18
3(b)	**Balloons**	0	0.00
3(c)	**Candy**	0.0291	4.29
3(d)	**Icecream**	0.0033	0.49
3(e)	**Straws**	0.0867	12.78
3(f)	**Plates**	0.0228	3.36
3(g)	**Cups**	0.0395	5.82
3(h)	**Glass**	0.0392	5.78
3(i)	**Forks**	0.0012	0.18
3(j)	**Spoons**	0.0384	5.66
3(k)	**Knives**	0	0.00
3(l)	**Trays**	0	0.00
3(m)	**Sweet Boxes**	0.0026	0.38
3(n)	**Invitation Cards**	0	0.00
3(o)	**Cigarette Packets**	0.5267	77.63
3(p)	**Carry Bags < 120 microns**	39.87	5876.21

3(q)	**Plastic Sheet < 50 microns**	3.49325	514.85
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	0	0.00
Total SUP Generated		**44.24**	**6520**

The category-wise distribution of SUP waste generated in Pune is depicted in the bar graph shown in **Fig 23.**

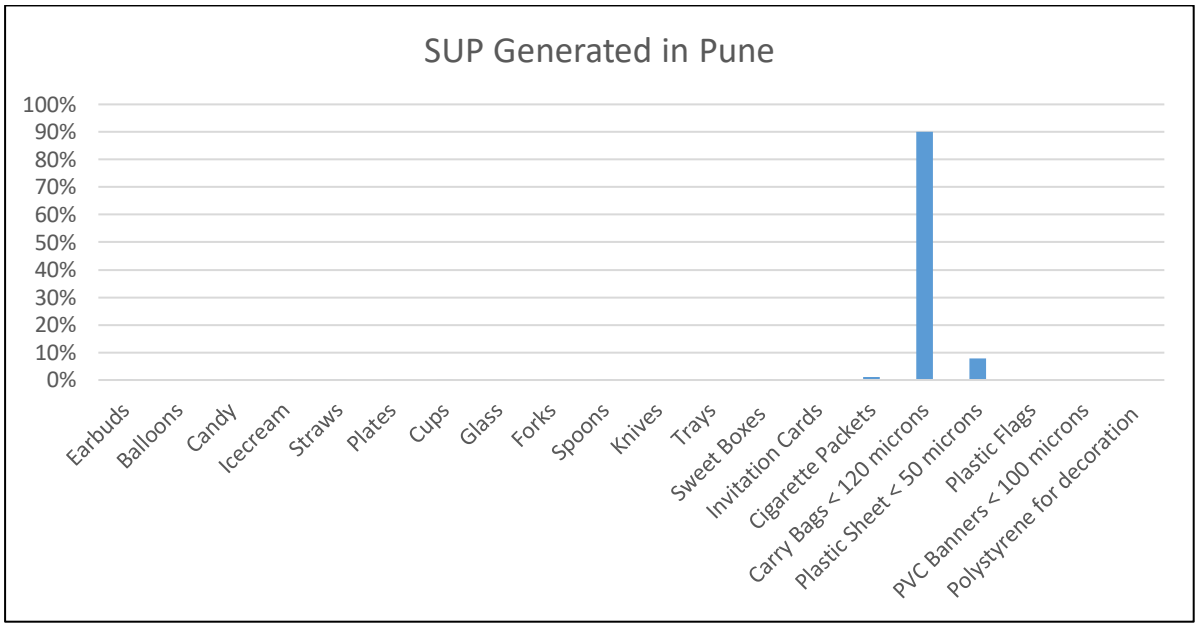


Fig 23: Category-wise distribution of SUP generated in Pune

Table 26: SUP Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	1263	
2	**Total Plastic Waste Disposed**	89.96	837.13
3.SUP Disposed			
3(a)	**Earbuds**	0.0113	0.11
3(b)	**Balloons**	0	0.00
3(c)	**Candy**	0.0031	0.03
3(d)	**Icecream**	0	0.00
3(e)	**Straws**	0.02373	0.22
3(f)	**Plates**	0.0027	0.03
3(g)	**Cups**	0	0.00
3(h)	**Glass**	0.0003	0.00
3(i)	**Forks**	0	0.00

3(j)	**Spoons**	0.00335	0.03
3(k)	**Knives**	0	0.00
3(l)	**Trays**	0	0.00
3(m)	**Sweet Boxes**	0	0.00
3(n)	**Invitation Cards**	0	0.00
3(o)	**Cigarette Packets**	0.005	0.05
3(p)	**Carry Bags < 120 microns**	14.32	133.26
3(q)	**Plastic Sheet < 50 microns**	2.86	26.61
3(r)	**Plastic Flags**	0	0.00
3(s)	**PVC Banners < 100 microns**	0	0.00
3(t)	**Polystyrene for decoration**	0	0.00
Total SUP disposed		**17**	**160**

The category-wise distribution of SUP waste disposed in Pune is depicted in the bar graph shown in **Fig 24.**

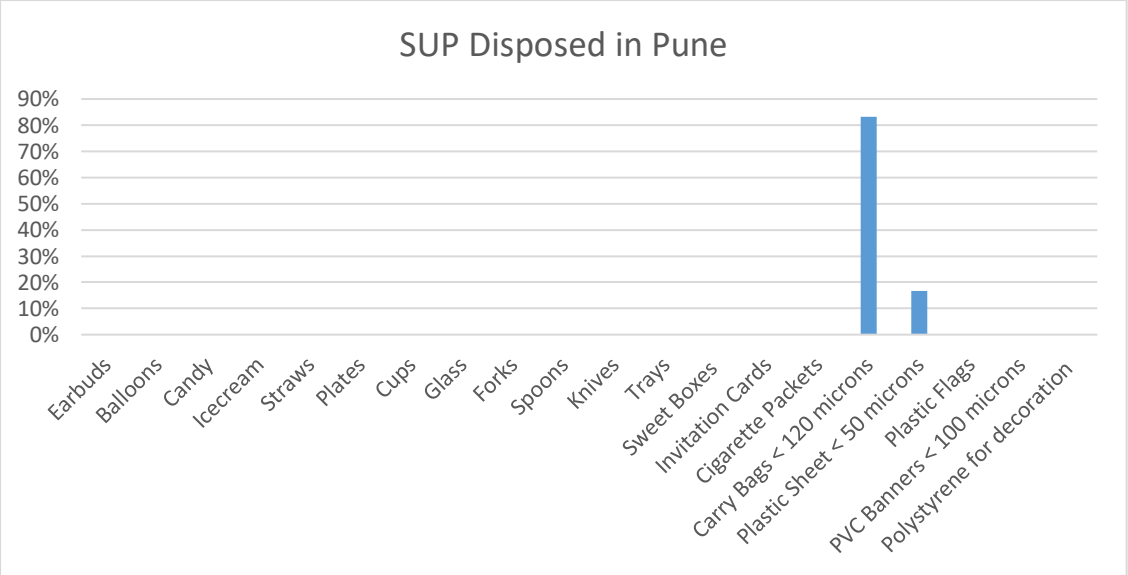


Fig 24: Category-wise distribution of SUP disposed in Pune

- **Overall Analysis**

The Plastic Waste, Plastic Packaging waste & SUP generated and disposed in Pune is summarized in **Table 27.**

Table 27: Plastic Waste Generation, disposal and Segregation with potential for utilization in Pune

Pune	Generated	Disposal	Qty Generated (TPA)	Qty. Disposed (TPA)	% Segregation with potential for utilization
Total	408	90	60198	837	99
PP	362	72	53353	673	99
SUP	44	17	6520	160	98
Others	46	18	6845	164	98

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in the Pune city is given in **Annexure V.**

4.6 Outlier Case-Mysuru

The quantity of mixed waste generated in the city is approx. 200750 TPA and the same quantity of mixed waste is being disposed in Mysuru. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total of 5460Kg Samples (mixed waste) were collected from generation point and 1007.6 Kg of samples were collected from the disposal point. The analysis of plastic waste, plastic packaging & SUP at both generation and disposal points are given in subsequent sections.

- **Analysis of Plastic Packaging**

The total quantity of Plastic Packaging waste at generation point and disposal point is summarized in **Table 28 and Table 29** respectively.

Table 28: Plastic Packaging Waste Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	5460	
2.	Total Plastic Waste generation	512	18821
3.Plastic Packaging generated			
3(a)	Category I	183.6	6750.49
3(b)	Category II	158.3	5820.28
3(c)	Category III	57.5	2114.13
3(d)	Category IV	3.2	117.66

Total Plastic Packaging Generated	**403**	**14803**

A pie chart representation of the category-wise plastic packaging waste generated in Mysuru is given in **Fig 25** below.

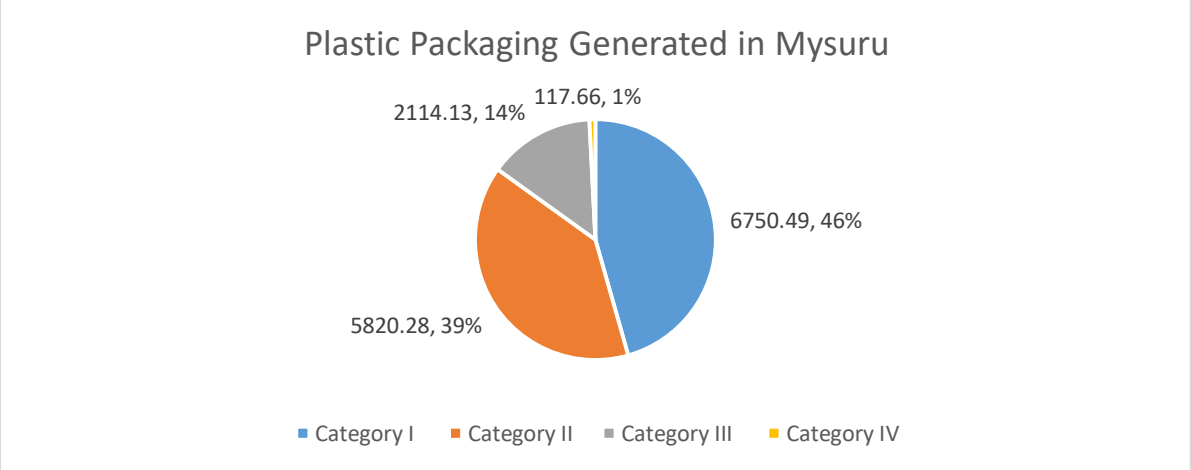


Fig 25: Category-wise plastic packaging waste generated in Mysuru

Table 29: Plastic Packaging Waste Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1.	Sample Size	1007.6	
2.	Total Plastic Waste disposed	254.35	50611
3.Plastic Packaging Disposed			
3(a)	Category I	17.25	3436.82
3(b)	Category II	126.25	25153.52 (more than generation)
3(c)	Category III	28.25	5628.41 (more than generation)
3(d)	Category IV	0	0.00 (more than generation)
Total Plastic Packaging Disposed		**172**	**34222**

Plastic Waste Disposal is greater than generation. As reported by RD Bengaluru, the plastic waste at disposal point may be greater due to plastic waste collected from the points of littering, street sweepings and drains & commercial establishments.

A pie chart representation of the category-wise plastic packaging waste disposed in Mysuru is given in **Fig 26** below.

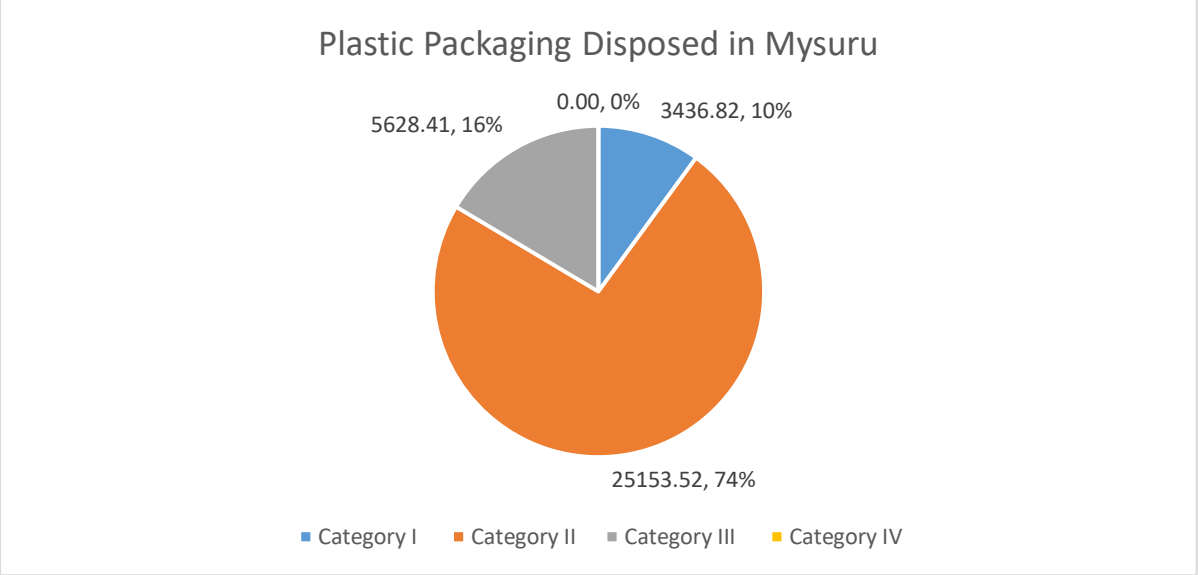


Fig 26: Category-wise plastic packaging waste disposed in Mysuru

- **Analysis of SUP**

The total quantity of SUP waste at generation point and disposal point in Mysuru City is summarized in **Table 30 & Table 31** respectively**.**

Table 30: SUP Generation

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	5460	
2	**Total Plastic Waste generation**	511.9	18871
3.SUP Generated			
3(a)	**Earbuds**	0.11	4.04
3(b)	**Straws**	0.1	3.68
3(c)	**Plates**	13.71	504.08
3(d)	**Cups**	3.1	113.98
3(e)	**Bowl**	0.4	14.71
3(f)	**Spoons**	1.22	44.86
3(g)	**Plastic Wrapping Papers**	0.25	9.19
3(h)	**Carry Bags < 120 microns**	62.68	2304.58
3(i)	**Polystyrene for decoration**	7.65	281.27
Total SUP Generated		**89.22**	**3280.39**

The category-wise distribution of SUP waste generated in Mysuru is depicted in the bar graph shown in **Fig 27.**

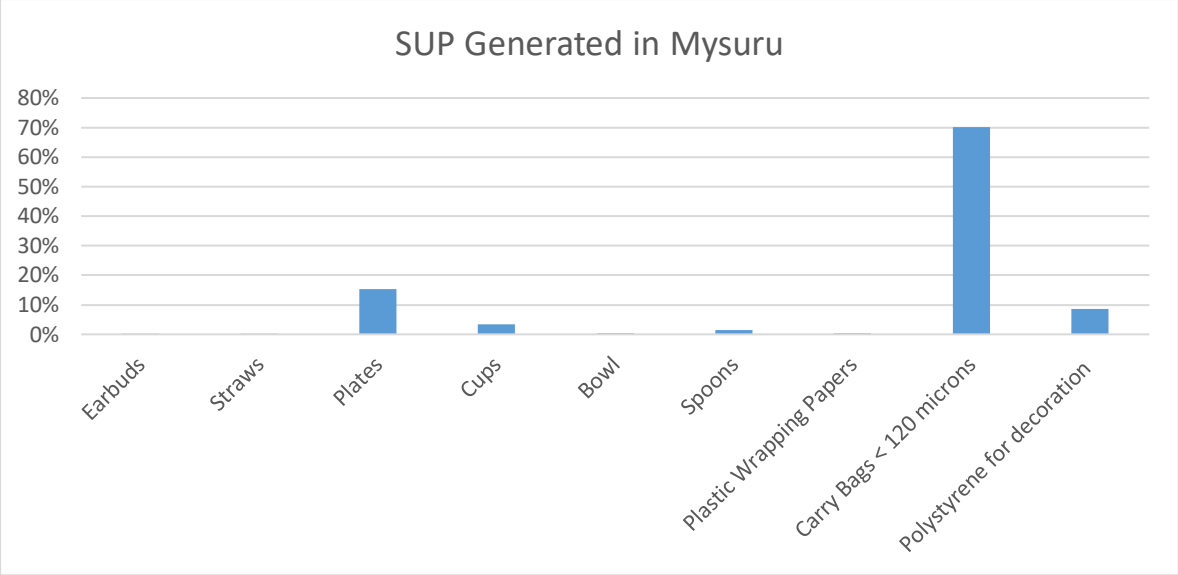


Fig 27: ***Category-wise distribution of SUP generated in Mysuru***

Table 31: SUP Disposal

S.No.	Particulars	Quantity in Sample (Kg)	Quantity (TPA)
1	**Sample Size**	1007.6	
2	**Total Plastic Waste disposed**	138.6	27614
3.SUP Disposed			
3(a)	**Plates**	3.2	637.55
3(b)	**Cups**	1.7	338.70
3(c)	**Bowl**	0	0.00
3(d)	**Spoons**	1.5	298.85
3(e)	**Carry Bags < 120 microns**	71.35	14215.47
3(f)	**Polystyrene for decoration**	0.9	179.31
Total SUP Disposed		**79**	**15671**

The category-wise distribution of SUP waste disposed in Mysuru is depicted in the bar graph shown in **Fig 28.**

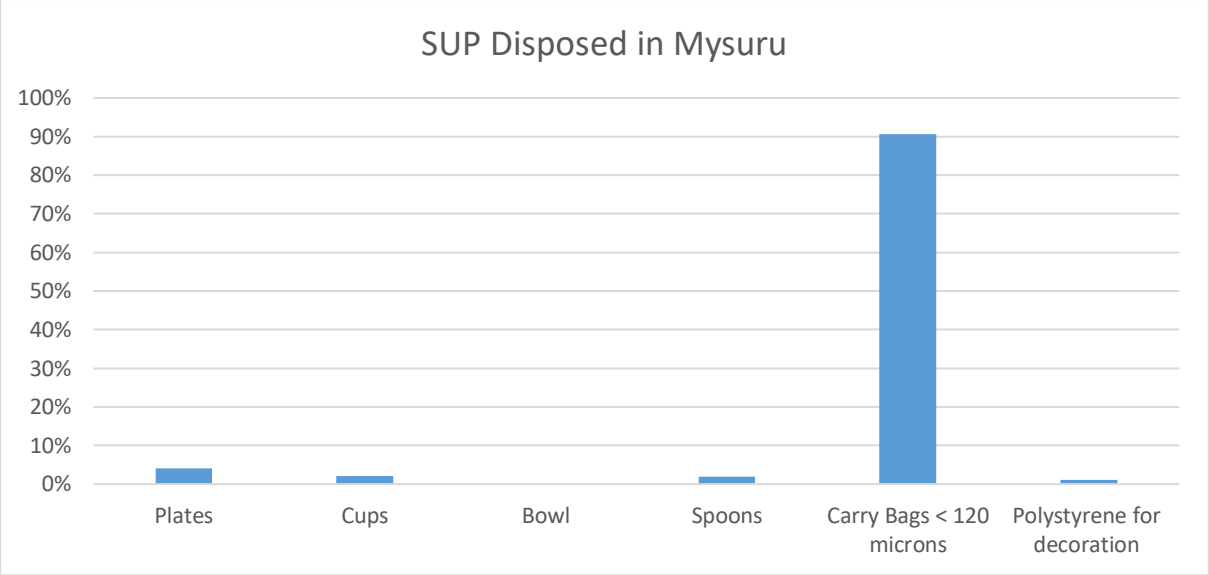


Fig 28: Category-wise distribution of SUP disposed in Mysuru

- **Overall Analysis**

The Plastic Waste, Plastic Packaging waste & SUP generated and disposed in Mysuru is summarized in **Table 32.**

Table 32: Plastic Waste Generation, disposal in Mysuru

Mysuru	Generated (Kg)	Disposal (Kg)	Qty Generated (TPA)	Qty. Disposed (TPA)
Total	512	254	18821	50611
PP	403	172	14803	34222
SUP	89	79	3280	15671
Others	109	82	4019	16389

The analysis of plastic waste, plastic packaging waste, and single-use plastic in Mysuru indicates a major discrepancy between generation and disposal quantities:

As clarified by RD Bengaluru, disposal sites in Mysuru handle additional plastic waste streams from Littering and open dumping points, Street sweepings, Drains and stormwater channels and Commercial establishments

This explains the disposal quantities exceeding generation recorded at sampling points. To ensure analytical accuracy in generation–disposal correlations, Mysuru data has been considered as an outlier case.

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in the Mysuru city is given in **Annexure VI**.

4.7 Vadodara

	Vadodara	
S.No.	Items	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.1076
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	-
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.01776
	Category-II	0.07247
	Category-III	0.01757
	Category-IV	0
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.064044
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	-
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	-
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	-
	Category-I	0.0033
	Category-II	0.0342
	Category-III	0.006
	Category-IV	0

8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.02892

The Plastic Waste, Plastic Packaging waste & SUP generated and disposed in Vadodara is summarized in **Table 33.**

Table 33: Plastic Waste, Plastic Packaging waste & SUP generated and disposed in Vadodara

Vadodara	Generated	Disposal	Qty Generated	Qty. Disposed	% Segregation with potential for utilization
Total	NA	NA	NA	NA	NA
PP (Kg/kg)	0.11	0.09	NA	NA	13.27
SUP (Kg/kg)	0.06	0.03	NA	NA	54.69
Others	NA	NA	NA	NA	NA

4.8 Lucknow

The quantity of mixed waste generated in the city is approx. 584000 TPA. Further, for assessment and characterisation of the plastic packaging and Single Use plastic, a total 3072 Kg Samples (mixed waste) were collected from generation point and 2770 Kg of samples were collected from the disposal point.

	Lucknow	
S.No.	Items	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.114
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.07382
	Category-II	0.0279
	Category-III	0.0087
	Category-IV	0.0018
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.062

	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	
	Category-II	
	Category-III	
	Category-IV	
8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	

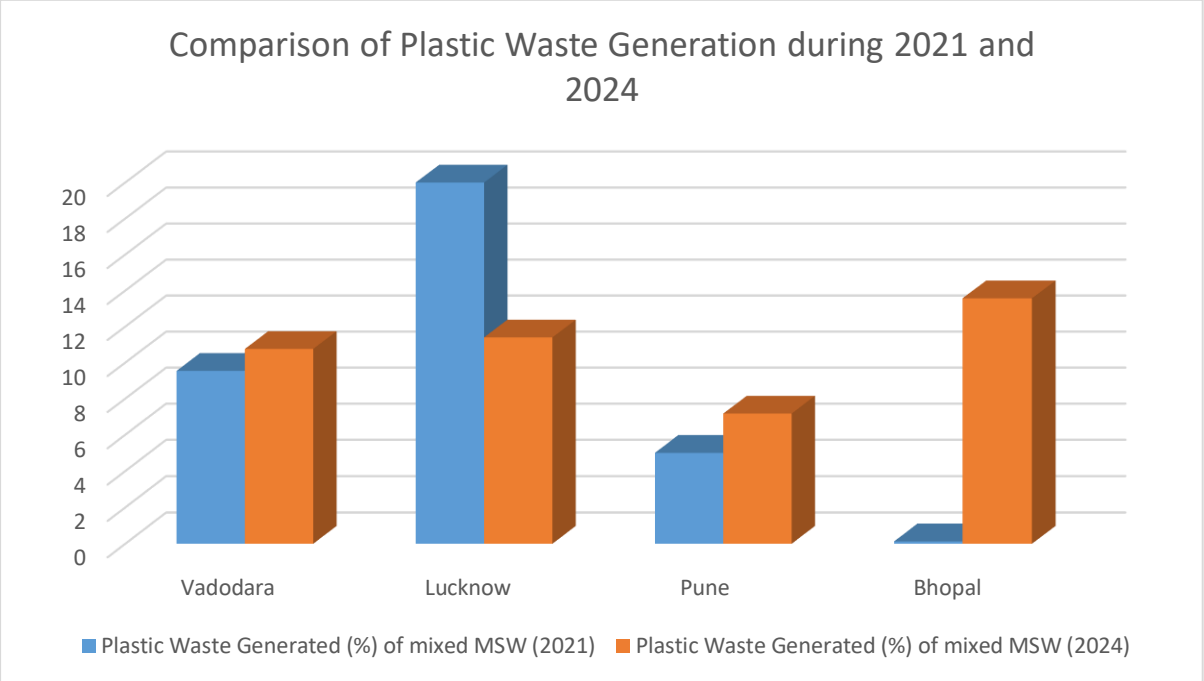
Lucknow	**Generated**	**Disposal**	**Qty Generated**	**Qty. Disposed**	**% Segregation with potential for utilization**
Total	426.00	NA	84883	NA	NA
PP (Kg/kg)	345.00	NA	68743	NA	NA
SUP	79.45	NA	15831	NA	NA
Others	81	NA	16140	NA	NA

4.9 Comparison of Plastic Waste Generation with assessment carried out during 2021

Plastic waste is an important part of mixed Municipal Solid Waste (MSW) in many cities. CPCB had also carried out an Assessment study of plastic waste in 2021. A comparison of the plastic waste as percentage of mixed waste for cities is given in the table below

S.No.	City	Plastic Waste Generated (%) of mixed MSW (2021)	Plastic Waste Generated (%) of mixed MSW (2024)
1.	Vadodara	9.54	10.76
2.	Lucknow	20	11.4
3.	Pune	5	7.17
4.	Bhopal	12-14%	13.57

The comparison of plastic waste generation as a percentage of mixed waste for the assessment carried out during 2021 and 2024 are depicted in graph below:



Following are the observations on the plastic waste as percentage of mixed waste between 2021 & 2024 for the four cities

- **Vadodara**: Plastic waste increased slightly from 9.54% to 10.76%.
- **Lucknow**: Big decrease from 20% to 11.4%, showing better waste management efforts.
- **Pune**: Increased from 5% to 7.17%, indicating more plastic generation.
- **Bhopal**: Small rise from 12–14% to 13.57%, staying almost the same.

5.0 OBSERVATION

5.1 Plastic waste Percentage

As per the assessment conducted by CPCB in above mentioned 7 cities it is observed that plastic waste content (as a percent of mixed waste) range from 7.17 to 15.3 at generation point and 4.4 to 25 at disposal point. The city wise variation in the plastic percentage is given in **fig 29 & fig 30** below.

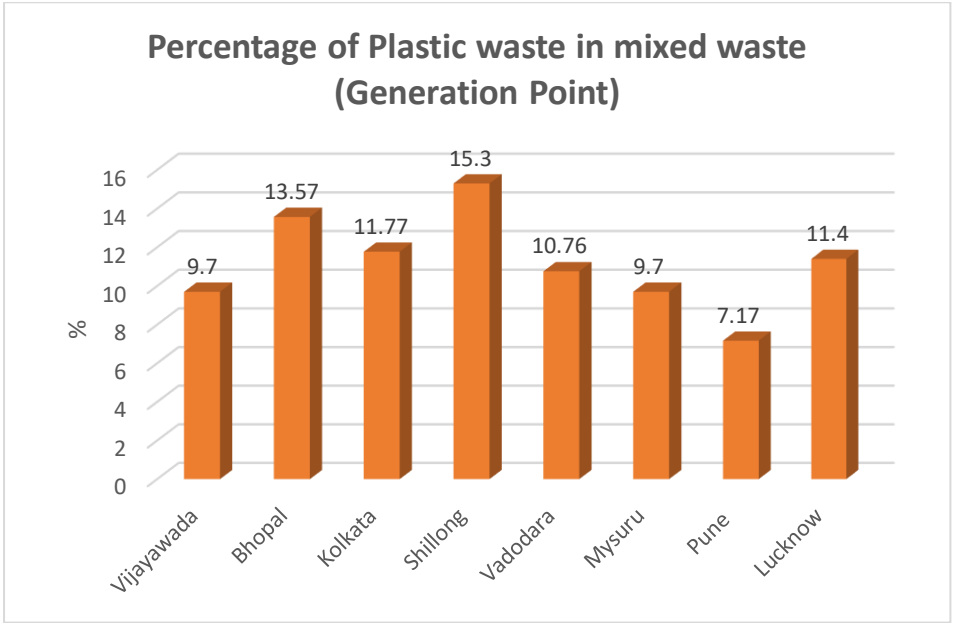


Fig 29: Plastic waste percentage at Generation point

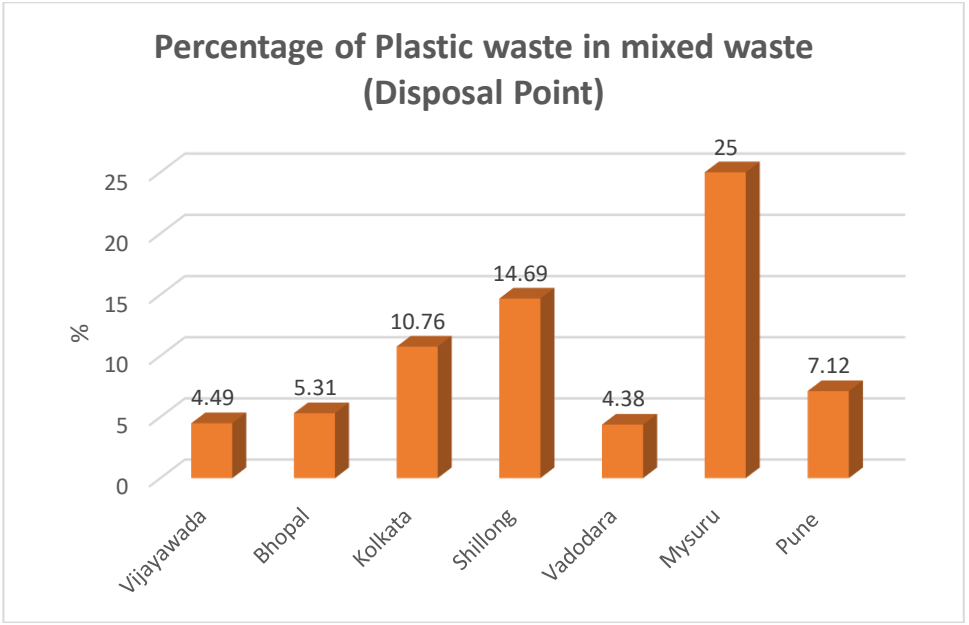


Fig 30: Plastic waste percentage at disposal point

5.2 Plastic packaging in Mixed waste

The quantity of Plastic Packaging generated and disposed are summarized in **table 34** below:

Table 34: Category wise Plastic Packaging at generation and disposal point

S.No.	City/Category	Category I (TPA)		Category II (TPA)		Category III (TPA)		Category IV (TPA)		Total Plastic Packaging(TPA)	
		Generation	Disposal	Generation	Disposal	Generation	Disposal	Generation	Disposal	Generation	Disposal
1	Vijayawada	4692.5	1884.31	11800.89	3348.88	5593.75	529.25	77.68	0	22164	5762
2	Bhopal	11822.4	759.74	8134.02	3790.59	14228.65	9006.04	272.83	21.63	34406	13578
3	Kolkata	3644.26	2131.39	12497.63	11283.57	6785.96	7553.63	0.83	1.6	22928	20980
4	Shillong	1339.45	1060.24	1448.4	1232.33	469.22	348.5	0	0	3257	2643
5	Mysuru	6750.49	3436.82	5820.28	25153.52	2114.13	5628.41	117.66	0	14803	34222
6	Pune	8803.25	166.66	33757.6	404.98	9345.63	172.06	1451.73	31.41	53353	673
7	Lucknow	43115.63		16310.94		5119.51		1055.08			

Plastic packaging waste percentage (as a percentage of mixed waste) range from 6 to 11.8 at waste generation point and 2.63 to 17.04 at waste disposal point. The variation across the cities is given **fig 31 & fig 32** below:

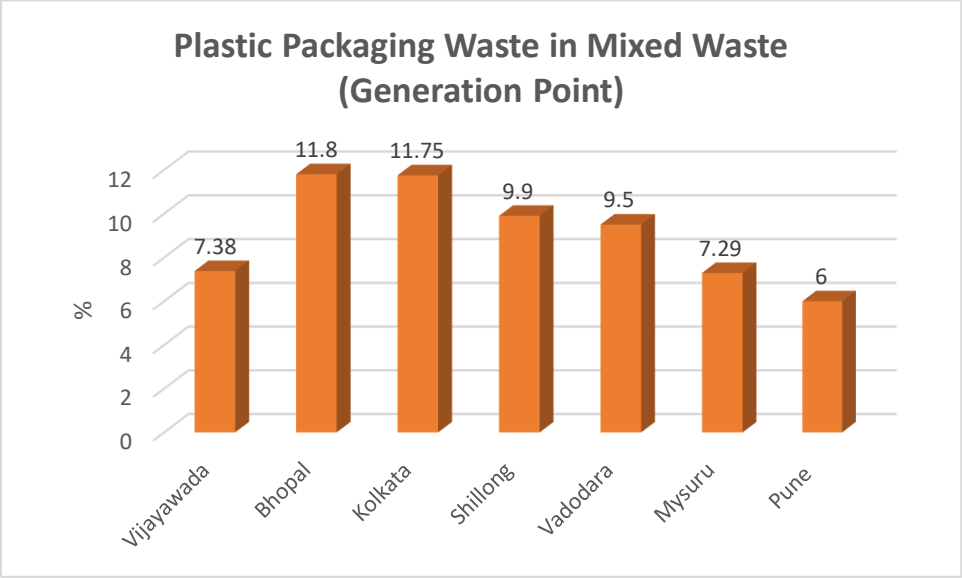


Fig 31: Plastic packaging waste in Mixed waste at Generation point

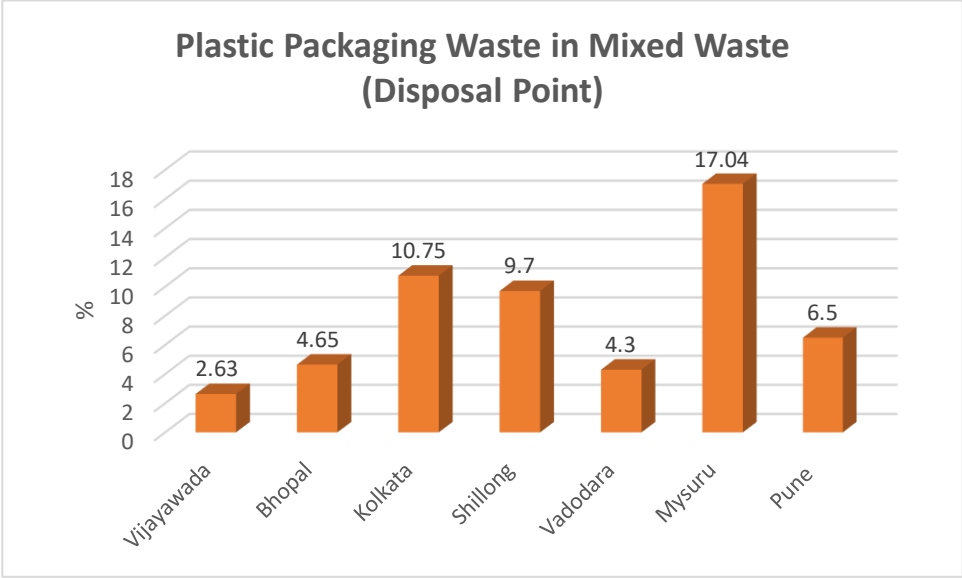


Fig 32: Plastic packaging waste in Mixed waste at Disposal point

5.2.1 Category wise plastic packaging in Mixed waste

Plastic packaging waste constitutes a significant portion, with Category II dominating in most cities at generation and disposal points. The Category wise variation in the cities is given in **fig 33 & fig 34** below:

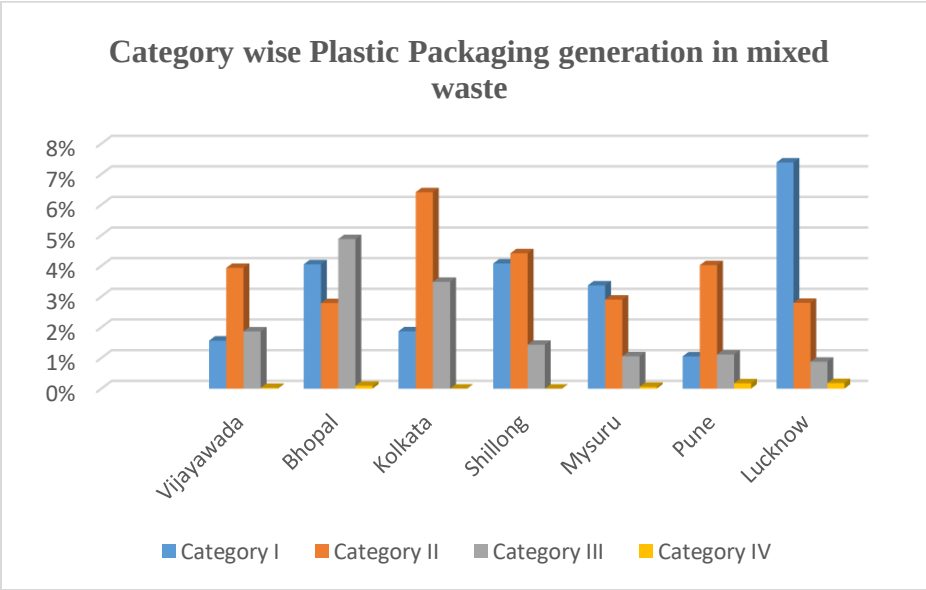


Fig 33: Category wise Plastic Packaging generation

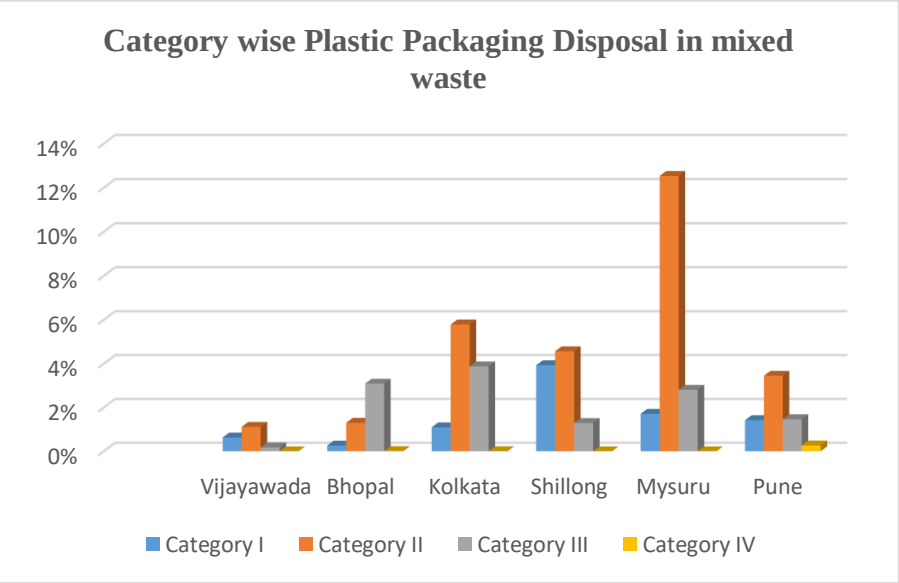


Fig 34: Category Wise Plastic Packaging disposal

5.3 Percentage of Single Use Plastic (SUP) in Mixed waste

SUP waste as a percentage of mixed waste is highest in Kolkata (7.47%) and lowest in Pune (0.78%) at generation point and highest in Bhopal (20.31) and lowest in Pune (1.36%) at disposal site. The variation across the cities is given in **fig 35 & fig 36** below:

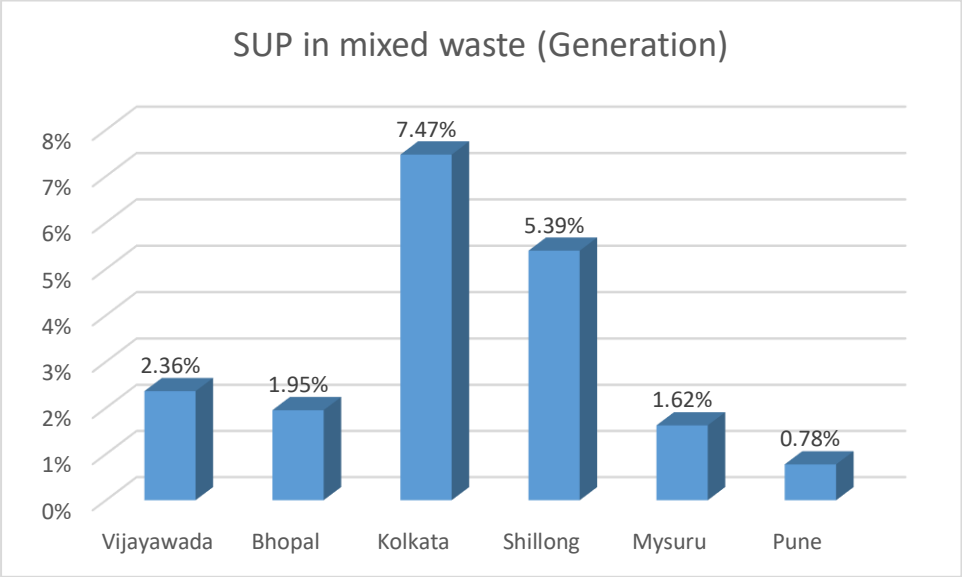


Fig 35: SUP in mixed waste at generation point

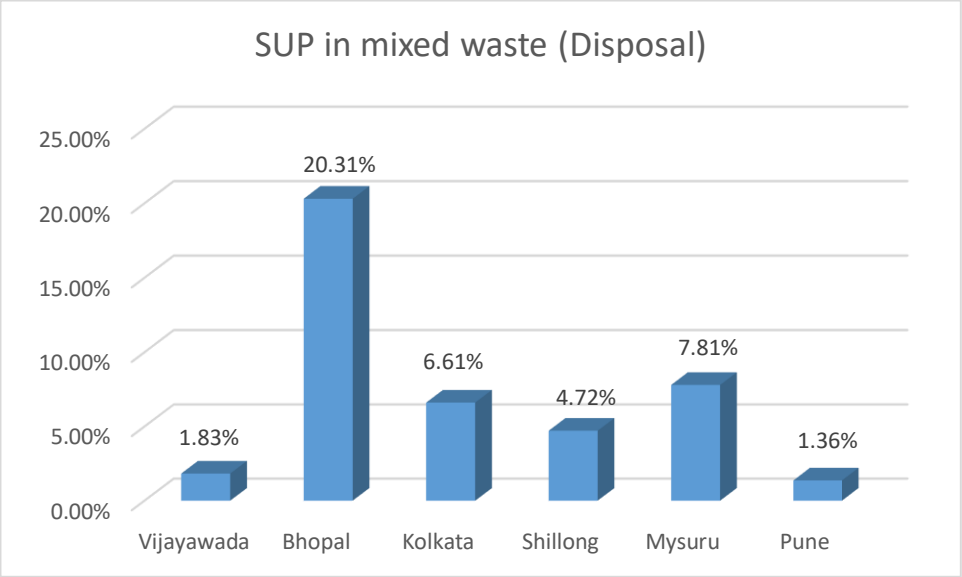


Fig 36: SUP in mixed waste at disposal point

5.3.1 Category Wise SUP in Mixed Waste

The category wise SUP at generation point and disposal point are summarized in **Table 35** below:

Table 35: Category wise SUP generation and disposal

S.No.	City/SUP Category	Vijayawada		Bhopal		Kolkata		Shillong		Mysuru		Pune	
		Generation (TPA)	Disposal (TPA)	Generation (TPA)	Disposal (TPA)	Generation (TPA)	Disposal (TPA)	Generation (TPA)	Disposal (TPA)	Generation (TPA)	Disposal (TPA)	Generation (TPA)	Disposal (TPA)
1	**Earbuds**	1.34	0.91	2.88	0.00	0.00	0.00	0.03	0.08	4.04		12.18	0.11
2	**Balloons**	0.00	0.00	4.93	0.00	0.00	0.00	0.00	0.00			0.00	0.00

3	**Candy**	0.80	0.00	3.33	0.00	0.00	0.00	0.00	0.00			4.29	0.03
4	**Icecream**	17.05	5.48	0.00	0.00	0.00	0.32	0.07	0.00			0.49	0.00
5	**Straws**	6.34	0.91	6.37	1.622	48.04	9.21	1.58	0.61	3.68		12.78	0.22
6	**Plates**	453.30	155.13	26.52	0.00	90.65	95.19	3.78	6.19	504.08	637.55	3.36	0.03
7	**Cups**	676.25	100.38	4.24	2.974	263.82	179.17	15.38	9.22	113.98 Bowl (14.71)	338.70	5.82	0.00
8	**Glass**	366.34	27.38	123.53	10.815	197.98	260.09	3.52	5.44			5.78	0.00
9	**Forks**	24.29	11.86	10.99	2.704	6.92	7.21	5.44	4.86			0.18	0.00
10	**Spoons**	38.57	3.65	17.20	4.056	22.50	29.41	10.30	9.58	44.86	298.85	5.66	0.03
11	**Knives**	1.96	0.00	0.00	0.00	11.07	2.24	1.86	0.80			0.00	0.00
12	**Trays**	171.79	109.50	25.69	11.35	446.77	258.97	0.00	0.00			0.00	0.00
13	**Sweet Boxes**	358.93	59.31	53.05	0.00	248.15	286.70	1.43	0.55			0.38	0.00
14	**Invitation Cards**	70.54	0.00	0.00	0.00	162.02	343.35	0.00	0.00			0.00	0.00
15	**Cigarette Packets**	116.52	6.39	0.00	0.00	624.37	112.98	5.02	4.84			77.63	0.05
16	**Carry Bags < 120 microns**	4517.05	3376.25	3855.19	2290	12031.96	11299.60	1181.10	924.04	2304.58	14215.47	5876.21	133.26
17	**Plastic Sheet < 50 microns**	224.38	50.19	1561.17	270.37	218.54	53.04	518.95	350.24			514.85	26.61
18	**Plastic Flags**	0.00	0.00	0.00	0.00	0.00		0.00	0.00			0.00	0.00
19	**PVC Banners < 100 microns**	26.79	91.25	0.00	0.00	0.00		0.00	0.00			0.00	0.00
20	**Polystyrene for decoration**	16.52	0.00	0.00	0.00	190.14		23.49	10.68	281.27	179.31	0.00	0.00
Total		7089	3999	5697	2594	14477	12901	1772	1275	3280	15671	6520	160

The category wise variation in SUP generation and disposal is given in **fig 37 & fig 38** below:

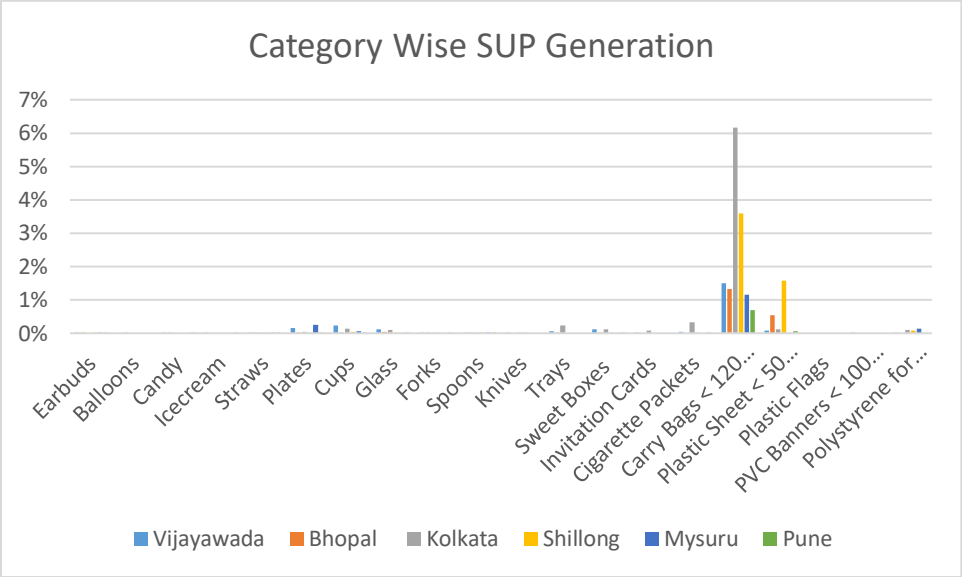


Fig 37: Category wise SUP generation

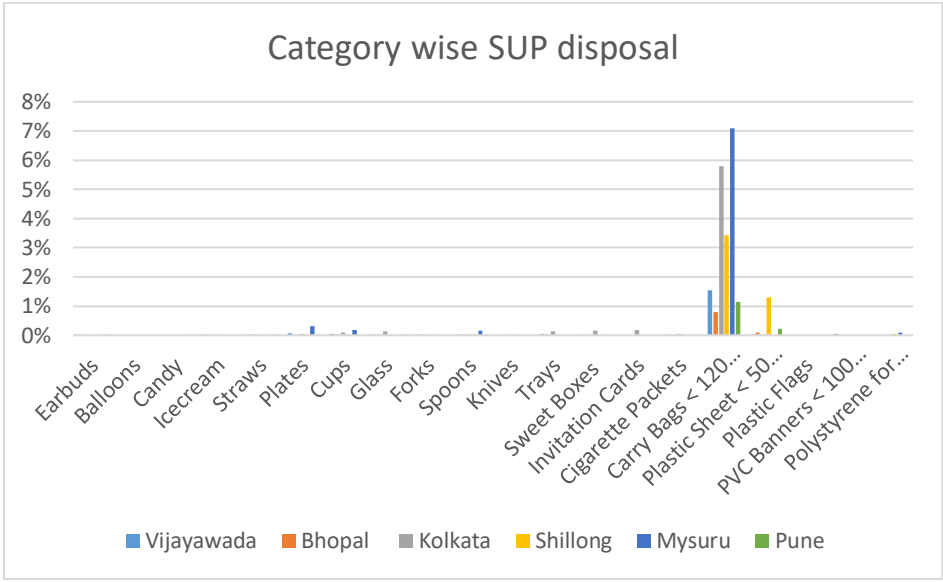


Fig 38: Category wise SUP disposal

- Plastic carry bags <120 microns and plastic sheets < 50 microns are the dominant categories of Single-Use Plastic (SUP) generation and disposal across all cities. Plastic carry bags generation ranges from 0.7% to 6% and disposal is 0.8% to 7%.
- Plastic Carry Bag <120 microns generation is highest in Kolkata and disposal is highest in Mysuru (7%).
- Categories like earbuds, balloons, candy sticks, ice cream sticks, and cutlery items (spoons, forks, knives) show negligible generation and disposal, close to 0% in all cities.

5.4. Plastic Waste Segregation with potential for utilization

The Segregation with potential for utilization of Plastic waste including Plastic Packaging and Single Use Plastic is given in **Table 36** below:

Table 36: Segregation with Potential for Utilization of Total Plastic Waste, Plastic Packaging and SUP

City	% Segregation with potential for utilization			
	Plastic Waste	Plastic Packaging	SUP	Others
Vijayawada	66	74	44	43
Shillong	21	19	28	25
Bhopal	59	61	54	50
Kolkata	9	8	11	11
Pune	99	99	98	98

- Pune has the highest plastic Segregation with potential for utilization across all categories, with values ranging from 98% to 99%.
- Kolkata and Shillong have the lowest Segregation with potential for utilization, with Kolkata ranging from 8% to 11% and Shillong from 19% to 28%.

A bar graph representation of the total plastic waste, Plastic Packaging & SUP Segregation with potential for utilization are given in **Fig 39 to fig 41** respectively.

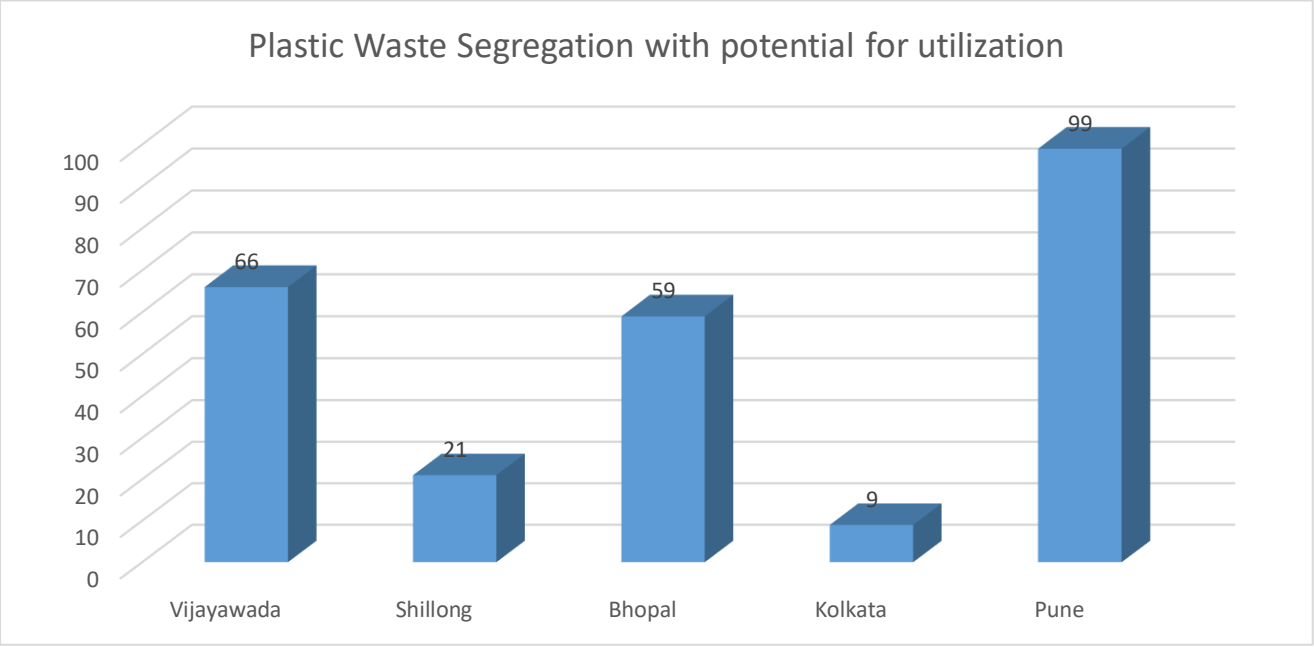


Fig 39: Total Plastic Waste Segregation with potential for utilization

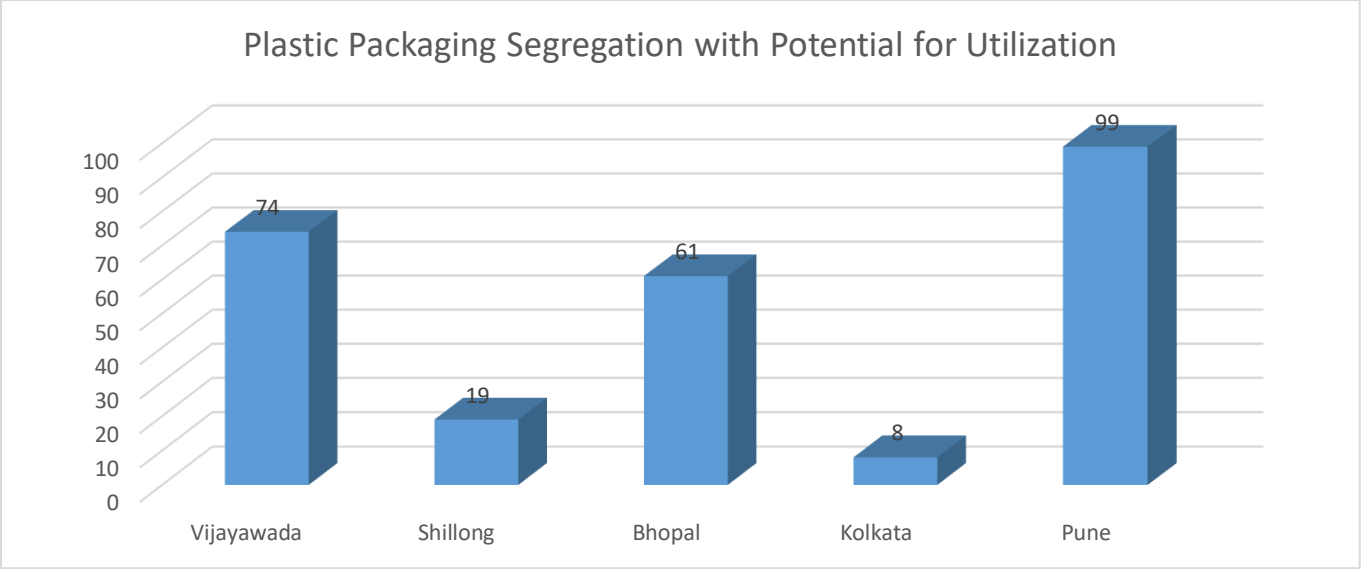


Fig 40: Plastic Packaging Segregation with potential for utilization

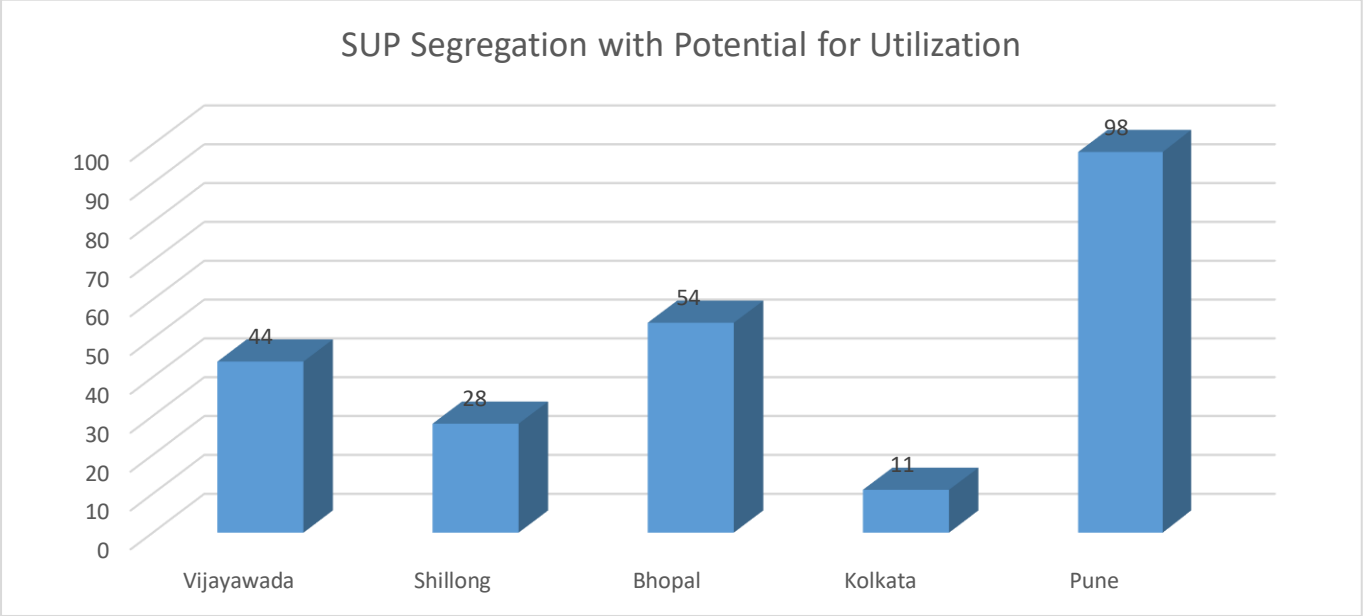


Fig 41: SUP Segregation with potential for utilization

6.0 Conclusions

- The percentage of plastic waste generated (as a percentage of mixed waste) varies among the cities, ranging from 7.17% to 15.3%. Significant regional variations in plastic waste generation and disposal across the all locations. Kolkata (11.7%) and Shillong (15.3%) exhibit the highest average quantities of plastic waste generation, while Pune (7%) generates the least.
- The percentage of plastic waste at the disposal point (as a percentage of mixed waste) ranges from 4.38% in Vadodara to 25% in Mysuru. Vadodara (4.38%), Vijayawada (4.49%), and Bhopal (5.31%) report the lowest plastic content at disposal, indicating better segregation or recovery practices. In contrast, Bangalore (25%), Shillong (14.69%), and Kolkata (10.76%) show higher disposal levels.

- Plastic packaging waste percentage (as a percentage of mixed waste) ranges from 6 to 11.8 at waste generation point and 2.63 to 17.04 at waste disposal point. At the generation point, the highest proportions are observed in Kolkata (11.75%) and Bhopal (11.8%), followed by Shillong (9.9%) and Vadodara (9.5%), indicating significant generation of plastic packaging. In contrast, Lucknow (6%) and Pune (7.29%) show lower levels. At the disposal point, Bangalore shows the highest value at 17.04%, indicating poor recovery of plastic packaging waste before final disposal. Kolkata (10.75%) and Shillong (9.7%) also exhibit high disposal rates, while Vijayawada (2.63%) and Vadodara (4.3%) show much lower percentages.
- At the generation point, Category II plastics dominate in most cities, with the highest generation observed in Kolkata (~7%), followed by Shillong and Pune (~4–5%), while Category I peaks in Lucknow (~7.5%). At the disposal point, the maximum percentage of disposal is Mysuru's Category II which is 13%, reflecting a gap in segregation and recovery. Other cities like Kolkata and Shillong also show significant disposal of Categories I–III, whereas Category IV remains consistently low across all locations.
- SUP waste as a percentage of mixed waste is highest in Kolkata (7.47%) and lowest in Pune (0.78%) at generation point and highest in Bhopal (20.31%) and lowest in Pune (1.36%) at disposal site. Further, the carry bags < 120 microns are most dominating across all abovementioned 20 categories of SUP at both generation and disposal points with highest generation and disposal in Kolkata and lowest disposal in Bhopal. Further, Plastic sheets < 50 microns generation is highest in Bhopal and lowest in Kolkata. At Disposal site, it is highest in Shillong and lowest in Bhopal. Categories like balloons, earbuds, and banners contribute minimally to the overall generation and disposal.
- The highest Segregation with potential for utilization of Plastic Waste is in the city of Pune (99%) and lowest is in Kolkata (9%). Of the plastic waste utilized, the plastic packaging utilized is highest in Pune (99%) and lowest in Kolkata (8%). Further, the Segregation with potential for utilization of SUP is highest in Bhopal (54%) and lowest in Kolkata (11%).
- The analysis showed that the amount of plastic waste disposed of in Mysuru is higher than the amount generated because extra waste came from littering spots, street sweepings, drains, and commercial areas. To keep the results accurate, the Mysuru data has been considered as an outlier. It is still included in the report for clarity and to show the real situation on the ground.
- As per above observation, it can be inferred that there are regional disparities in plastic waste management, emphasizing the need for localized strategies to enhance waste reduction, segregation, and recycling efforts.

Annexure I

Detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in Vijayawada city

	Vijayawada	
S.No	**Items**	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.097
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	0.0738
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.0156
	Category-II	0.0393
	Category-III	0.0186
	Category-IV	0.0002
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.02363
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste)**	0.044883
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q1d)**	0.0263125
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	
	Category-I	0.0086
	Category-II	0.0152
	Category-III	0.0024
	Category-IV	0

8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.01826

Based on above assessment, plastic waste and single use plastic (SUP) waste generation in the city can be estimated as given below:

i. Quantity of Plastic Waste Generation:

On an average the total mixed waste generated in city is Approximately 3,00,000 TPA

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1) = 0.097

Quantity of Plastic Waste Generated (QT**)** = Q1*Q = 0.097x 300000 = 29287.5 TPA

ii. Quantity of Plastic Packaging Waste Generation:

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) Q2 = 0.073883

Quantity of Plastic Packaging Waste Generated (Qpack) = Q2*Q

Qpack = 22165 TPA

iii. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q3 = 0.02363

Quantity of SUP Waste Generated (QSUP) = Q3*Q

QSUP = 0.02363 x 300000 = 7089 TPA

iv. Quantity of Other (Non-packaging waste)

Qother = QT-Qpack

Qother = 29287.5 - 22165

Qother = 7122.5 TPA

v. Quantity of Plastic Waste Disposed

Average quantity of plastic waste generated at disposal point (kg of plastic waste/ kg of mixed waste) Q1d= 0.044883

Vijayawada municipal corporation is sending approximately 2,19,000 *TPA of mixed municipal solid waste final disposal. (QD)*

Quantity of Plastic Waste Disposed (QTD) = Q1d*QD

QTD = 9829 TPA

vi. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) Q2d = 0.0263125

Quantity of Plastic Packaging Waste Disposed (QpackD)= Q2d*QD

QpackD = 5762 TPA

vii. Quantity of SUP Waste Disposed (QSUPD)

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

Q3d = 0.01826

QSUPD = Q3d*QD

QSUPD = 3999 TPA

viii. Quantity of Other (Non-packaging waste) Disposed

QotherD = QTD-QpackD

QotherD = 4067 TPA

ix. Quantity of Plastic waste Segregation with potential for utilization

Qutilised/processed = QT-QTD

Qutilised/processed = 29287.5 – 9829 = 19,458 TPA

Study conducted for Vijaywada city is enclosed as **Annexure-A**

Annexure II

Detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in Shillong city

	Shillong	
S.No.	Items	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.153
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	0.099
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.04077
	Category-II	0.044087
	Category-III	0.014283
	Category-IV	0
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.0539
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	0.14691
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	0.097
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.03925
	Category-II	0.045625
	Category-III	0.01305
	Category-IV	0

	Shillong	
S.No.	Items	**Average/Ratio**
8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.0491

Based on above assessment, plastic waste and single use plastic (SUP) waste generation in the city can be estimated as given below:

i. Quantity of Plastic Waste Generation:

Considering Quantity of Mixed Waste generated in the town (TPA) (Q)

= 32,850 Tons per annum

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1) = 0.153

Quantity of Plastic Waste Generated (QT**)** = Q1*Q = 5029.05 TPA

ii. Quantity of Plastic Packaging Waste Generation:

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) Q2 = 0.099

Quantity of Plastic Packaging Waste Generated (Qpack) = Q2*Q

Qpack = 3257.15 TPA

iii. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q3 = 0.053

Quantity of SUP Waste Generated (QSUP) = Q3*Q

QSUP = 1771.9 TPA

iv. Quantity of Other (Non-packaging waste)

= 32,850 - 3252.15

=29,597.85 Tons per Annum

v. Quantity of Plastic Waste Disposed

Average quantity of plastic waste generated at disposal point (kg of plastic waste/ kg of mixed waste) Q1d= 0.14691

Considering Quantity of Mixed Waste Disposed (TPA) (QD)= 27,010 Tons per annum

Quantity of Plastic Waste Disposed (QTD) = Q1d*QD

QTD = 3968.22 TPA

vi. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) Q2d = 0.097

Quantity of Plastic Packaging Waste Disposed (QpackD)= Q2d*QD

QpackD = 2641.07 TPA

vii. Quantity of SUP Waste Disposed (QSUPD)

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

Q3d = 0.0491

QSUPD = Q3d*QD

QSUPD = 1327.128 TPA

viii. Quantity of Other (Non-packaging waste) Disposed

QotherD = QTD-QpackD

QotherD = 27,010 - 2641.07= 24,368.93 TPA

ix. Quantity of Plastic Waste Segregation with potential for utilization

Qutilised/processed = QT-QTD

Qutilised/processed = = 5026.05 - 3968.22 = 1058.28 TPA

Study conducted for Shillong city is enclosed as **Annexure-B**

Annexure III

The detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in Bhopal city

	Bhopal	
S.No.	**Items**	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.1357
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	0.1180
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.0404
	Category-II	0.0278
	Category-III	0.0487
	Category-IV	0.0009
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.0195
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	0.0531
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	0.0465
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.0026
	Category-II	0.0129
	Category-III	0.0308
	Category-IV	0.0001

8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.0089

Based on above assessment, plastic waste and single use plastic (SUP) waste generation in the city can be estimated as given below:

i. Quantity of Plastic Waste Generation

On an average the total mixed waste generated city is Approximately 292000 TPA

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1) = 0.135

Quantity of Plastic Waste Generated (QT**)** = Q1*Q = 39650.76 TPA

ii. Quantity of Plastic Packaging Waste Generation

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) Q2 = 0.1180

Quantity of Plastic Packaging Waste Generated (Qpack) = Q2*Q

Qpack = 34457.97 TPA

iii. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q3 = 0.0195

Quantity of SUP Waste Generated (QSUP) = Q3*Q

QSUP = 5695.09 TPA

iv. Quantity of Other (Non-packaging waste)

Qother = QT-Qpack

Qother = 39650- 34457.97

= 252349.24 TPA

v. Quantity of Plastic Waste Disposed

Average quantity of plastic waste generated at disposal point (kg of plastic waste/ kg of mixed waste) Q1d= 0.0531

Quantity of Mixed Waste disposed in town TPA= 12775 TPA

Quantity of Plastic Waste Disposed (QTD) = Q1d*QD

QTD = 677.82 TPA

vi. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) Q2d = 0.0465

Quantity of Plastic Packaging Waste Disposed (QpackD)= Q2d*QD

QpackD = 594.03 TPA

vii. Quantity of SUP Waste Disposed

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) Q3d = 0.0089

QSUPD = Q3d*QD

QSUPD =113.48 TPA

viii. Quantity of Other (Non-packaging waste) Disposed

QotherD = QTD-QpackD

QotherD = 12097.17 TPA

ix. Quantity of Plastic waste Segregation with potential for utilization

Qutilised/processed = QT-QTD

Qutilised/processed = 38972.934 TPA

Study conducted for Bhopal city is enclosed as **Annexure-C.**

Annexure IV

Detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in Kolkata city

	Kolkata	
S.No.	Items	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.1177
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	0.1175
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.01868
	Category-II	0.06408
	Category-III	0.03479
	Category-IV	4.25532E-06
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.0746
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	0.1076
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	0.1075
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.0109
	Category-II	0.0578
	Category-III	0.0387
	Category-IV	8.22E-06
8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.0663

Based on above assessment, plastic waste and single use plastic (SUP) waste generation in the city can be estimated as given below:

i. **Quantity of Plastic Waste Generation:**

On an average the total mixed waste generated in city is Approximately 1,95,030.85 Tons per Annum

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1) = 0.1177

Quantity of Plastic Waste Generated (QT**)** = Q1*Q = 22,939.08 TPA

ii. **Quantity of Plastic Packaging Waste Generation:**

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) Q2 = 0.1175

Quantity of Plastic Packaging Waste Generated (Qpack) = Q2*Q

Qpack = 22,928.71 TPA

iii. **Quantity of SUP Waste Generation**

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q3 = 0.0746

Quantity of SUP Waste Generated (QSUP) = Q3*Q

QSUP = 14,563.23 TPA

iv. **Quantity of Other (Non-packaging waste)**

Qother = QT-Qpack

Qother = 22,961.08 – 22,928.71

= 32.37 Tons per Annum

v. **Quantity of Plastic Waste Disposed**

Average quantity of plastic waste generated at disposal point (kg of plastic waste/ kg of mixed waste) Q1d= 0.1076

Considering Quantity of Mixed Waste Disposed (TPA) (QD)= 1,95,030.85 Tons per Annum

Quantity of Plastic Waste Disposed (QTD) = Q1d*QD

QTD = 20,979.84 TPA

vi. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) Q2d = 0.1075

Quantity of Plastic Packaging Waste Disposed (QpackD)= Q2d*QD

QpackD = 20,970.22 TPA

vii. Quantity of SUP Waste Disposed (QSUPD)

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

Q3d = 0.0663

QSUPD = Q3d*QD

QSUPD = 12,937.42 TPA

viii. Quantity of Other (Non-packaging waste) Disposed

QotherD = QTD-QpackD

QotherD = 20,979.84 – 20,970.22 = 9.62 TPA

ix. Quantity of Plastic Waste Segregation with potential for utilization

Qutilised/processed = QT-QTD

Qutilised/processed = 22,961.08 TPA – 20,979.84 TPA = 1,981 TPA

Study conducted for Kolkata city is enclosed as **Annexure-D**

Annexure VI

Detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in Pune city

	Pune	
S.No.	Items	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.0717
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	0.06
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.01048
	Category-II	0.040211
	Category-III	0.01113
	Category-IV	0.00172
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.1081
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	0.0712
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	0.065
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.0141
	Category-II	0.03445
	Category-III	0.01463
	Category-IV	0.0026
8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.01364

Based on above assessment, plastic waste and single use plastic (SUP) waste generation in the city can be estimated as given below:

i. Quantity of Plastic Waste Generation:

Considering Quantity of Mixed Waste generated in the town (TPA) (Q)

= 839500 Tons per annum

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1) = 0.0717

Quantity of Plastic Waste Generated (QT**)** = Q1*Q = 60197.57 TPA

ii. Quantity of Plastic Packaging Waste Generation:

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) Q2 = 0.06

Quantity of Plastic Packaging Waste Generated (Qpack) = Q2*Q

Qpack = 53358.21 TPA

iii. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q3 = 0.007766

Quantity of SUP Waste Generated (QSUP) = Q3*Q

QSUP = 6520 TPA

iv. Quantity of Other (Non-packaging waste)

Qother = QT-Qpack

= 60197.57 TPA - 53358.21 TPA

=6,839.36 Tons per Annum

v. Quantity of Plastic Waste Disposed

Average quantity of plastic waste generated at disposal point (kg of plastic waste/ kg of mixed waste) Q1d= 0.0712

Considering Quantity of Mixed Waste Disposed (TPA) (QD)= 11753 *Tons per annum*

Quantity of Plastic Waste Disposed (QTD) = Q1d*QD

QTD = 837.13 TPA

vi. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) Q2d = 0.065

Quantity of Plastic Packaging Waste Disposed (QpackD)= Q2d*QD

QpackD = 775.11 TPA

vii. Quantity of SUP Waste Disposed (QSUPD)

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

Q3d = 0.01364

QSUPD = Q3d*QD

QSUPD = 160.33TPA

viii. Quantity of Other (Non-packaging waste) Disposed

QotherD = QTD-QpackD

QotherD = 837.13-775.11 = 62.02 TPA

ix. Quantity of Plastic Waste Segregation with potential for utilization

Qutilised/processed = QT-QTD

Qutilised/processed = 59360.44TPA

Study conducted for Pune city is enclosed as **Annexure-E**

Annexure VII

Detailed estimation of Plastic Waste, Plastic Packaging waste, SUP generation and disposal in Mysuru city

	Mysuru	
S.No.	Items	**Average/Ratio**
	Generation point	
1	**Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1)**	0.094
2	**Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) (Q2)**	0.0729
3	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.0335
	Category-II	0.0284
	Category-III	0.0105
	Category-IV	5.86E-04
4	**Average quantity of SUP waste generated (SUP in kg / kg of mixed waste) (Q3)**	0.0163
	Disposal point	
5	**Average quantity of plastic waste at disposal point (kg of plastic waste/ kg of mixed waste) Q1d)**	0.25
6	**Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) (Q2d)**	0.1704
7	**Average quantity of plastic packaging waste category wise generated (kg of plastic packaging waste / kg of mixed waste)**	
	Category-I	0.017119
	Category-II	0.12529
	Category-III	0.02803
	Category-IV	0

8	**Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste) (Q3d)**	0.31

Based on above assessment, plastic waste and single use plastic (SUP) waste generation in the city can be estimated as given below:

i. Quantity of Plastic Waste Generation:

Considering Quantity of Mixed Waste generated in the town (TPA) (Q)

= 200750 Tons per annum

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (Q1) = 0.094

Quantity of Plastic Waste Generated (QT**)** = Q1*Q = 18871 TPA

ii. Quantity of Plastic Packaging Waste Generation:

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste) Q2 = 0.0729

Quantity of Plastic Packaging Waste Generated (Qpack) = Q2*Q

Qpack = 14802.55 TPA

iii. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q3 = 0.0163

Quantity of SUP Waste Generated (QSUP) = Q3*Q

QSUP = 3283 TPA

iv. Quantity of Other (Non-packaging waste)

Qother = QT-Qpack

= 18871 TPA - 14644 TPA

=4,227 Tons per Annum

v. Quantity of Plastic Waste Disposed

Average quantity of plastic waste generated at disposal point (kg of plastic waste/ kg of mixed waste) Q1d= 0.25

Considering Quantity of Mixed Waste Disposed (TPA) (QD)= 200750 *Tons per annum*

Quantity of Plastic Waste Disposed (QTD) = Q1d*QD

QTD = 50675.63 TPA

vi. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste) Q2d = 0.1704

Quantity of Plastic Packaging Waste Disposed (QpackD)= Q2d*QD

QpackD = 34218.75 TPA

vii. Quantity of SUP Waste Disposed (QSUPD)

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

Q3d = 0.31

QSUPD = Q3d*QD

QSUPD = 15669.9 TPA

viii. Quantity of Other (Non-packaging waste) Disposed

QotherD = QTD-QpackD

QotherD = 50675.63 – 34218.75= 16,456.88 TPA

Study conducted for Mysuru city is enclosed as **Annexure-** F

CENTRAL POLLUTION CONTROL BOARD
REGIONAL DIRECTORATE – CHENNAI

CHARACTERIZATION AND ASSESSMENT OF PLASTIC PACKAGING WASTE AT VIJAYAWADA, ANDHRA PRADESH

1. INTRODCUTION

The CPCB, HO vide letter dated 03.07.2024 requested Regional Directorate to conduct a study in one of the cities in their jurisdiction for implementation of SOP for Characterization and Assessment of Plastic Packaging Waste and Single Use Plastics (SUPs). CPCB, RD Chennai selected Vijayawada city in Andhra Pradesh having million plus population for the study. The meeting was conducted with Smt. K V Satyavathi, Additional Commissioner (Projects) of Vijayawada Municipal Corporation (VMC) on 11th July 2024 for planning of the study and requested to provide all necessary support including manpower for conducting the study jointly with VMC. Accordingly, the study was Jointly conducted by a team of officials from RD Chennai comprising of Ms Sowmya D, Scientist E and Sh Prabhu H Ganchi, Scientist B along with the officials of VMC and Ward Sanitation and Environment Secretaries - Sh Shaik Karimulla, Sh Puppala Sai Pavan Kumar and Sh Turimella Abhishikt during 15th July 2024 to 23rd July 2024.

2. OBJECTIVE

The objectives of the study are as follow:

i. Identification and Quantification of total plastic waste in the municipal solid waste and categorize it into different category i.e. Cat-I, Cat-II, Cat-III, Cat-IV plastic waste and Single Use Plastics (SUPs)
ii. Quantification of plastic packaging waste generated across various sectors (e.g., residential, commercial.)

3. STUDY AREA

Vijayawada is the administrative headquarters of the NTR district, Andhra Pradesh. It is a well-established commercial, political, educational and cultural centre of Andhra Pradesh. The city having a population of 11,95,150 (approximately as per 2024) consists of a dynamic urban landscape unfolds where the majority of residents belong to the middle-income group. The total area under the Vijayawada Municipal Corporation (VMC) is 61.88 sq. kms and the total waste generated in the city is 800 TPD (including 90 TPD of Construction and Demolition Waste). For administrative purpose, city is divided into three zone and named as Circle 1, Circle 2 and Circle 3. All waste generated in the city is collected by VMC through door-to-door collection and transported to waste transfer stations located at Ajith Singh

Nagar and Auto Nagar. The waste from Circle 1 and Circle 2 is sent to transfer station located at Ajith Nagar whereas waste from Circle 3 is sent to transfer station located at Auto Nagar. Out of 800 TPD of waste generated, approximately 600 TPD of waste is sent to Jindal Waste to Energy plant located at Guntur district for disposal from transfer stations. Approximately 90 TPD of Construction and Demolition Waste are disposed through filling in low laying area and remaining 110 TPD of valuables such as plastics, metals etc are collected by rag pickers and recycled. During the study, sample sorting and weighing were carried out at 2 transfer stations.

4. METHODOLOGY

The area of city is divided into three zones Circle 1, Circle 2 and Circle 3 for administrative purpose and subsequently various wards in the zone. The same zones were considered for the study and further divided into residential wards with Middle-income, Economically Weaker Section (EWS), mixed wards/slums and Commercial wards (Market Area).

Since Vijayawada has a million plus population, as per the Table 1 of SOP the sampling is to be carried out for 7(k) days. Accordingly, the total number of vehicle to be sample for 7 days comes out to be 49 (n). Out of 49 samples, 28 samples are collected from generation points and 21 samples from disposal points. The samplings were carried out from 15.07.2024 to 23.07.2024.

The samples were collected from generation point in each of the circle with different income category. Since in this case there are only three zones the fourth sample is again collected from circle 1. Similarly, on the second day, two samples were collected from circle 2 instead of one sample and so on. The vehicle selected from generation point were named as V1, V2, V3 and so on.

In the study, waste transported from transport stations to waste to energy plant is considered as disposal point. All the waste generated in the city is collected and brought to the 2 transfer stations and from there it is lifted and transported to the Waste to Energy plant for final disposal. Thus, the vehicle carrying waste from transfer stations to W2E plant for disposal were named as D1, D2 and D3 for Circle 1, Circle 2 and Circle 3 respectively. Similarly, for next day it is named as D4, D5 and D6 for Circle 1, Circle 2 and Circle 3 and so on for subsequent days.

During the study only two sample were collected from disposal point due to breakdown of weighing machine. The sample collected were D1 and D3. It is informed by the VMC the new weighing machine has been purchased and further study of remaining disposal point will be carried out from 28.08.2024.

The waste collected in identified vehicle (i.e. sample) were discharged in a designated area in transfer stations. Using the Quartering and coning method, the sample was reduced to 120 kg sample for characterization and assessment purpose.

The total plastic waste in 120 kg sample was identified and categorized into various category as Cat-I, Cat-II, Cat –III, Cat –IV plastic waste and Single Use Plastics (SUPs). The SUPs is further sorted into ear buds, balloons etc. The above exercise was repeated for all 28 samples from generation point and 2 sample from disposal point as per SOP.

5. ANALYSIS AND RESULTS

The results of the study are as follow:

5.1 Distribution of the sampling locations

Table 1: Sample location distribution

	CIRCLE 1			CIRCLE 2			CIRCLE 3		
	Vehicle	**Category**	**Location**	**Vehicle**	**Category**	**Location**	**Vehicle**	**Category**	**Location**
DAY 1	**V1**	Middle Income	Midhila Nagar	**V3**	Economically Weaker Sections	Asn-Stp apartments	**V4**	Commercial	Revenue Colony
	V2	Mixed (Res & Com)	Murupilla Chittigari Park Area						
	D1	Random Vehicle		**D2**	Random Vehicle		**D3**	Random Vehicle	
DAY 2	**V5**	Economically Weaker Sections	Police Colony	**V6**	Commercial	Hanuman peta	**V8**	Middle Income	Damodaram Sanjivaya Nagar
				V7	Mixed (Res & Com)	Satyaranayana puram			
	D4	Random Vehicle		**D5**	Random Vehicle		**D6**	Random Vehicle	
DAY 3	**V9**	Commercial	Tara Peta	**V10**	Middle Income	PNT Colony-Ajith Singh Nagar	**V11**	Economically Weaker Sections	Padmavahi Ghat Area
							V12	Mixed (Res & Com)	High School Road Area
	D7	Random Vehicle		**D8**	Random Vehicle		**D9**	Random Vehicle	
DAY 4	**V13**	Middle Income	RTC Work Shop Area	**V15**	Economically Weaker Sections	Subba Raju Nagar	**V16**	Commercial	KP Nagar

	V14	Mixed (Res & Com)	Mango Market Area						
	D10	Random Vehicle		**D11**	Random Vehicle		**D12**	Random Vehicle	
DAY 5	**V17**	Economically Weaker Sections	Frizer Peta	**V18**	Commercial	Governor peta	**V20**	Middle Income	Siva Shankara Road Area-Ramaling eswara Nagar
				V19	Mixed (Res & Com)	Fire Station Area, Prakash Nagar			
	D13	Random Vehicle		**D14**	Random Vehicle		**D15**	Random Vehicle	
DAY 6	**V21**	Commercial	Radham Center Area	**V22**	Middle Income	Bhanu Nagar	**V23**	Economically Weaker Sections	Ranigarit hota
							V24	Mixed (Res & Com)	Darsipeta
	D16	Random Vehicle		**D17**	Random Vehicle		**D18**	Random Vehicle	
DAY 7	**V25**	Middle Income	Vellampal li Colony	**V27**	Economically Weaker Sections	A&B Blocks-Vambay Colony	**V28**	Commercial	Badava Peta
	V26	Mixed (Res & Com)	Iron Yard Area						
	D19	Random Vehicle		**D20**	Random Vehicle		**D21**	Random Vehicle	

Note: - Only D1 and D3 samples were collected and analyzed, study of remaining samples i.e. D2, D4 - D21 is scheduled to be carried out from 28.08.2024.

5.2 Sample collection and Analysis

Table 2A: Plastic Waste characterization (Plastic Packaging category wise): Generation points

Vehicle Load	Sorting sample size (Kg)	Total PW (kg)	Category I PW (Kg)	Category II PW (Kg)	Category III PW (Kg)	Category IV PW (Kg)
1	120	8.83	1.37	3.93	1.84	0.03
2	120	11.16	1.857	4.03	1.94	-
3	120	8.63	1.012	5.08	0.96	0.05
4	120	8.87	1.987	4.21	0.652	0.08
5	120	10.03	1.812	4.54	1.655	-
6	120	10.42	3.757	5.95	0.1	0.06
7	120	7.61	0.807	4.24	1.068	-
8	120	13.44	0.937	8.22	1.59	-
9	120	11.11	0.957	4.96	2.875	0.07
10	120	12.89	1.692	4.155	4.04	0.02
11	120	11.40	1.937	5.02	1.935	-
12	120	10.14	1.757	5.89	0.855	0.05
13	120	9.52	1.117	3.59	1.12	-
14	120	13.05	2.802	4.96	1.875	0.08
15	120	13.37	1.882	4.065	2.895	-
16	120	10.27	2.047	2.13	3.15	-
17	120	13.77	2.782	3.955	2.865	-
18	120	14.03	0.747	7.23	2.96	0.07
19	120	13.50	0.837	6.23	2.63	-
20	120	14.20	0.747	4.31	4.01	-
21	120	13.66	1.707	6.28	3.045	0.06
22	120	12.90	2.802	3.105	3.59	0.09
23	120	10.20	1.877	4.68	2.025	-
24	120	12.31	1.837	4.98	1.825	0.04

25	120	13.84	2.537	4.79	3.14	-
26	120	13.74	3.297	4.21	3.78	0.1
27	120	11.73	1.787	4.23	2.17	-
28	120	13.40	3.867	3.2	2.06	0.07
Total	**3360**	**328.02**	**52.556**	**132.17**	**62.65**	**0.87**

Table 2B: Plastic Waste characterization (Plastic Packaging category wise): Disposal points

Vehicle Load	Sorting sample size (Kg)	Total PW (kg)	Category I PW (Kg)	Category II PW (Kg)	Category III PW (Kg)	Category IV PW (Kg)
1	**2**	**3**	**4**	**5**	**6**	**7**
1	120	7.36	0.95	3.385	0.39	-
2	120	3.412	1.115	0.285	0.19	-
Total	**240**	**10.772**	**2.065**	**3.67**	**0.58**	**0**

Table 3A: Plastic waste characterization (Single Use Plastic) – Generation point

Vehicle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total Sorting Size (kg)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Total Plastic Waste (Kg)	8.83	11.16	8.63	8.87	10.03	10.42	7.61	13.44	11.11	12.89	11.40	10.14	9.52	13.05	13.37
SUP															
Earbuds (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balloons (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Candy (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ice Cream (Kg)	-	-	-	-	0.015	-	-	-	0.035	-	-	-	-	-	0.01
Straws (Kg)	-	0.01	0.001	0.01	0.001	0.001	-	0.001	-	-	-	-	-	-	0.001
Plates (Kg)	0.1	0.11	-	-	0.15	-	-	0.2	-	0.055	-	-	0.05	0.25	0.13

Cups (Kg)	0.29	0.3	0.19	0.53	0.3	-	0.15	0.3	0.28	0.109	0.025	0.12	0.215	0.34	0.13
Glass (Kg)	0.019	0.02	0.13	0.095	0.02	0.05	0.15	0.035	-	0.14	0.105	0.22	0.01	0.25	0.015
Forks (Kg)	0.001	0.01	0.001	0.05	0.005	-	0.01	0.001	-	0.01	0.013	0.021	0.01	0.001	0.01
Spoons (Kg)	0.003	0.03	0.012	0.031	0.012	-	0.01	0.001	0.011	0.01	0.02	0.012	0.01	0.001	0.01
Knives (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trays (Kg)	-	-	-	-	-	0.015	0.02	-	-	0.1	-	0.018	0.035	0.2	0.27
Sweet Boxes (Kg)	0.06	0.13	-	-	0.365	0.02	0.095	0.06	-	0.15	-	0.107	0.05	-	0.35
Invitation Cards (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-
Cigarette Packets (Kg)	-	-	-	0.01	0.06	-	-	-	0.04	0.13	0.035	-	0.015	0.033	0.03
< 120 microns	1.13	2.12	1.1	1.2	1.065	0.37	1.028	2.015	1.85	1.89	2.01	1.028	3.1	2.235	3.29
< 50 microns	0.04	0.13	0.09	0.01	0.032	0.012	0.03	0.08	0.03	0.375	0.15	0.06	0.002	0.001	0.28
Plastic Flags (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PVC Banners <100 microns	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Polystyrene for decoration (Kg)	-	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (kg)	**1.643**	**3.31**	**1.524**	**1.936**	**2.025**	**0.468**	**1.493**	**2.693**	**2.246**	**2.969**	**2.358**	**1.586**	**3.697**	**3.311**	**4.526**

Vehicle	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**Total (kg)**	**Average kg/kg of waste**
Total Sorting Size (kg)	120	120	120	120	120	120	120	120	120	120	120	120	120	**3360**	
Total Plastic Waste (Kg)	10.27	13.77	14.03	13.50	14.20	13.66	12.90	10.20	12.31	13.84	13.74	11.73	13.40	**328.02**	**0.097625**
SUP														**0**	
Earbuds (Kg)	-	-	-	0.012	0.001	-	0.002	-	-	-	-	-	-	**0.015**	**0.0000045**
Balloons (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	**0.0000000**

Candy (Kg)	-	-	-	-	-	-	-	-	0.009	-	-	-	-	**0.009**	**0.0000027**
Ice Cream (Kg)	-	0.03	-	0.02	-	0.059	-	-	0.022	-	-	-	-	**0.191**	**0.0000568**
Straws (Kg)	0.005	0.002	-	0.008	0.006	-	-	-	0.004	0.01	-	0.001	0.01	**0.071**	**0.0000211**
Plates (Kg)	0.85	0.31	0.22	0.23	0.57	-	0.042	0.115	0.13	0.815	0.65	0.1	-	**5.077**	**0.0015110**
Cups (Kg)	0.27	0.18	1.17	0.33	0.23	0.41	0.295	0.015	0.11	0.3	0.065	0.27	0.65	**7.574**	**0.0022542**
Glass (Kg)	0.07	0.018	0.001	0.11	0.015	-	0.12	0.11	0.19	0.75	0.015	0.085	1.36	**4.103**	**0.0012211**
Forks (Kg)	0.02	0.006	-	0.001	0.002	-	0.03	0.004	0.018	0.001	0.001	0.001	0.045	**0.272**	**0.0000810**
Spoons (Kg)	0.08	0.011	0.001	0.02	0.002	0.021	0.015	0.02	0.013	0.001	0.02	0.01	0.045	**0.432**	**0.0001286**
Knives (Kg)	-	-	-	-	0.01	-	-	-	0.012	-	-	-	-	**0.022**	**0.0000065**
Trays (Kg)	0.22	0.011	0.185	0.025	0.005	-	0.13	-	0.015	0.01	0.045	0.07	0.55	**1.924**	**0.0005726**
Sweet Boxes (Kg)	0.08	0.365	0.22	0.19	0.27	0.035	0.155	-	0.158	0.115	0.32	0.185	0.54	**4.02**	**0.0011964**
Invitation Cards (Kg)	-	-	0.47	-	-	0.12	-	-	-	-	-	-	-	**0.79**	**0.0002351**
Cigarette Packets (Kg)	0.135	0.045	0.135	0.029	0.05	0.04	0.118	0.055	-	0.035	0.035	0.055	0.22	**1.305**	**0.0003884**
< 120 microns	1.115	3.125	0.6	2.6	3.9	1.85	2.015	1.16	2.855	1.29	1.14	2.73	0.78	**50.591**	**0.0150568**
< 50 microns	0.1	0.039	0.025	0.23	0.04	0.03	0.382	0.14	0.09	0.045	0.03	0.04	-	**2.513**	**0.0007479**
Plastic Flags (Kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**	**0.0000000**
PVC Banners <100 microns	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.3**	**0.0000893**
Polystyrene for decoration (Kg)	-	-	-	-	0.035	-	-	-	-	-	-	-	-	**0.185**	**0.0000551**
Total (kg)	**2.945**	**4.142**	**3.027**	**3.805**	**5.136**	**2.565**	**3.304**	**1.619**	**3.626**	**3.372**	**2.321**	**3.547**	**4.2**	**79.394**	

Table 3B: Plastic waste characterization (Single Use Plastic) – Disposal point

Vehicle	1	2	**Total (kg)**	**Average kg/kg of waste**
Total Sorting Size (kg)	120	120	240	
Plastic waste (kg)	7.36	3.412	10.772	0.04488
SUP			0	
Earbuds (Kg)	-	0.001	0.001	0.0000042
Balloons (Kg)	-	-	0	0.0000000
Candy (Kg)	-	-	0	0.0000000
Ice Cream (Kg)	-	0.006	0.006	0.0000250
Straws (Kg)	-	0.001	0.001	0.0000042
Plates (Kg)	0.05	0.12	0.17	0.0007083
Cups (Kg)	-	0.11	0.11	0.0004583
Glass (Kg)	0.02	0.01	0.03	0.0001250
Forks (Kg)	0.01	0.003	0.013	0.0000542
Spoons (Kg)	-	0.004	0.004	0.0000167
Knives (Kg)	-	-	0	0.0000000
Trays (Kg)	-	0.12	0.12	0.0005000
Sweet Boxes (Kg)	0.02	0.045	0.065	0.0002708
Invitation Cards (Kg)	-	-	0	0.0000000
Cigarette Packets (Kg)	-	0.007	0.007	0.0000292
< 120 microns	2.5	1.2	3.7	0.0154167
< 50 microns	0.015	0.04	0.055	0.0002292
Plastic Flags (Kg)	-	-	0	0.0000000
PVC Banners <100 microns	-	0.1	0.1	0.0004167
Polystyrene for decoration (Kg)	-	-	0	0.0000000
Total (kg)	**2.615**	**1.767**	**4.382**	

5.3 Assessment of Plastic Waste

1. Quantity of Plastic Waste Generation

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

Q_1= (328.02/3360) = 0.097625 = 9.76%

On an average the total mixed waste generated in a day is 800 TPD (inclusive of 90 TPD of Construction and Demolition waste)

Thus, total mixed generated in a year = 800 x 365 = 292000 TPA = Approximately 3,00,000 TPA

From above, the Quantity of Mixed Waste generated in the town is considered as (Q) = 3,00,000 Tons per annum

Quantity of Plastic Waste Generated (Q_T) = Q_1*Q = (328.02/3360) x 300000 = 29287.5 TPA

Quantity of Plastic Waste Generated per day = 78.1 TPD

2. Quantity of Plastic Packaging Waste Generation

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste)

Q_2 = (52.556 +132.17 + 62.65 + 0.87)/3360

Q_2 = 248.246/3360

Q_2 = 0.073883 = 7.4%

Quantity of Plastic Packaging Waste Generated (Q_{pack}) = Q_2*Q

Q_{pack} = 0.073883 x 300000 = 22165 TPA

3. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

Q_3 = 79.394/3360

Q_3 = 0.02363 = 2.36%

Quantity of SUP Waste Generated (Q_{SUP}) = Q_3*Q

Q_{SUP} = 0.02363 x 300000 = 7089 TPA

4. Quantity of Other (Non-packaging waste)

$Q_{other} = Q_T - Q_{pack}$

$Q_{other} = 29287.5 - 22165$

$Q_{other} = 7122.5$ TPA (This includes SUP and other plastic waste excluding packaging waste)

5. Quantity of Plastic Waste Disposed

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

$Q_{1d} = (10.772/240) = 0.044883 = 4.48\%$

Vijayawada municipal corporation is sending approximately 600 TPD of mixed municipal solid waste to waste to energy plant at Guntur for final disposal.

Quantity of Mixed Waste Disposed (Q_D) = 600 TPD X 365 = 2,19,000 TPA

Quantity of Plastic Waste Disposed (Q_{TD}) = $Q_{1d} * Q_D$

$Q_{TD} = (10.772/240) \times 2,19,000$

$Q_{TD} = 9829$ TPA

6. Quantity of Plastic Packaging Waste Disposed

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste)

$Q_{2d} = (2.065 + 3.67 + 0.58)/240$

$Q_{2d} = 6.315/240$

$Q_{2d} = 0.0263125 = 2.63\%$

Quantity of Plastic Packaging Waste Disposed (Q_{packD})= $Q_{2d} * Q_D$

$Q_{packD} = 0.0263125 \times 2,19,000 = 5762$ TPA

7. Quantity of SUP Waste at Disposal

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

$Q_{3d} = 4.382/240$

$Q_{3d} = 0.01826 = 1.82\%$

Quantity of SUP Waste Disposed (Q_{SUPD}) = Q_{3d}*Q_D

Q_{SUPD} = 0.01826 x 2,19,000 = 3999 TPA

8. Quantity of Other (Non-packaging waste) Disposed

$Q_{otherD} = Q_{TD}-Q_{packD}$

Q_{otherD} = 9829 - 5762

Q_{otherD} = 4067 TPA (This includes SUP and other plastic waste excluding packaging waste)

9. Quantity of Plastic waste Utilised/Processed

$Q_{utilised/processed} = Q_T-Q_{TD}$

$Q_{utilised/processed}$ = 29287.5 – 9829 = 19,458 TPA

At transfer stations, approximately 19,458 TPA of plastic waste is collected and utilized/ processed through rag pickers prior to sending remaining mixed waste for final disposal at waste to energy plant.

6. OBSERVATIONS

6.1 Quantification of Plastic Waste

a. At Generation Location

Type of Waste	Quantity (TPA)	% of Total solid waste generated
Plastic Waste generated	29287.5	9.76 %
Plastic Packaging Waste generated	22165	7.39 %
Single Use Plastics (SUPs) generated	7089	2.36 %
Other plastic wastes	33.5	0.007 %

i. In Vijayawada Municipal Corporation (VMC) jurisdiction, approximately, 800 TPD of municipal solid waste including 90 TPD of C&D waste is generated. This accounts for approximately 3,00,000 TPA of municipal solid waste generation.

ii. The study shows that in Vijayawada, 1 kg of municipal solid waste consist of 0.097625 kg i.e. 9.76% of plastic waste at generation sites. Quantity of Plastic Waste Generated per day is 78.1 TPD and per annum is 29287.5 TPA

iii. Average quantity of plastic packaging waste in municipal solid waste is 7.4% and SUP is 2.36%. It is estimated that approximately 22165 TPA of Plastic Packaging Waste and 7089 TPA of SUP waste are generated. The quantity of Non-packaging waste generated is 7122.5 TPA, which includes SUP and other plastic waste excluding packaging waste.

iv. In total plastic waste generated, 75.68% is plastic packaging waste and 24.20% is SUPs.

b. At Disposal Location

Type of Waste	Quantity (TPA)	% of Total waste disposed
Plastic Waste disposed	9829	4.48 %
Plastic Packaging Waste disposed	5762	2.63 %
Single Use Plastics (SUPs) disposed	3999	1.82 %

i. Vijayawada municipal corporation is disposing approximately 600 TPD of MSW through waste to energy plant located at Guntur. At disposal locations, average quantity of plastic waste present per kg of mixed municipal solid waste is 0.044883 kg i.e. 4.48%. Annually 2,19,000 TPA of mixed municipal solid waste is disposed through waste to energy plant and out of this 9829 TPA is plastic waste.

ii. At disposal site, average quantity of plastic packaging waste content in municipal solid waste is 2.63% and SUP is 1.82%. It is estimated that approximately 5762 TPA of Plastic Packaging Waste and 3999 TPA of SUP waste are disposed.

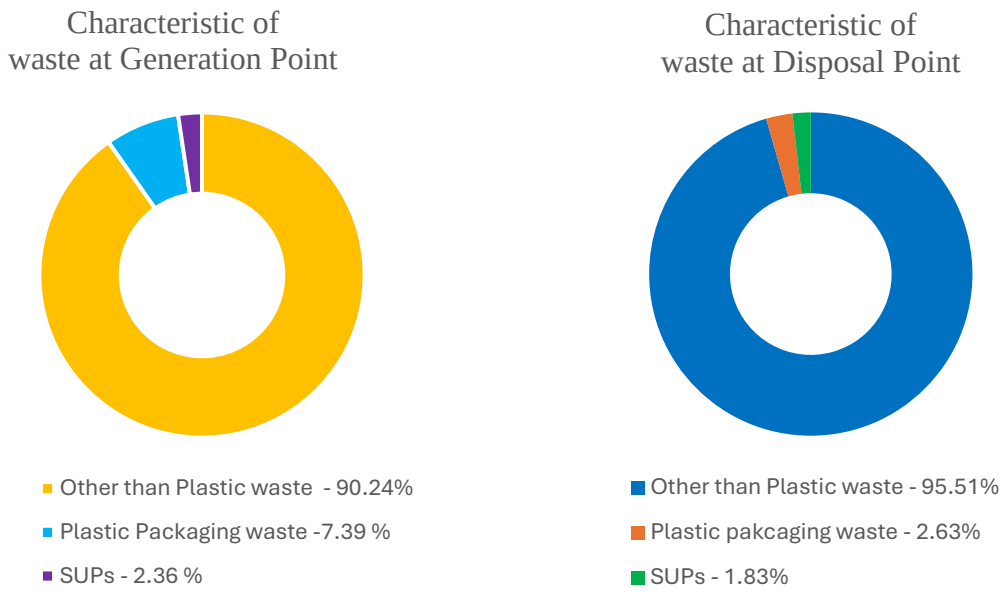
iii. Approximately, 25.99 % of plastic packaging waste generated and 56.41% of SUPs generated are disposed through waste to energy plant.

c. Utilized/processed through rag pickers

Type of Waste	Quantity (TPA)	% of Total plastic waste generated
Plastic Waste generated	29287.5	-
Plastic Waste disposed	9829	33.56 %
Plastic Waste utilized/processed	19458.5	66.44 %

i. This indicates, at transfer stations approximately 19,458 TPA of plastic waste from municipal solid waste are collected by rag pickers or informal sector and further utilized/processed.

ii. Approximately, 66.44 % of plastic waste generated is utilized/processed and 33.56% of plastic waste is disposed through waste to energy plant.



6.2 Manpower and Equipment Cost

Category	Numbers required	Working Hours	Cost per Hour/ Cost per item	Total Cost (For 7 days)
Workers	10	8 hours/ Day	₹ 65/-	₹ 36,400/-
Workers Health Allowance	10	8 hours/ Day	₹ 25/-	₹ 14,000/-
Collection bins 80 Liters Capacity	10	For entire exercise	₹ 1,300/-	₹ 13,000/-
Collection Bins 12 Liters Capacity	20	For entire exercise	₹ 400/-	₹ 8,000/-
Weighing machine Max 50Kgs with 10 grams accuracy	1	For entire exercise	₹ 4,750/-	₹ 4,750/-

Weighing machine Max 25Kgs with 1 gram accuracy	1	For entire exercise	₹ 2600/-	₹ 2,600/-
PPE Kits	10	Per Day	₹ 350/-	₹ 24,500/-
Tarpaulin sheets (30FT X 18FT)	4	For entire exercise	₹ 1500/-	₹ 6,000/-
Cellophane Tape	1	For entire exercise	₹ 94/-	₹ 94/-
			TOTAL	**₹ 1,09,344**

The total cost incurred in the entire study is ₹1,09,344/-.

6.3 Challenges identified during the study

1. The quantity of waste generated varies with the season in a locality.
2. The characteristic of MSW varies with the season. During rainy season it is difficult to carry out the study due to high moisture content in the waste. Carrying out this exercise during a rainy day may interfere with the result due to added weight of water drops on wet plastic. Therefore, it is better to avoid sampling on rainy days and to be carried out only on dry days.
3. It is very difficult to carry out this task without providing prior training to the workers about the 4 categories of waste and SUP that need to be separated. Prior training should be provided to workers at least for 2 hours in categorization of plastic waste by showing color pictures of different categories of plastic wastes.
4. The selection of the workers for carrying out categorization should be based on their eye sight. The workers with good vision and healthy should be selected for this task.
5. Preference should be given to workers who know how to read so that they can put the categorized plastic in its appropriate bin by reading the label on it. This will speed up the process of assessment.
6. Sometimes the plastic waste came with added dirt and mud which add up weight to actual weight of plastic. In such cases cleaning the dirt and mud and weighing delay the assessment process.
7. The flower waste came with sharp ball pins and staples stuck to flower stalks turned out to be dangerous to workers who are categorizing the waste. Workers should be careful while handling flower waste which is used for decoration purpose.

8. Sometimes the medical waste may also appear in sample which is collected from residential areas. The collection staff of the vehicles should be intimated prior to the collection so that they can make sure that no medical waste mixes with the sample.
9. Categorizing the SUP which is >120 microns and <50 microns is difficult process which need a gauge to measure. This turned out to be a lengthy and time taking process.
10. It is difficult to identify compostable plastic compare to other three categories.
11. The CPCB registration number is printed with small letters often not visible due to added dirt. This makes it difficult to identify compostable plastic.
12. Detection and quantification of small size plastic items like earbuds etc. was more difficult and time consuming.

7. RECOMMENDATIONS

1. The sampling and characterization may be carried out during non- rainy days to get realistic results.
2. Proper training should be given to the workers involved in the characterization and assessment of Plastic packaging waste.
3. Number of samples may be reduced as sampling for 7 days in Million plus cities in time and manpower consuming.
4. Community may be educated regarding different category of Plastic waste and their segregation at source for better management of plastic waste.

Name(s) officials:	Sowmya D, Scientist 'E' Prabhu H Ganchi, Scientist 'B'
(Prabhu H Ganchi) Scientist 'B'	(Sowmya D) Scientist 'E'

PHOTOGRAPHS

	
Bins for the collection of Plastic waste into different category	**Identification of a category of plastic waste by VMC official.**
	
Dumping of waste in a designated area for sorting	**Cone and Quarter Method for sampling of waste**
	
Sorting of the plastic waste into different category	**Sorting of the plastic waste into different category**

Annexure B

REPORT ON ASSESSMENT & CHARACTERIZATION OF PLASTIC WASTE AT SHILLONG MUNICIPALITY

REGIONAL DIRECTORATE (NORTH-EAST)

CENTRAL POLLUTION CONTROL BOARD

CTO BUILDING, SHILLONG-793004

CONTRIBUTIONS

Overall Coordination & Implementation
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Introduction:

The Plastic Waste Management (PWM) Rules of 2016 along with subsequent amendments, laid out a statutory framework for effective plastic waste management in the country. As per the provision of PWM Rules, the local bodies are required to assess the quantum of plastic waste generated in their jurisdiction and report the same in the Annual Report to be submitted to the concerned State Pollution Control Boards (SPCBs)/ Pollution Control Committees (PCCs), which in turn compiles the same and submits it to Central Pollution Control Board (CPCB). In this regard, CPCB has prepared Standard Operating Procedure (SOP) for the characterisation & assessment of Plastic Waste incorporating the provision of PWM Rules.

Further, as per the action plan for Plastic Waste Management prepared in accordance with the directions given during the PAC meeting at CPCB Delhi, Regional Directorates of CPCB are required to carry out the characterization and assessment of plastic packaging waste and SUPs in one city as per the procedure delineated in the SOP. In this Regard, Regional Directorate (North-East), CPCB, Shillong has conducted the characterisation and assessment of plastic packaging waste and Single Use Plastic (SUP) waste in the Shillong Municipal Area from 09.09.2024 to 14.09.2024.

Sample Planning & Study Area:

Shillong is the capital city in the state of Meghalaya with more than 1 lakh population (with a population of 1,43,229 according to the 2011 census). This study focuses on the Shillong municipal area governed by the Shillong Municipal Board (SMB). The Shillong Municipality is divided into 27 wards, as illustrated in **Figure 1**.

Since, medium or heavy vehicles being utilized to collect municipal waste, 480 kgs per vehicle is considered as vehicle load size applicable to all the selected areas. Moreover, the sample collection from the generation points is equally divided across all the 27 wards that were divided into four zones as per the details shown in **Table 1**. Since, Shillong has only one dumping site, selected vehicles from each 4 zones are assessed at that dumping/disposal site as per the methodology prescribed in the SOP. A total of 21 vehicles from the generation points and 24 vehicles at the disposal site are assessed and characterised for plastic packaging and Single Use Plastic (SUP) waste during the sampling period using *Cone & Quarter method* as per SOP.

Table 1: Sample Location Distribution

	Zone-1		Zone-2		Zone-3		Zone-4		
Day	Ward 1-6		Ward 7-13		Ward 14-21		Ward 22-27		Total Vehicle Samples
	Generation Points	Disposal Site	Generation Points	Disposal Site	Generation Points	Disposal Site	Generation Points	Disposal Site	
1	Laitumkhrah residential	Laitumkhrah Residential	Civil Secretariate	Civil Secretariate	Mawprem	Mawprem	Lumparing	Lumparing	8
2	-	Lachumiere	Polo	Polo	2 X Bara bazar market, Motphran	Bara Bazar market Motphran	Laban	Laban	8
3	Laitumkhrah market	Laitumkhrah market	Barik	Barik	Gari-Khana	Gari-Khana	Bishnupur	Bishnupur	8
4	Malki	Malki	Jail Road	Keating Road, PB	Jaiaw	Jaiaw	Rilbong	Rilbong	8
5	Lachumiere	Lachumiere	-	Civil Secretariate	-	Mawprem	Oxford Hills	Oxford Hills	6
6	Malki	Malki	Civil Secretariate	Civil Secretariate	Mawkhar	Mawkhar	-	Bishnupur	7

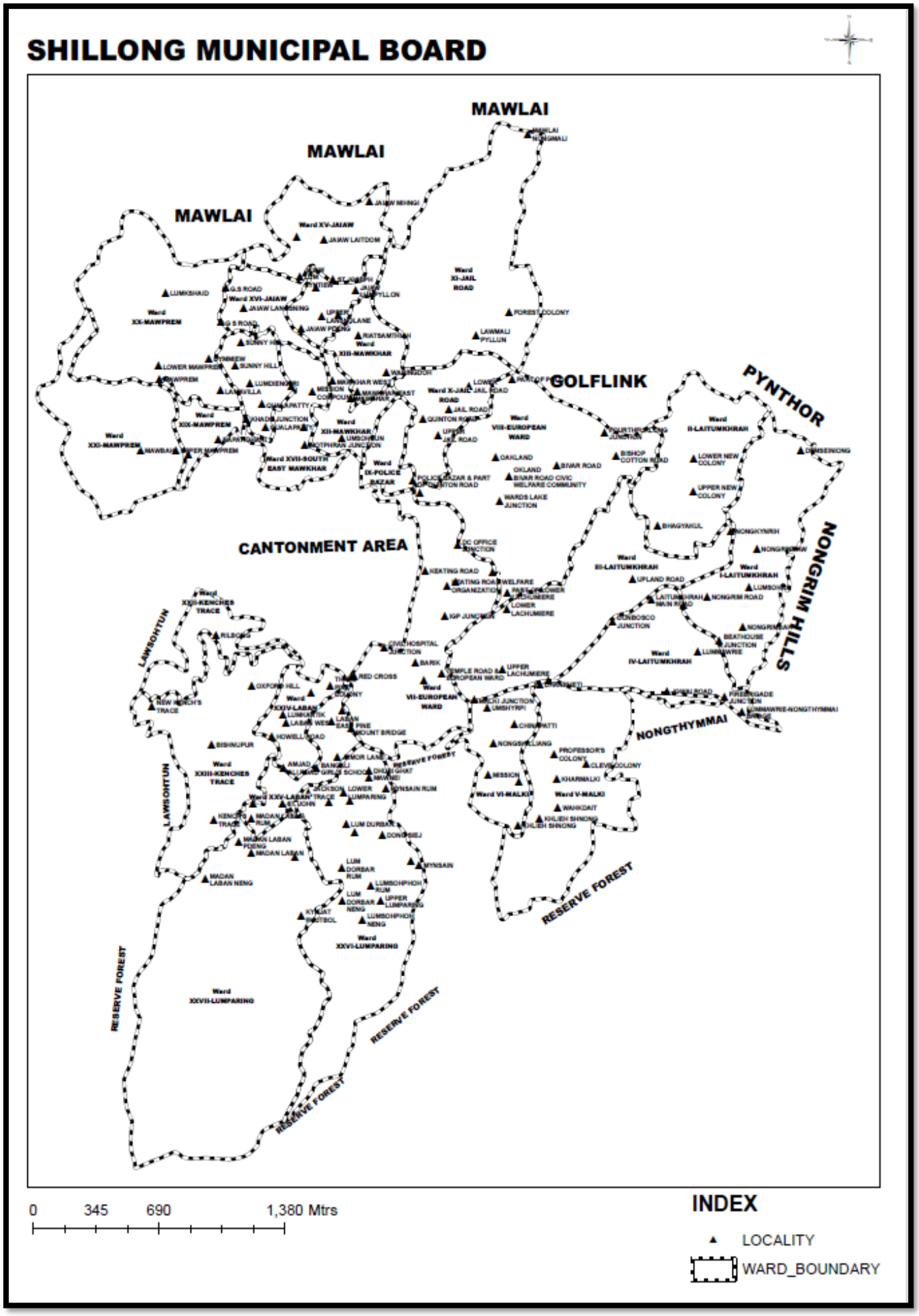


Figure 1: Study Area (Shillong Municipality)

Waste characterisation:

First, waste was characterised into two categories plastic waste and others. Subsequently, the total plastic waste was sorted and weighed into 4 categories, as per the EPR guidelines. Each sub-category was weighed and registered in the data sheet as given below in the Table 2(A & B).

Table 2 (A & B): Plastic Waste (PW) characterization (Plastic Packaging category wise)

A. Generation Point

Vehicle Load No.	Sorting Sample Size (Kg)	Total PW (kg)	Category1 PW (Kg)	Category2 PW (Kg)	Category3 PW (Kg)	Category 4 PW (Kg)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	120	19.6	7.0	4.2	1.0	-
2	120	21.5	8.0	4.5	2.0	-
3	120	19.55	7.62	4.78	2.8	-
4	120	16.25	6.80	3.75	1.32	-
5	120	18.19	2.79	1.56	0.93	-
6	120	16.47	0.61	5.65	-	-
7	120	25.59	1.6	14.13	3.5	-
8	120	14.595	5.165	4.4	0.2	-
9	120	18.00	0.810	8.840	3.89	-
10	120	16.95	7.58	3.5	1.2	-
11	120	17.73	0.93	5.35	4.9	-
12	120	16.742	4.107	4.45	1.425	-
13	120	18.49	8.1	2.79	0.8	-
14	120	19.57	3.55	7.89	2.35	-
15	120	17.73	1.23	6.79	2.43	-
16	120	15.88	3.23	3.99	1.5	-
17	120	19.08	8.4	3.95	1.2	-
18	120	16.55	4.87	3.38	1.9	-
19	120	18.93	6.86	5.71	0.35	-
20	120	20.5	6.8	4.75	1.63	-
21	120	17.89	6.70	6.75	0.67	-
	∑ (2) =	∑ (3) =	∑ (4) =	∑ (5) =	∑ (6) =	∑ (7) =
Total	**2520**	**385.787**	**102.752**	**111.110**	**35.995**	**0**

B. Disposal Point

Vehicle Load No.	Sorting Sample Size (Kg)	Total PW (kg)	Category1 PW (Kg)	Category2 PW (Kg)	Category3 PW (Kg)	Category4 PW (Kg)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	120	18.58	6.2	3.95	1.2	-
2	120	18.15	5.78	4.85	1.7	-
3	120	18.45	7.22	5.1	1.9	-
4	120	17.5	7.50	3.5	1.05	-
5	120	16.35	5.56	4.1	2.2	-
6	120	17.55	2.9	1.8	1.5	-
7	120	24.88	1.1	14.75	-	-
8	120	15.3	5.65	3.98	0.8	-
9	120	16.78	0.59	9.840	2.99	-
10	120	18.15	8.5	3.9	1.0	-
11	120	16.45	0.71	6.34	4.63	-
12	120	17.43	4.321	5.02	1.315	-
13	120	17.37	7.22	2.56	0.55	-
14	120	17.83	3.1	8.12	2.22	-
15	120	17.53	1.18	6.94	2.19	-
16	120	16.37	2.84	4.79	1.39	-
17	120	17.35	4.86	3.59	2.7	-
18	120	17.05	4.98	5.77	1.35	-
19	120	16.88	6.92	5.34	1.36	-
20	120	16.13	5.07	3.43	1.58	-
21	120	17.73	6.35	4.91	0.55	-
22	120	18.95	3.78	6.85	1.2	-
23	120	18.13	6.40	5.95	1.17	-
24	120	16.23	4.321	6.02	0.615	-
	∑ (2) =	**∑ (3) =**	**∑ (4) =**	**∑ (5) =**	**∑ (6) =**	**∑ (7) =**
Total	**2880**	**423.12**	**113.05**	**131.4**	**37.16**	**0**

Banned SUPs waste sorting:

Table 3 (A&B): Plastic waste characterization (Single Use Plastic)

A. Generation point

			Vehicle Load No.	Vehicle Load No. 1	Vehicle Load No. 2	Vehicle Load No. 3	Vehicle Load No. 4	Vehicle Load No. 5	Vehicle Load No. 6	Vehicle Load No. 7	Vehicle Load No. 8	Vehicle Load No. 9	Vehicle Load No. 10	Vehicle Load No. 11	Vehicle Load No. 12	Vehicle Load No. 13	Vehicle Load No. 14	Vehicle Load No.15	Vehicle Load No. 16	Vehicle Load No. 17	Vehicle Load No. 18	Vehicle Load No. 19	Vehicle Load No. 20	Vehicle Load No. 21	Avg kg/Kg of waste
1		a	Sorting sample size (Kg)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	
		b	Plastic waste (Kg)	19.6	21.5	19.55	16.25	18.19	16.47	25.59	14.595	18	16.95	17.73	16.742	18.49	19.57	17.73	15.88	19.08	16.55	18.93	20.5	17.89	0.1530
			SUPs																						
2	Plastic Sticks	a	Earbuds (Kg)			0.002																			0.0000
		b	Balloons (Kg)																						-
		c	Candy (kg)																						-
		d	Ice Cream (Kg)			0.005																			0.0000
		e	Straws (Kg)		0.01							0.003											0.078	0.03	0.0000
3	Cutlery Items	a	Plates (Kg)			0.14						0.05						0.1							0.0000
		b	Cups (Kg)	0.151		0.18			0.13			0.1				0.06		0.35			0.209				0.00047
		c	Glass (Kg)		0.04				0.05	0.05	0.1					0.03									0.0001
		d	Forks (Kg)		0.01		0.009	0.02		0.07	0.04	0.03		0.02	0.02	0.04	0.010	0.05		0.028			0.03	0.04	0.00017
		e	Spoons (Kg)	0.05	0.02	0.015	0.02	0.02	0.04	0.05	0.04			0.08	0.07	0.05	0.052	0.05	0.027	0.066	0.02	0.02	0.07	0.03	0.0003
		f	Knives (Kg)				0.008	0.03	0.05	0.03	0.02		0.005												0.0001
		g	Trays (Kg)																						
4	Packaging/ Wrapping Films	a	Sweet box (Kg)													0.024		0.086							0.0000
		b	Invitation Cards (Kg)																						
		c	Cigarette Packets (Kg)	0.025	0.01		0.063			0.085		0.035	0.02	0.039		0.036			0.023			0.049			0.00015
5	Carry bags	a	<120 microns (Kg)	5.324	4.90	3.252	4.10	9.38	8.79	3.315	2.118	3.721	3.595	4.361	3.62	4.961	2.618	4.718	4.222	4.315	3.118	4.221	3.595	2.361	0.0359
6	Plastic sheets	b	<50 microns (Kg)	1.85	2.01	0.756	0.18	2.94	1.05	2.76	2.512	0.521	1.05	2.05	3.05	1.599	2.89	1.926	2.538	1.121	2.421	1.54	3.547	1.309	0.0157
7	Other Items	a	Plastics flags (Kg)																						
		b	PVC banners <100 um.(Kg)																						
		c	Polystyrene for decoration (Kg)					0.51	0.1								0.21		0.35		0.632				0.0007
			Total	7.4	7	4.35	4.38	12.91	10.21	6.36	4.83	4.46	4.67	6.55	6.76	6.8	5.78	7.28	7.16	5.53	6.4	6.01	7.32	3.77	0.0539

B. Disposal Point

			Vehicle Load No.	Vehicle Load No. 1	Vehicle Load No. 2	Vehicle Load No. 3	Vehicle Load No. 4	Vehicle Load No. 5	Vehicle Load No. 6	Vehicle Load No. 7	Vehicle Load No. 8	Vehicle Load No. 9	Vehicle Load No. 10	Vehicle Load No. 11	Vehicle Load No. 12	Vehicle Load No. 13	Vehicle Load No. 14	Vehicle Load No.15	Vehicle Load No. 16	Vehicle Load No. 17	Vehicle Load No. 18	Vehicle Load No. 19	Vehicle Load No. 20	Vehicle Load No. 21	Vehicle Load No. 22	Vehicle Load No. 23	Vehicle Load No. 24	Avg kg/Kg of waste
1		a	Sorting sample size (Kg)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	
		b	Plastic waste (Kg)	18.58	18.15	18.45	17.5	16.35	17.55	24.88	15.3	16.78	18.15	16.45	17.43	17.37	17.83	17.53	16.37	17.35	17.05	16.88	16.13	17.73	18.95	18.13	16.23	0.1469
			SUPs																									
2	Plastic Sticks	a	Earbuds (Kg)	0.005		0.003																						0.0000
		b	Balloons (Kg)																									-
		c	Candy (kg)																									-
		d	Ice Cream (Kg)																									-
		e	Straws (Kg)									0.003											0.012	0.03		0.02		0.0000
3	Cutlery Items	a	Plates (Kg)			0.08					0.2	0.05							0.08								0.25	0.0002
		b	Cups (Kg)	0.11		0.10		0.11	0.08			0.212	0.091				0.08				0.20							0.0003
		c	Glass (Kg)		0.03					0.06	0.1						0.12		0.03					0.13		0.11	0.0002
		d	Forks (Kg)				0.01	0.07		0.07	0.08	0.03		0.02	0.02		0.010		0.07	0.028		0.04		0.04		0.03		0.0002
		e	Spoons (Kg)	0.05	0.02	0.012	0.03	0.05	0.04	0.055	0.04		0.07	0.08	0.07	0.05	0.052	0.05	0.027	0.066	0.02	0.02	0.07	0.03	0.07	0.05		0.00035
		f	Knives (Kg)				0.01	0.02		0.03	0.02		0.005															0.0000
		g	Trays (Kg)																									
4	Packaging/ Wrapping Films	a	Sweet box (Kg)													0.024											0.035	0.0000
		b	Invitation Cards (Kg)																									
		c	Cigarette Packets (Kg)	0.035	0.01		0.075			0.085		0.035	0.02	0.039	0.044	0.036			0.023			0.049				0.065		0.0002
5	Carry bags	a	<120 microns (Kg)	4.93	3.90	3.32	4.54	2.87	8.83	7.39	2.67	2.118	3.721	3.595	4.15	3.92	3.78	5.327	4.973	4.18	3.222	2.15	4.315	3.118	4.915	3.05	3.57	0.0342
6	Plastic sheets	b	<50 microns (Kg)	2.1	1.86	0.715	0.785	1.37	2.30	1.34	1.76	0.912	0.843	1.036	2.49	3.01	0.348	1.77	2.07	1.576	1.528	1.00	1.121	2.702	2.005	1.395	1.309	0.0129
7	Other Items	a	Plastics flags (Kg)																									
		b	PVC banners <100 um.(Kg)																									
		c	Polystyrene for decoration (Kg)						0.10									0.08	0.077	0.35			0.532					0.0004
				7.23	5.82	4.23	5.45	4.49	11.35	9.03	4.87	3.36	4.75	4.77	6.774	7.04	4.39	7.22	7.35	6.2	4.95	3.26	6.05	5.92	7.12	4.61	5.274	0.0491

Assessment of Plastic Waste:

1. Quantity of Plastic Waste Generation

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (data sheet at Table 2A & Table 3A)

Q1= (Σ Row 1b) / (Σ Row 1a)

OR

Q1= (Σ Column 3) / (Σ Column 2)

= (385.787 kg/2520 kg)

= 0.153

Considering Quantity of Mixed Waste generated in the town (TPA) (Q)

= 32,850 Tons per annum

(considering 90 Tons per day as per the data submitted in the annual report of 2023 by Shillong Municipal Board)

Quantity of Plastic Waste Generated (TPA) (Q_T)

= Q1*Q = 0.153 x 32,850

= 5026.05 Tons per Annum

2. Quantity of Plastic Packaging Waste Generation

Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste)

(Q2) = (Σ (Column 4) +Σ (Column 5) +Σ (Column 6) + Σ (Column 7))/ (Σ (Column 2)

(data sheet at Table 2A)

= (102.752 + 111.110 + 35.995 + 0)/ 1890

= 249.857/2520

= 0.099

Quantity of Mixed Waste generated (TPA) = 32,850 Tons per annum

Quantity of Plastic Packaging Waste Generated (Q_{pack})(TPA)

= 0.099 x 32,850

= 3252.15 Tons per Annum

3. Quantity of SUP Waste Generation

Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

(Q3) = (Σ (Row 2a… 7c) / (Σ (Row 1a) (data sheet Table 3A)

Q3 = 135.93/2520

= 0.0539

Quantity of Mixed Waste generated (TPA) = 32,850 tons per annum

Quantity of Plastic Packaging Waste Generated (TPA) (Q_{SUP}) = Q3*Q

= 1771.9 tons per annum

4. **Quantity of Other (Non-packaging waste)**

$Q_{other} = Q_T - Q_{pack}$

= 32,850 - 3252.15

=29,597.85 tons per annum

5. **Quantity of Plastic Waste Disposed**

Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

Q1d= (Σ Column 3) / (Σ Column 2) – *refer Table 2B*

OR

Q1d= (Σ Row 1b) / (Σ Row 1a) – *refer Table 3B*

= (423.12/2880)

Considering Quantity of Mixed Waste Disposed (TPA) (Q_D)= 27,010 Tons per annum

(considering 74 Tons per day collection as per the data submitted in the annual report of 2023 by Shillong Municipal Board)

Quantity of Plastic Waste Disposed (TPA) (QTD) = $Q1d*Q_D$

= 27,010 x (423.12/2880)

= 3968.22 Ton per Annum

6. **Quantity of Plastic Packaging Waste Disposed**

Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste)

(Q2d) = (Σ (Column 4) +Σ (Column 5) +Σ (Column 6) + Σ (Column 7)) / (Σ (Column 2) ----(*refer Table 2B*)

= (113.05+131.4 + 37.16)/ 2880

= 281.61/2880

= 0.097

Quantity of Mixed Waste Disposed (TPA) Q_D= 27,010 Ton per Annum

Quantity of Plastic Packaging Waste Disposed (Qpack D)(TPA) = $Q2d*Q_D$

=2641.07 Tonnes per Annum

7. **Quantity of SUP Waste at Disposal**

Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

(Q3d) = (Σ (Row 2a… 7c) / (Σ (Row 1a) ---(*refer Table 3B*)

= 141.508/2880

= 0.0491

Quantity of Mixed Waste Disposed (TPA) = 27,010 Tons per Annum

Quantity of SUP Waste Disposed (TPA) (QSUP)D = $Q3d*Q_D$

=0.0491 x 27,010= 1327.128 Tons per Annum

8. **Quantity of Other (Non-packaging waste) Disposed**

Qother D = QT (D)-Qpack D

= 27,010 - 2641.07

= 24,368.93 tons per Annum

9. **Quantity of Plastic waste Utilized/Processed**

Q utilised/processed = QT-QTD

= 5026.05 - 3968.22

= 1058.28 Tons per Annum

Conclusion:

A comprehensive characterization and assessment of plastic waste in the Shillong municipal area, governed by the Shillong Municipal Board (SMB), was conducted from September 9 to September 14, 2024. During this period, 21 vehicles were evaluated at waste generation points, and 24 vehicles were assessed at the disposal site, focusing on plastic packaging and banned single-use plastic (SUP) waste. The sampling followed the Cone & Quarter method as outlined in the standard operating procedures (SOP) prescribed by CPCB.

The analysis at the generation sites revealed that plastic waste (including both plastic packing wastes and banned single-use plastic (SUP) items) constitutes approximately 15% of the total municipal solid waste (MSW) generated in the Shillong Municipality, with SUPs alone accounting for around 5.3%. With an estimated mixed waste generation of 90 tons per day (TPD), or 32,850 tons annually, the total plastic waste generation was calculated to be about 5,026.05 tons annually. Among this, approximately 1,771.9 tons are attributed to banned SUPs, predominantly consisting of plastic carry bags with thicknesses of less than 50 and 120 microns.

In terms of waste collection, the SMB processes about 74 TPD, equating to 27,010 tons annually. At the disposal site, plastic waste accounted for approximately 14.69% of the collected MSW, totaling an estimated 3,968.22 tons per year. This indicates a significant shortfall of over 1,000 tons of uncollected plastic waste. Similar to the findings at generation points, banned SUP items also contributed close to 5% of the MSW at the disposal site, again dominated by thin plastic carry bags.

While collected plastic packaging waste is processed for recycling with the assistance of local self-help groups, a majority of SUP items end up in landfill sites. These findings highlight an urgent need for enhanced waste management practices, increased public awareness, and potential policy interventions to mitigate plastic waste generation and improve recycling efforts in the Shillong Municipality. This data serves as a vital baseline for future research and initiatives aimed at addressing the environmental challenges posed by plastic waste in hilly-urban settings.

Recommendations:

1. The ULB must rigorously enforce the PWM Rules, 2016, as amended, within the city to ban the use of prohibited single-use plastic items.

2. A huge dump of multilayer plastic packaging waste and Single use plastic carry bags were seen in the dump/processing site. Appropriate actions should be taken to handle these wastes in accordance with the regulations. The Shillong Municipal Board (SMB) has recently begun sending these wastes to nearby cement plants for co-processing, as reported by their representatives.

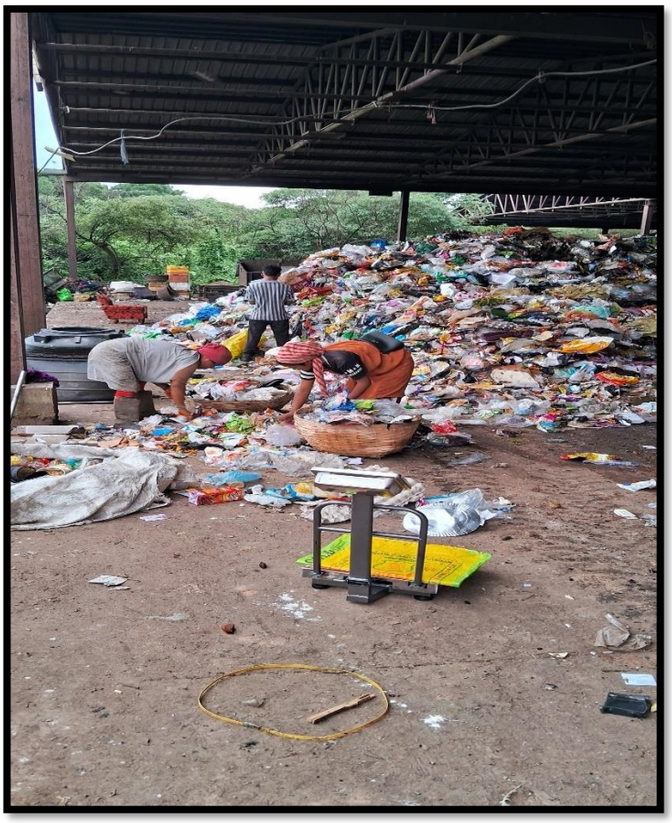
Photographs taken during the Assessment

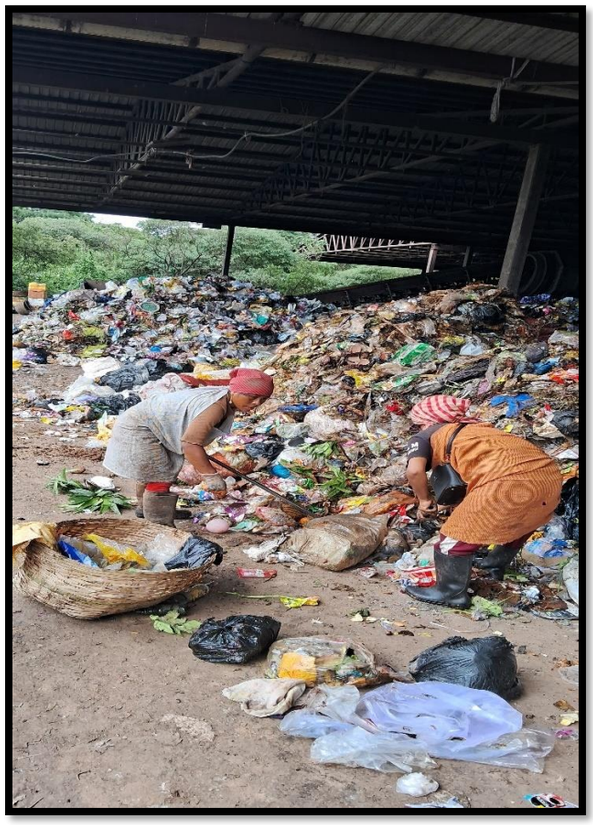




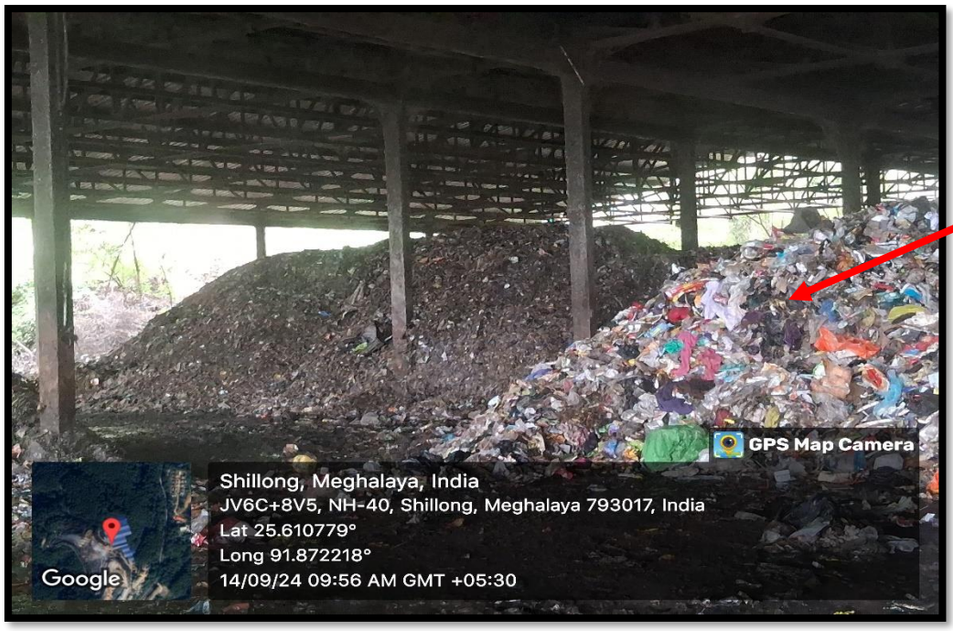



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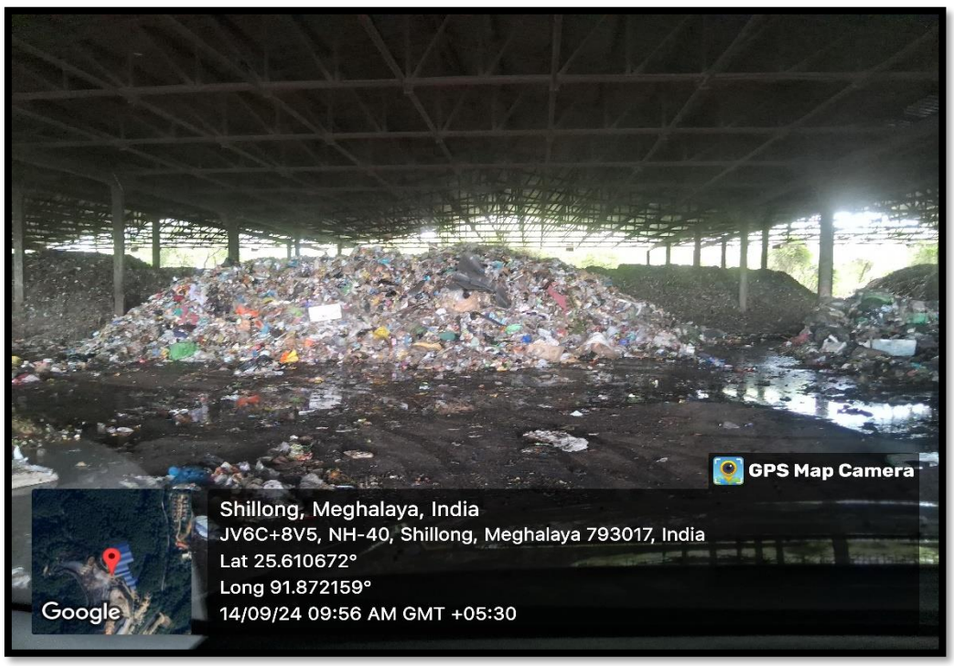


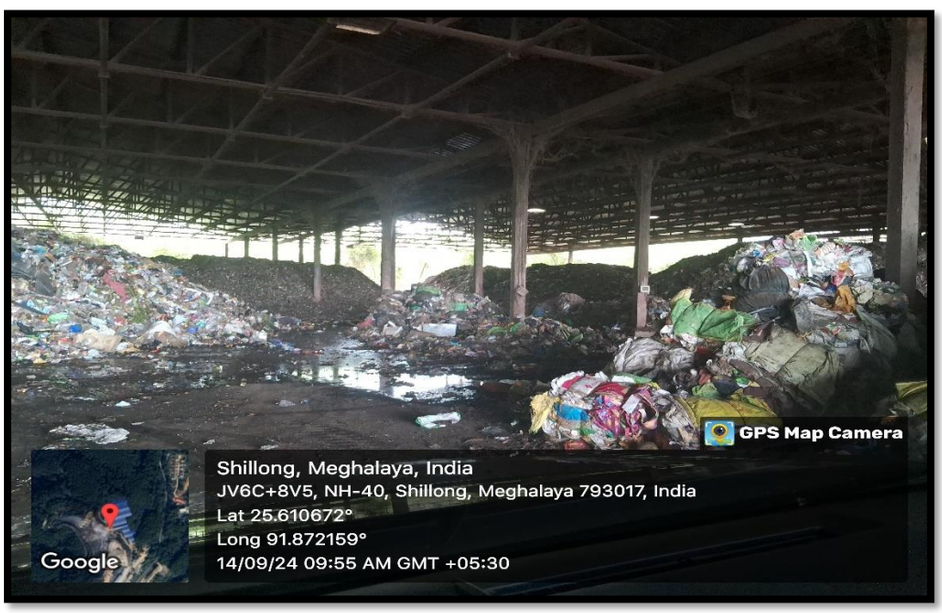



ML 01 7593



Dump of plastic waste after separation





Central Pollution Control Board
Regional Directorate, Bhopal

Report On Assessment and Characterization of Plastic Waste at Bhopal M.P.

With reference to HO letter dated 03.07.2024 regarding the assessment and Characterization of Plastic Waste, study carried out at Bhopal during 05.08.2024 to 09.08.2024 at various Garbage Transfer Stations and final disposal site at Aadampur.

The main objectives of the study are as follows:

i. Assessment and Characterization of Plastic Waste.
ii. Quantification of plastic in MSW.
iii. Characterisation of plastic waste under EPR categories.
iv. Characterization and quantification of banned SUP items in MSW.

The RD, Bhopal conducted study in Bhopal under 'Assessment and Characterization of Plastic Waste in Bhopal'. The study involved assessment and characterization of plastic waste in different areas of Bhopal. The protocol of ASTM as well as methodology involving quartering and coning process as per SOP of CPCB has been followed for sampling for quantification of plastic waste from the total solid waste from generation and disposal sites. The objective of this study is to identify the current status of the waste composition, and generation, and also to understand the existing ecosystem of plastic production, plastic waste recycling, and its management in Bhopal. Bhopal is having a door-to-door collection, good waste segregation, and waste processing infrastructure.

To assess the management of plastic waste w.r.to above points the Garbage Transfer Station and material recovery facility (MRF) established by Bhopal Municipal Corporations were visited along with the officials of MPPCB and Municipal Corporation. The following team members conducted the study:

1. Dr Anoop Chaturvedi, Scientist B
2. Sh Arvind Singh Scientist, MPPCB Bhopal
3. Sh. Aarsh Tiwari, SSA
4. Sh. Jagjeevan JLA
5. Ms. Alfa Monika Lakda, JLA
6. Sh. Shiv Kumar Kushwaha,JLA
7. Sh Surendra Ku Bhatiya, MTS
8. Officials of Municipal corporation

The population of Bhopal is approximately 1798218 as per census 2011, a dynamic urban landscape unfolds where the majority of residents belong to the middle-income group. Apart from residential areas there are few slum areas within the city with market hubs including wholesale and retail shops. To efficiently manage the generated waste, Nagar Nigam has signed MOU with waste management agency. All generated waste is collected by Nagar Nigam from 11 Garbage Transfer Stations (GTS) located in different areas. The Material Recovery Facility has been installed in all the GTS to recover the recyclable items including plastic. Recyclable material are manually separated and remaining are being sent to the disposal site of the city i.e. Aadampur for further recovery of RDF.

During the characterization exercise, the waste was primarily categorized as dry and wet waste. The dry waste was further categorized into dry waste other than plastic (cardboard; paper and millboard; shoes-leather and rubber separately; cloth; metal; glass; domestic Hazardous waste; compostable bags) and plastic waste further categorized in 4 categories as per EPR (PET; HDPE; LDPE; PVC; PP; PS; MLP and packaging wrappers) and SUP to get a clear understanding of the waste types obtained during the characterization.

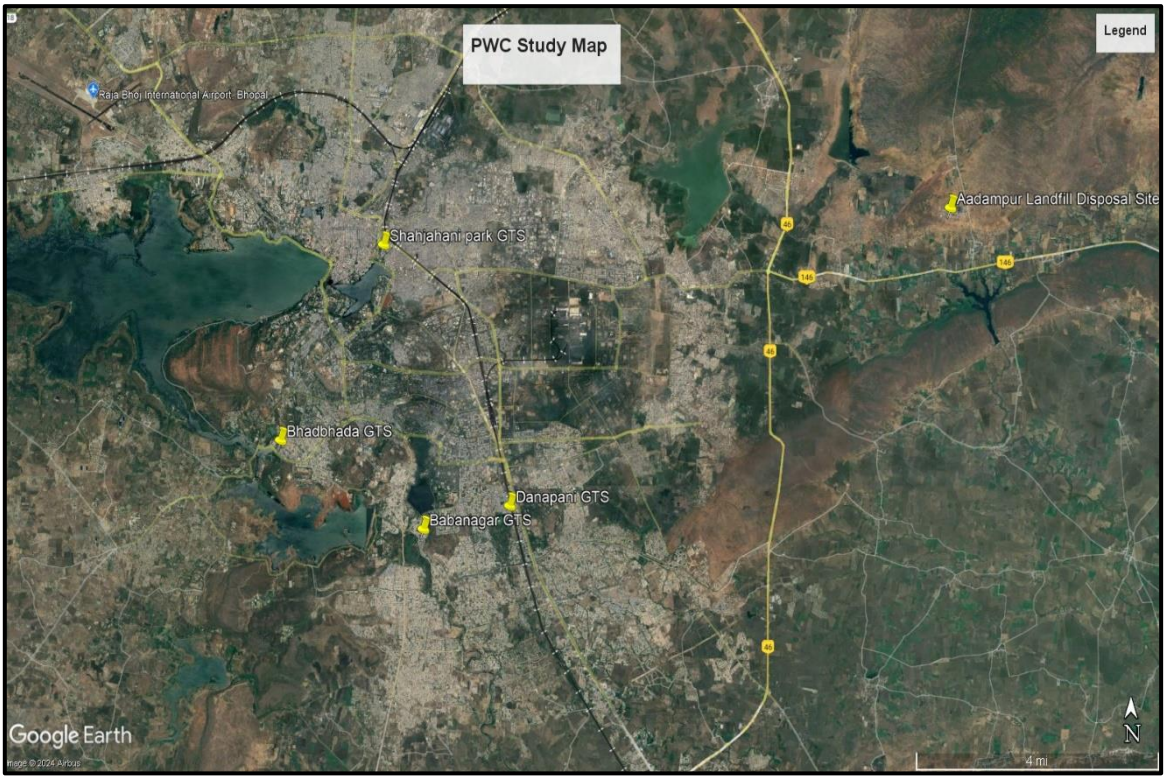
Step One: Determination of parameter for waste Characterization

- No. of Vehicle to be sampled (n): 45 (9 vehicle in a day)
- Duration of sampling (No of Days) (k): 5
- Vehicle load size: 315 to 530 kg
- Sorting Sample size: 85 to 150 kg

Step Two: Distribution of the sampling locations

City area is divided into four zones East, West, North & South and subsequently various wards in the zone are divided into Middle-income residential wards, Economically Weaker Section (EWS) residential wards/slums and Commercial wards (Market Area) and others. In addition, one disposal point is also identified in each Zone and centralised disposal site of city. Location distribution, Map & details are given below:

S.No	Location	Zone covered	Remark
01	Dana-Pani GTS	6, 10, 11, 12, 19	It covers Arera colony and Shahpura area.
02	Baba Nagar GTS	7, 8, 18, 21	It covers Kolar road and E-8 area
03	Bhadbhada GTS	6, 8, 21	It covers New market, neelbad, Nehru nagar area
04	Shahjhani Park GTS	5, 7, 11	It covers old Bhopal area
05	Aadampur landfill site	All zones	It is located at outside of Bhopal and having RDF and composting facility.



According to the present waste collection process in Bhopal, plastic is collected with dry waste and from there it goes to a GTS for further sorting of recyclable material in MRF and sent to disposal site through big size capsule containers having the capacity of 14 to 18 Ton. The MRF is a facility that receives materials and then uses a combination of equipment and manual labour to separate and densify materials in preparation for shipment downstream to recyclers of the particular materials recovered. Typical materials recovered at MRFs includes ferrous metal, thermocol, PVC & Nylone shoe soles, PET, HDPE, and mixed paper etc. after preliminary sorting of the plastic the collected waste sent to main disposal site for further conversion of remaining waste material into RDF. The RDF bales are then sold to local cement manufacturers unit.

As per information in Bhopal approx. 800 TPD mixed solid waste generated and 35 TPD inert sent for final disposal after recovery of material, composting and RDF.

Step Three: Sample Preparation

A total 5 locations (GTS & Dumping Site) were selected for discharge of designated vehicle loads, manual sorting activities, and weighing operations. The location found to be flat, level, and away from the normal waste handling and processing areas.

- The entire vehicle load was discharged in a designated area.
- The sampled waste was mixed and using the Quartering and coning, the vehicle load size (315-530 kg) reduced to Sorting sample size (85-150 kg).
- The entire vehicle load has been disposed on the ground and divided into four parts. Two samples positioned diagonally opposite to each other were selected for the next step, the other two were discarded. The process was repeated to reduce the size of the sample from 100 % to 25 %.

Step Four.: Assessment of Plastic Waste is given below:

1. Quantity of Plastic Waste Generation
   39650.76 TPA

2. Quantity of Plastic Packaging Waste Generation
   34457.97 TPA

3. Quantity of SUP Waste Generation
   5695.09

4. Quantity of Other (Non-packaging waste)
   252349.24 TPA

5. Quantity of Plastic Waste Disposed
   677.82 TPA

6. Quantity of Plastic Packaging Waste Disposed
   594.03 TPA

7. Quantity of SUP Waste Disposed
   113.48 TPA

8. Quantity of Other (Non-packaging waste) Disposed
   12097.17 TPA

9. Quantity of Plastic waste Utilised/Processed
   38972.934 TPA

The average quantity of plastic waste generation has been estimated as 13.57% of total mixed solid waste. The single-use plastics (SUP) with respect to total mixed solid waste is found approx. 2 % and after collection by Nagar Nigam approximately 98 % of plastic either processed in MRF/RDF/Recycled.

Challenges Faced During the Study

- Cherry Picking of the waste especially category-1 is common issue in all the GTS.
- Waste collection and segregation/sorting at MRF centre is integral part of GTS. After segregation of valuable materials, remaining waste sent to landfill site for making of RDF. Hence finalisation of end disposal point was found to be difficult.
- Non-Woven bags not considered either in EPR or SUP during study.
- The quantity of inert waste disposed at landfill site was taken from Form-V i.e. annual report of PWM.

- Quantity of plastic waste may vary during festive season, summer & rainy season etc.

The plastic waste characterisation and quantification data for both generation and disposal points are enclosed in the Annexures as given below.

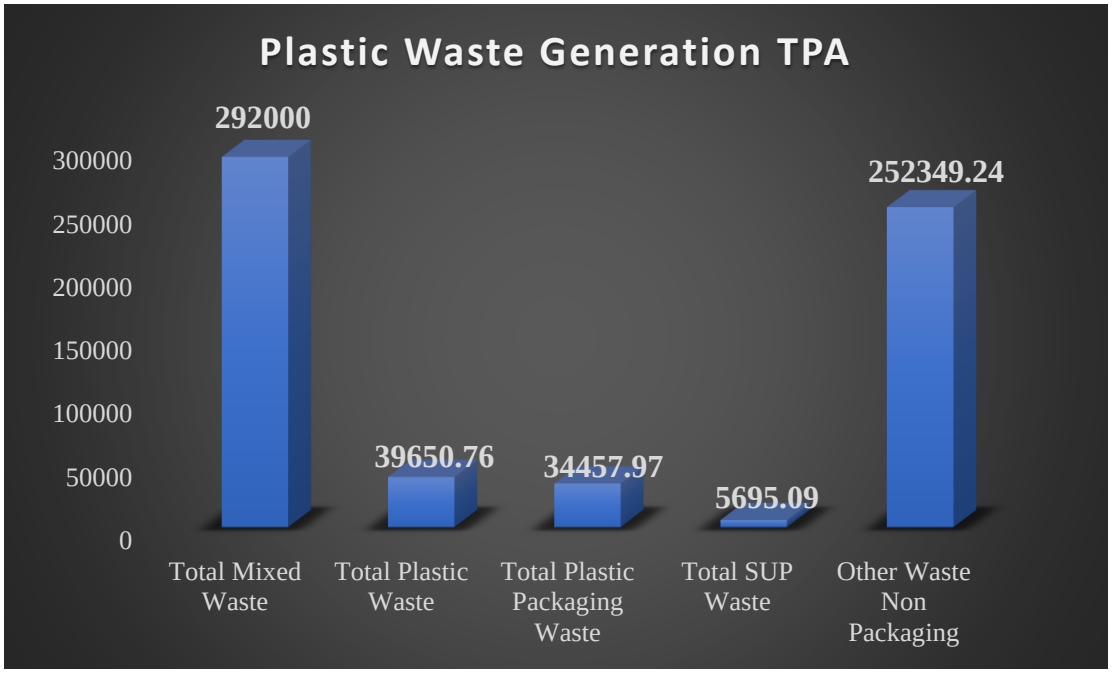
Annexure-I: Plastic Waste Generation Data

Annexure II: Single Use Plastic Generation Data

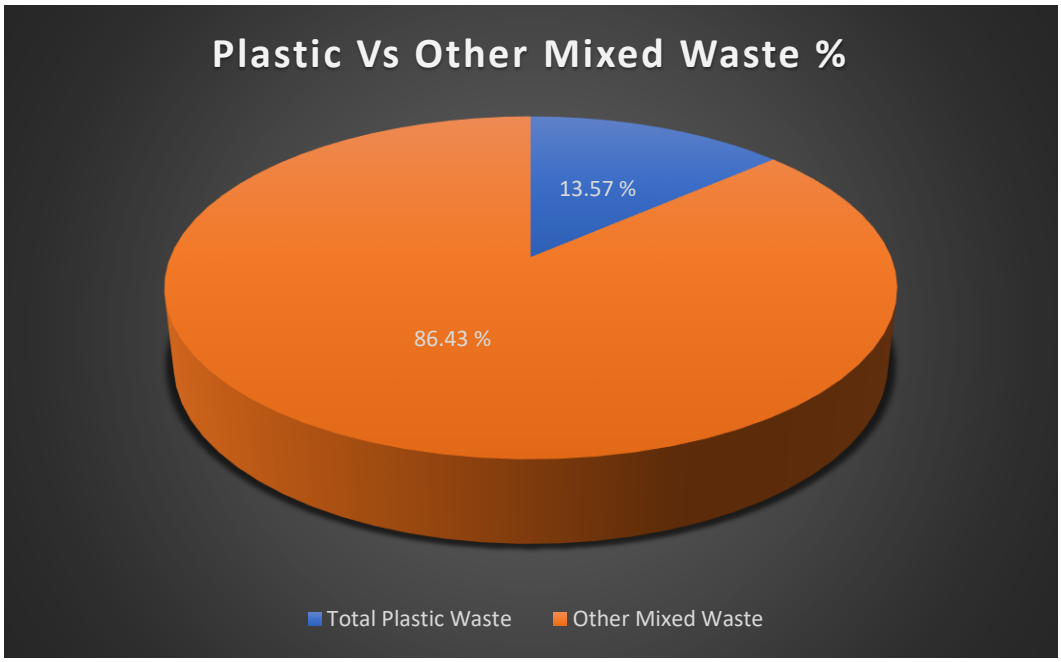
Annexure III: Plastic Waste Disposal Data

Annexure IV: Single Use Plastic Disposal Data

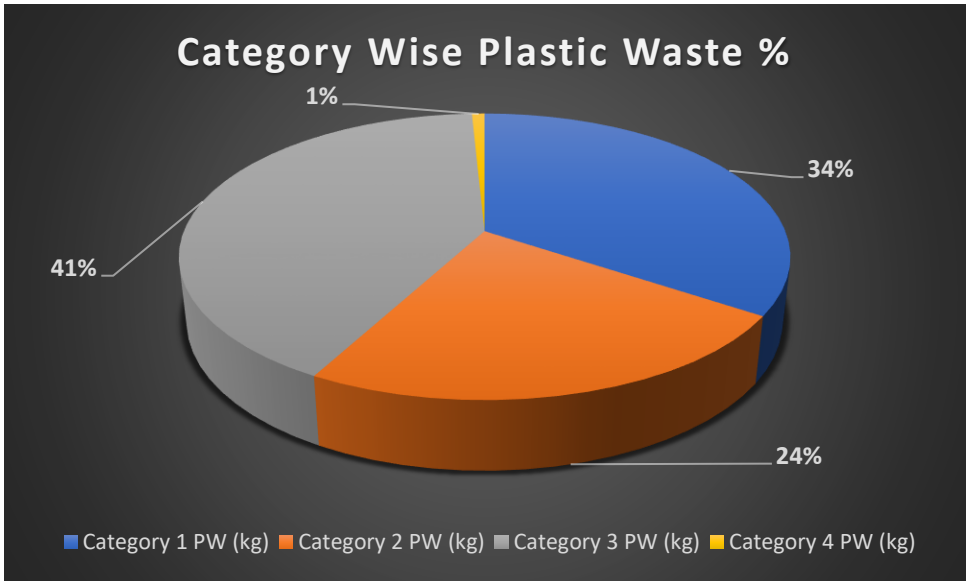
Plastic Waste Generation TPA



Plastic Vs Other Mixed Waste %



Category Wise Generated Plastic Waste %



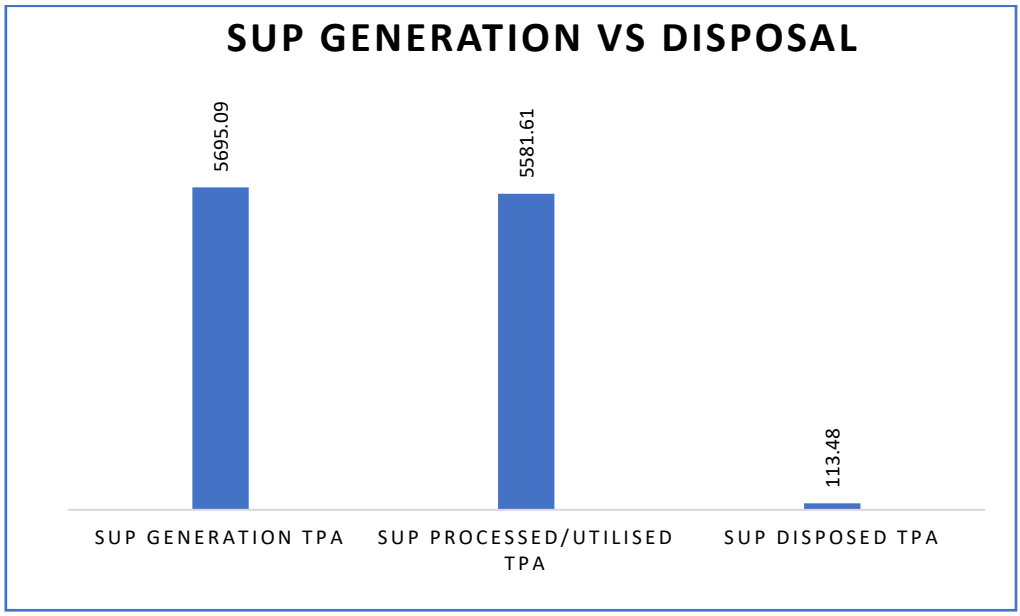
% of Packaging Waste and SUP at Generation Point



Plastic Waste Utilisation



SUP Generation Vs Disposal Data



Photograph of Study



Characterisation Team at GTS



Preparation of Characterisation



Mixed Waste Sorting



Quartering & Coning of Mixed Waste



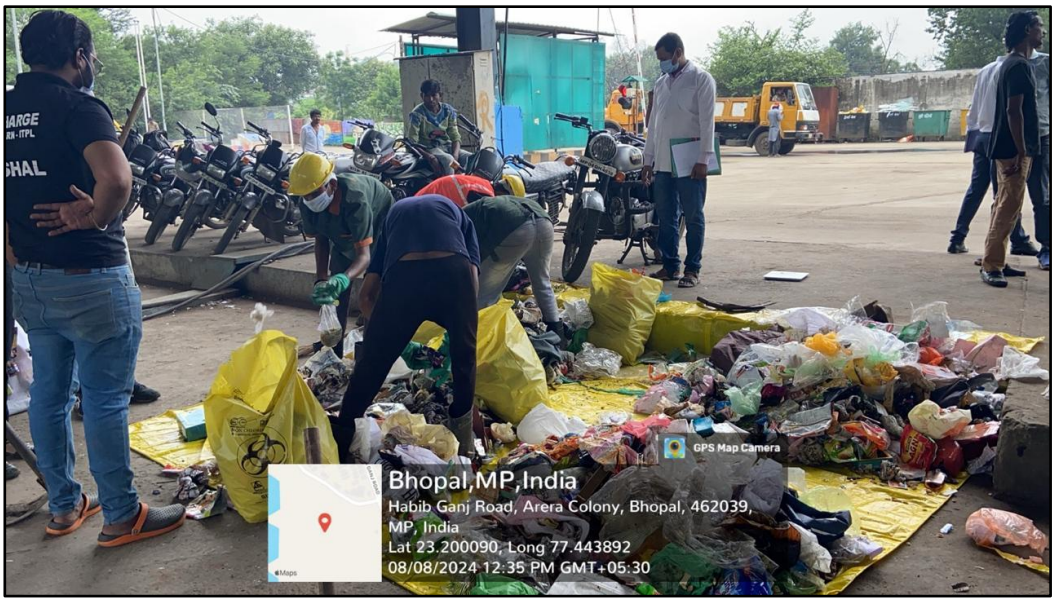
Quartering & Coning of Mixed Waste





Waste Characterisation at Disposal Site





Quartering & Coning at GTS & Disposal Site





Mixed Waste Sorting



Quantification of Category-I Plastic



Sample Preparation at Aadampur Dumping Site



Weighing of Sorted Plastic Waste

Central Pollution Control Board Regional Directorate Bhopal
Plastic Waste characterization at Generation points

Vehicle No	Date & Location	Area	Total Waste (Dry + Wet)	Sorting Sample Size (Kg)	Total Plastic Waste (Kg)	Category 1 PW (kg)	Category 2 PW (kg)	Category 3 PW (kg)	Category 4 PW (kg)
MP04-LD-0144	Danapani 05.08.2024	Zone-12 Ward 58	460	115	14.6	3.8	3.08	5.6	0.2
MP04-DB-1310		Zone-10 Ward 49	330	85	11.9	2.8	2.7	4.7	0.1
MP04-GB-3480		Zone-6 Ward 51	470	120	15.2	4.2	2.93	6.2	0.15
MP04-GB-3157		Zone-13 Ward 53	345	90	14.9	4.8	3	5.3	0
MP04-LD-0155		Zone-13 Ward 55	385	100	15.8	5.2	3.4	5.45	0.1
MP04-GB-3282		Zone-19 Ward 85	475	120	13.3	3.7	2.38	4.8	0
MP04-ZG-5178		Zone-10 Ward 49	355	90	12.5	3.6	2.89	4.5	0
MP04-GB-3258	Baba Nagar 06.08.2024	Zone-8 Ward 46	425	106	15.9	4.05	3.1	6.4	0.2
MP04-GB-3060		Kolar Road Zone-18	450	112	17.2	3.45	3.45	8.15	0.6
MP04-LD-6276		Kolar Road Zone-18	480	120	16.2	4.2	3.25	4.95	0.15
MP04-GB-3083		Zone-8 Ward 30	390	90	15.4	4.6	3	5.7	0
MP04-GB-4839		Zone-18 Ward 83	485	120	16.85	5.2	3.3	6.1	0.1
MP04-GB-3438		Zone-21 Ward 25	345	90	14.4	5	2.4	5.4	0.1
MP04-GB-4595		Zone-7 Ward 31	500	125	16	4.8	3.5	5.7	0.15
MP04-GB-4559	Bhadbhada 07.08.2024	Zone-8 Ward 27	315	80	11	3	2.55	4	0
MP04-GB-3057		Zone-6 Ward 47	405	110	13.5	4	2.5	4.85	0
MP04-LD-0126		Zone-8 Ward 29	415	110	14.45	4.6	3.3	5.3	0
MP04-LD-0388		Zone-21 Ward 24	355	90	12.3	3.2	2.9	4.7	0.1
MP04-GB-3156		Zone-8 Ward 28	460	120	15.7	4.5	2.8	5.8	0.15
MP04-LD-6280		Zone-21 Ward 32	490	120	13.6	3.8	3.3	4.8	0.1
MP04-GB-3316		Zone-7 Ward 31	420	105	14	4.7	2.5	5.2	0
MP04-LD0122	Shahjani Park 08.08.2024	Zone-5 Ward 22	575	140	17.2	5.6	3	6.3	0.2
MP04-GB-3165		Zone-7 Ward 34	560	130	14.2	4.2	3	4.9	0
MP04-LD-0141		Zone-11 Ward 41	460	115	12.9	3.85	2.5	4.4	0.1
MP04-LD-6290		Zone-11 Ward 70	585	150	16.4	4.55	2.9	5.9	0.15
MP04-ZG-4563		Zone-5 Ward 19	530	130	14.6	5.2	2.95	4.45	0.1
MP04-ZG-4535		Zone-7 Ward 35	500	125	16.3	4.4	3	6.2	0.15
MP04-LD-3276		Zone-7 Ward 33	440	110	13.8	4.1	3.05	4.2	0
MP04-LD-1456	Danapani & Bhadbhada 09.08.2024	Zone-21 Ward 32	355	90	15.3	3.9	4.6	5.2	0
MP04-GB-3190		Zone-8 Ward 30	420	100	14.8	5.1	2.75	4.95	0.15
MP04-LD-6286		Zone-10 Ward 45	400	100	15.4	6.3	3.35	4.25	0
MP04-LC-9659		Zone-12 Ward 59	405	100	16.7	5.7	3.65	5.3	0.2
MP04-GB-3369		Zone-7 Ward 33	485	120	17.8	6.2	3.4	5.8	0.15
MP04-ZG-4572		Zone-11 Ward 35	525	125	16.7	5.1	3.4	6.1	0.1
MP04-GB-2950		Zone-18 Ward 83	395	100	16.4	4.6	3.55	6.2	0.1
Total				3853	523.2	156	107.33	187.75	3.6

1	Average Quantity of Plastic waste Generated (Kg of plastic waste/kg of mixed waste) **Q1**	0.135790293
	Quantity of Mixed Waste generated in town TPA **Q**	292000
	Quantity of Plastic Waste Generation TPA **QT**=Q1*Q	39650.76564

2	Average Quantity of plastic packaging waste generated (Kg of plastic packaging waste/kg of mixed waste) Q2	0.118006748
	Quantity of Mixed Waste generated in town TPA **Q**	292000
	Quantity of Plastic Packaging Waste Generation TPA **Qpack**=Q2*Q	34457.97041

Central Pollution Control Board Regional Directorate Bhopal
Plastic Waste characterization (SUP) at Generation points

	Vehicle Load No.	MP04-LD-0144	MP04-DB-1310	MP04-GB-3480	MP04-GB-3157	MP04-LD-0155	MP04-GB-3282	MP04-ZG-5178	MP04-GB-3258	MP04-GB-3060	MP04-LD-6276	MP04-GB-3083	MP04-GB-4839	MP04-GB-3438	MP04-GB-4595	MP04-GB-4559	MP04-GB-3057	MP04-LD-0126	MP04-LD-0388	MP04-GB-3156	MP04-LD-6280	MP04-GB-3316	MP04-LD0122	MP04-GB-3165	MP04-LD-0141	MP04-LD-6290	MP04-ZG-4563	MP04-ZG-4535	MP04-LD-3276	MP04-LD-1456	MP04-GB-3190	MP04-LD-6286	MP04-LC-9659	MP04-GB-3369	MP04-ZG-4572	MP04-GB-2950	Average Kg/Kg
	Sorting Sample Size (Kg)	115	85	120	90	100	120	90	106	112	120	90	120	90	125	80	110	110	90	120	120	105	140	130	115	150	130	125	110	90	100	100	100	120	125	100	
	Plastic Waste (Kg)	14.6	11.9	15.2	14.9	15.8	13.3	12.5	15.9	17.2	16.2	15.4	16.85	14.4	16	11	13.5	14.45	12.3	15.7	13.6	14	17.2	14.2	12.9	16.4	14.6	16.3	13.8	15.3	14.8	15.4	16.7	17.8	16.7	16.4	
	SUPs (Kg)																																				
Plastic Sticks	Earbuds	0.002	0	0	0.002	0	0.004	0	0	0	0.002	0	0.004	0	0	0	0.004	0	0	0.002	0	0	0.002	0	0	0.004	0	0	0.002	0	0	0	0.002	0	0.002	0	0.006	9.86244E-06
	Balloons	0	0	0	0.01	0	0	0	0	0.012	0	0	0	0	0	0	0.01	0	0	0.011	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0.012	1.687E-05
	Candy	0	0	0	0	0.015	0	0	0	0	0	0.014	0	0	0	0	0	0	0	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.14197E-05
	Ice Cream	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Straws	0.004	0	0	0.012	0	0	0	0.008	0	0	0	0	0.016	0	0	0	0.008	0	0.004	0	0.008	0	0	0	0	0.012	0	0	0	0	0	0.004	0	0	0	0.008	2.18012E-05
Cutlery Items	Plates	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0.15	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	9.08383E-05
	Cups	0.015	0	0	0	0	0	0	0	0	0.015	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0.016	0	0	0	0	0	0	0	0	0	0	1.45341E-05
	Glass	0.04	0.06	0	0	0.1	0	0.15	0	0.2	0	0	0	0.15	0	0	0.3	0	0	0	0.2	0	0	0	0	0.1	0	0.15	0	0	0	0.06	0	0	0.12	0	0.000423047
	Forks	0	0	0.012	0	0	0.014	0	0	0	0	0	0.015	0	0	0.012	0	0	0.015	0	0	0	0.012	0.013	0.014	0	0	0	0.013	0.011	0.014	0	0	0	0	0	3.7633E-05
	Spoons	0.01	0.012	0.015	0	0.012	0	0	0.01	0	0	0	0.02	0	0.01	0.016	0	0.01	0	0	0.01	0.02	0	0	0.008	0	0.012	0	0.028	0.016	0	0.008	0	0.01	0	0	5.89151E-05
	Knives	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trays	0.025	0.01	0.016	0	0.01	0	0.02	0.016	0	0.02	0	0.025	0.01	0	0	0.025	0	0.016	0.015	0	0	0.024	0.01	0	0.02	0	0.015	0	0	0	0.012	0	0.025	0	0.01	0.015	8.79834E-05
Packaging /Wrapping Films	Sweet Box	0.1	0	0	0	0.2	0	0	0	0.1	0	0	0	0	0.2	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000181677
	Invitaion Card	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cigarette Packets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carry Bags	<120 microns	1.32	0.95	1.42	1.6	1.3	2.02	1.31	1.85	1.1	1.65	1.8	1.5	1.2	1.45	1.25	1.85	1.1	0.95	2.1	1.1	1.2	1.75	1.6	1.4	1.9	1.35	2.2	1.75	1.2	0.95	1.15	1.25	1.7	1.3	1.35	0.013202699
Plastic Sheets	<50 microns	0.5	0.3	0.75	0.4	0.8	0.85	0.75	0.9	0.6	0.9	0.8	0.5	0.3	0.9	0.25	0.6	0.3	0.3	0.7	0.4	0.6	0.3	0.5	0.7	0.6	0.45	0.8	0.65	0.8	0.35	0.35	0.4	0.85	0.8	0.65	0.005346483
Other Items	Plastic flags	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PVC banners < 100 µm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	polystyrene for decoration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2.016	1.332	2.213	2.024	2.537	2.888	2.23	2.784	2.012	2.587	2.614	2.064	1.676	2.71	1.528	2.789	1.418	1.281	2.832	1.835	1.828	2.088	2.123	2.122	2.624	1.94	3.175	2.443	2.027	1.326	1.574	1.675	2.562	2.23	2.041	

3	Average Quantity of SUP waste generated (SUP in Kg/Kg of mixed waste) **Q3**	0.019503763
	Quantity of Mixed Waste generated TPA	292000
	Quantity of SUP Waste generated TPA **QSUP**	5695.098884

4	Quantity of other (Non-Packaging waste)	252349.24

Central Pollution Control Board Regional Directorate Bhopal
Plastic Waste characterization at Disposal points

Vehicle Load No	Date	Area	Sorting Sample Size (Kg)	Total Plastic Waste (Kg)	Category 1 PW (kg)	Category 2 PW (kg)	Category 3 PW (kg)	Category 4 PW (kg)
1	05.08.2024	5 Garbage Transfer Point & Final Disposal Site at Aadampur	95	6.06	0.23	1.60	3.62	0.02
2			110	6.66	0.31	2.00	4.00	0.00
3	06.08.2024		115	6.56	0.27	1.77	3.69	0.01
4			110	5.75	0.15	1.73	3.62	0.02
5	07.08.2024		100	5.69	0.31	0.85	3.00	0.00
6			105	5.63	0.23	1.42	3.42	0.00
7	08.08.2024		115	5.69	0.31	0.50	3.35	0.01
8			120	6.50	0.54	2.31	3.88	0.02
9	09.08.2024		100	4.17	0.22	0.93	2.09	0.01
10			110	4.60	0.25	0.91	2.65	0.01
Total			1080	57.30	2.81	14.02	33.31	0.08

5	Average Quantity of Plastic waste Generated (Kg of plastic waste/kg of mixed waste) **Q1**d	0.053058862
	Quantity of Mixed Waste disposed in town TPA **Qd**	12775
	Quantity of Plastic Waste Disposed TPA **QTd**=Q1*Q	677.8269676

6	Average Quantity of plastic packaging waste disposed (Kg of plastic packaging waste/kg of mixed waste) Q2d	0.046499288
	Quantity of Mixed Waste disposed in town TPA **Qd**	12775
	Quantity of Plastic Packaging Waste disposed TPA **Qpackd**=Q2*Q	594.028401

8	Quantity of other (Non-Packaging waste) Disposed TPA **Qother D**	12097.17303

9	Quantity of Plastic waste utilised/processed TPA	38972.934

Central Pollution Control Board Regional Directorate Bhopal
Plastic Waste characterization (SUP) at Disposal points

		Vehicle Load No.1	Vehicle Load No.2	Vehicle Load No.3	Vehicle Load No.4	Vehicle Load No.5	Vehicle Load No.6	Vehicle Load No.7	Vehicle Load No.8	Vehicle Load No.9	Vehicle Load No.10	Average Kg/Kg of waste
	Sorting Sample Size (Kg)	95	110	115	110	100	105	115	120	100	110	
	Plastic Waste (Kg)	6.06	6.66	6.56	5.75	5.69	5.63	5.69	6.50	5.84	6.44	
	SUPs (Kg)											
Plastic Sticks	Earbuds	0	0	0	0	0	0	0	0	0	0	0
	Balloons	0	0	0	0	0	0	0	0	0	0	0
	Candy	0	0	0	0	0	0	0	0	0	0	0
	Ice Cream	0	0	0	0	0	0	0	0	0	0	0
	Straws	0.001	0	0.004	0	0	0	0	0.001	0	0	5.55556E-06
Cutlery Items	Plates	0	0	0	0	0	0	0	0	0	0	0
	Cups	0	0.005	0	0	0	0	0.006	0	0	0	1.01852E-05
	Glass	0.02	0	0	0.01	0	0	0.01	0	0	0	3.7037E-05
	Forks	0	0	0.004	0	0.006	0	0	0	0	0	9.25926E-06
	Spoons	0.004	0	0.007	0	0	0	0	0	0.004	0	1.38889E-05
	Knives	0	0	0	0	0	0	0	0	0	0	0
	Trays	0	0.005	0.01	0	0.008	0	0.015	0	0	0.004	3.88889E-05
Packaging /Wrapping Films	Sweet Box	0	0	0	0	0	0	0	0	0	0	0
	Invitaion Card	0	0	0	0	0	0	0	0	0	0	0
	Cigarette Packets	0	0	0	0	0	0	0	0	0	0	0
Carry Bags	<120 microns	0.32	0.1	0.3	0.3	2	0.3	2	0.4	1.1	1.65	0.007842593
Plastic Sheets	<50 microns	0.1	0.1	0	0.1	0.2	0.2	0.1	0.2	0	0	0.000925926
Other Items	Plastic flags	0	0	0	0	0	0	0	0	0	0	0
	PVC banners < 100 µm	0	0	0	0	0	0	0	0	0	0	0
	polystyrene for decoration	0	0	0	0	0	0	0	0	0	0	0
	Total	0.445	0.21	0.325	0.41	2.214	0.5	2.131	0.601	1.104	1.654	

7	Average Quantity of SUP waste at disposal (SUP in Kg/Kg of mixed waste) **Q3**d	0.008883333
	Quantity of Mixed Waste disposed TPA	12775
	Quantity of SUP Waste disposed TPA **QSUPd**	113.4845833

Annexure D

Report on Characterization and Assessment of Plastic Packaging Waste and SUPs in Kolkata



CENTRAL POLLUTION CONTROL BOARD
REGIONAL DIRECTORATE, KOLKATA

(AUGUST, 2024)

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1. Introduction

The Plastic Waste Management (PWM) Rules of 2016, along with subsequent amendments, provide a comprehensive statutory framework for the effective management of plastic waste in India. Local bodies are required to assess the quantity of plastic waste generated within their jurisdictions and report this data annually to the State Pollution Control Boards (SPCBs) or Pollution Control Committees (PCCs).

To address the inconsistencies in plastic waste assessment methodologies across different regions, the Central Pollution Control Board (CPCB) has developed a Standard Operating Procedure (SOP) for plastic waste characterization and assessment. This SOP provides a standardized approach, ensuring accurate and consistent data collection and reporting across the country. The procedures outlined include sampling methods, waste characterization, data validation, and reporting guidelines, supporting better regulatory compliance and effective plastic waste management in India.

As part of the action plan for Plastic Waste Management, the Regional Directorates (RDs) are tasked with carrying out the characterization and assessment of plastic packaging waste and single-use plastics (SUPs) in one city within their jurisdiction, following the procedures outlined in the SOP.

In accordance with these directives, the Regional Directorate, Kolkata conducted the characterization and assessment of plastic packaging waste within the Kolkata Municipal Corporation (KMC) area. The Dhapa landfill site was designated as the disposal point, and 18 Wards under the KMC, whose waste is disposed of at the Dhapa landfill site, were selected as the generation points for this study. The study was carried out during 23.08.2024 to 30.08.2024 and KMC alongwith WBPCB also participated actively in the study.

2. Actions Taken for initiation of study

Upon receiving communication from Central Pollution Control Board, Delhi regarding characterization and assessment of plastic packaging waste vide their letter no. CP-20/117/2021-UPC-II-HO-CPCB-HO-Part (7) dated 03.07.2024, several key actions were undertaken to initiate and carry out this study:

- 15.07.2024: A letter was sent by CPCB RD Kolkata to West Bengal Pollution Control Board (WBPCB) requesting for coordination with the study.
- 05.08.2024: A meeting was held at the State Urban Development Agency (SUDA) with officials from SUDA, KMC, and WBPCB to request these concerned authorities for their valuable cooperation in carrying out the study.
- 07.08.2024: A follow-up meeting was conducted at WBPCB with officials from WBPCB, SUDA and KMC. During this meeting, CPCB presented a brief overview along with methodology of the study and discussed the future plan of action.
- 08.08.2024: A letter was sent to Chief Municipal Engineer, KMC requesting for ‘Sample Plan Location Distribution’ and necessary arrangements for the study.

- 12.08.2024: CPCB, WBPCB, and KMC officials conducted a field visit to assess the availability of on ground logistics and identify additional requirements for the study.
- 20.08.2024: In a meeting held at KMC; CPCB and KMC officials decided the sampling locations based on their socioeconomic status and finalized the corresponding dates for sampling of those locations. Accordingly, the study was commenced on 23.08.2024.

3. Study Area: Kolkata Municipal Corporation

Kolkata is the capital city of West Bengal. Kolkata Municipal Corporation comprises of 16 Boroughs divided into 144 Wards. According to its District Environment Plan 2021, Kolkata generates 4500 MT of solid waste per day, of which 217 TPD is plastic waste.

For our study, 18 Wards under the KMC were distributed across four zones i.e. North, South, East, and West, based on their geographic locations. KMC further provided the socioeconomic categorization of each these Wards, which was essential for the study. Solid waste generated from 18 wards is around 19,50,30.58 TPA and disposed at Dhapa landfill. Dhapa landfill is situated in the Eastern side of Kolkata i.e. in Ward No. 57 under Borough No. VII). The selected Wards are highlighted in the below provided figure.

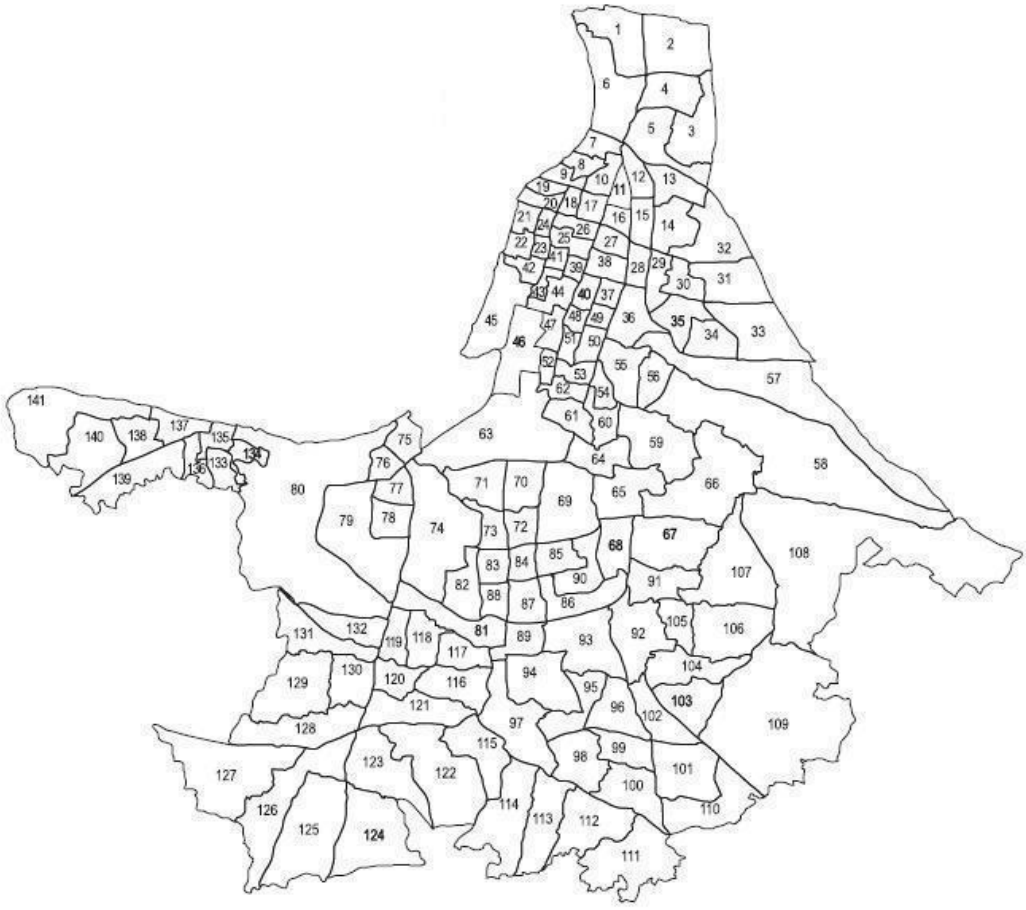


Fig: Wards of Kolkata Municipal Corporation

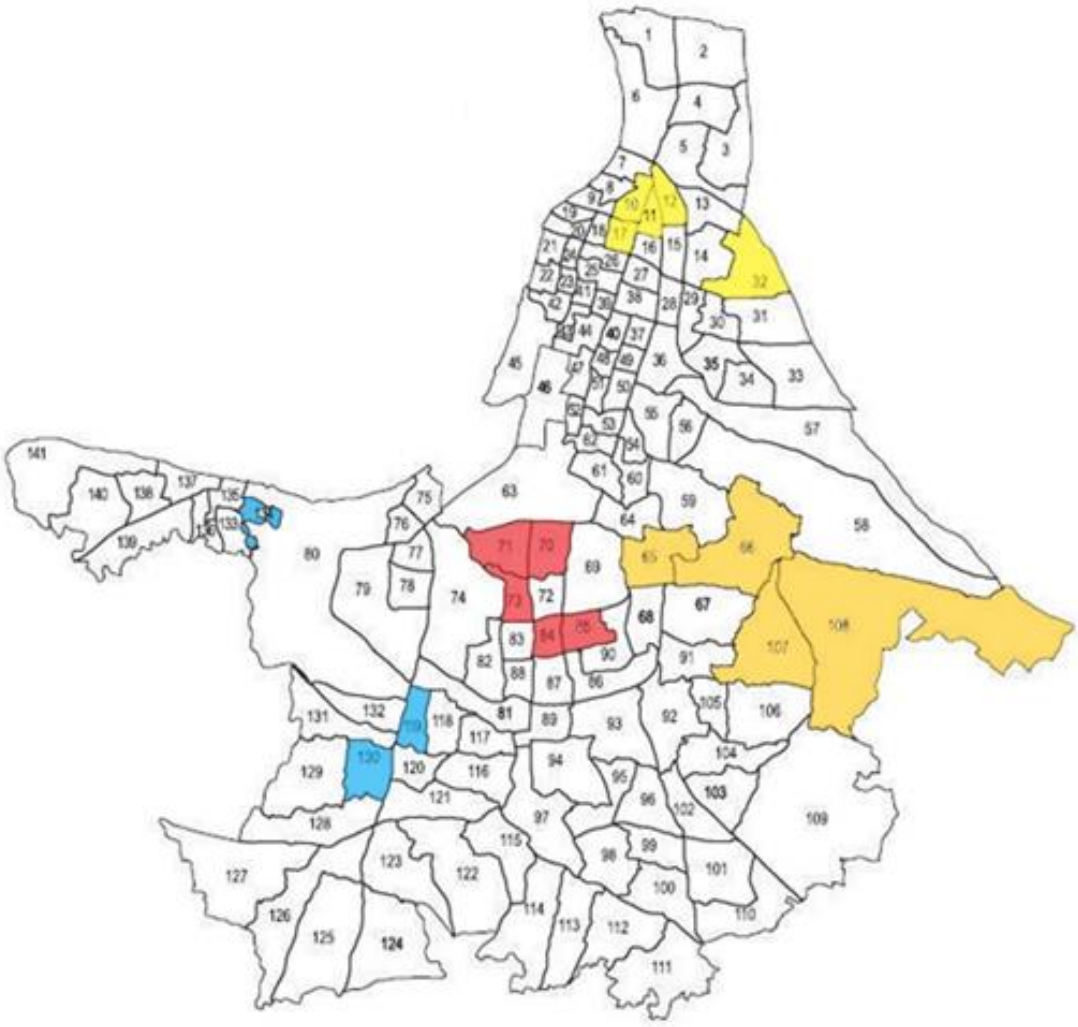


Fig: Wards selected for the study

	North Kolkata
	South Kolkata
	East Kolkata
	West Kolkata

3.1 Ward-wise Waste Generation and Disposal (as per information provided by KMC)

Sl. No.	Location	Ward No.	Total waste (Wet+Dry) generated (TPA)	Total waste (Wet+Dry) disposed (TPA)
1.	North Kolkata	12	2893.53	2893.53
		32	15504.75	15504.75
		10	4453.77	4453.77
		11	5248.88	5248.88
		17	4362.34	4362.34
2.	South Kolkata	84	7536.37	7536.37
		70	6585.36	6585.36
		71	7919.89	7919.89
		85	3095.95	3095.95
		73	7008.08	7008.08
3.	East Kolkata	107	28670.73	28670.73
		65	19011.02	19011.02
		108	19763.04	19763.04
		66	44754.03	44754.03
4.	West Kolkata	144	2757.37	2757.37
		119	2532.67	2532.67
		134	6267.44	6267.44
		130	6665.36	6665.36
		Total	195030.58	195030.58

3.2 Sampling Location Distribution

Considering categories to be covered as per SOP, these below-mentioned 18 Wards were selected to cover all the categories such as MI, EWS, CW, MX. These Wards were suggested by KMC considering ease of vehicle movement and sample collection for the study.

Table 1: Sampling Wards and schedule

		North Kolkata		South Kolkata		East Kolkata		West Kolkata		Total sampling point
Date	Day	Category	Location	Category	Location	Category	Location	Category	Location	
23.08.2024	1	MI	Borough 2, Ward 12	EWS	Borough 8, Ward 84	CW	Borough 12, Ward 107	MX	Borough 16, Ward 144	4+4
24.08.2024	2	EWS	Borough 3 , Ward 32	CW	Borough 8, Ward 70& 71	MX	Borough 7, Ward 65	MI	Borough 13, Ward 119	4+4
27.08.2024	3	CW	Borough 2, Ward 10& 11	MX	Borough 8, Ward 85	MI	Borough 7, Ward 108	EWS	Borough 15, Ward 134	4+4
28.08.2024	4	MX	Borough 2 , Ward 17	MI	Borough 9, Ward 73	EWS	Borough 7, Ward 66	CW	Borough 14, Ward 130	4+4
29.08.2024	5	-	-	CW	Borough 8, Ward 70& 71	CW	Borough 12, Ward 107	MX	Borough 16, Ward 144	3+4
30.08.2024	6	EWS	Borough 3 , Ward 32	-	-	-	-	MI	Borough 13, Ward 119	2+4

Key:
- MI: Middle Income
- EWS: Economically Weaker Section
- CW: Commercial Wards
- MX: Mixed

4. Methodology

The sampling of mixed waste at the Dhapa landfill was conducted from 23rd August to 30th August 2024 in the presence of officials from the CPCB and KMC. Prior to the commencement of the study, KMC personnel involved in on-site segregation were thoroughly briefed to ensure the study adhered to the SOP. However, it is important to note that heavy to moderate rainfall on three out of the six sampling days may have slightly added to the weight of the waste, as characterization had to be carried out in an open area.

Waste collected from the respective Wards was delivered to their designated Compactor Stations. Each day, 200 to 400 kg of mixed waste (depending on availability) from the selected Wards was sampled to assess and characterize plastic waste at the generation point. However, the compactor stations also received mixed waste from other Wards which were not part of this study. After compaction at the stations, the waste was transferred to the Dhapa landfill site vide tipper trucks arranged by the KMC as per requirement of sampling as mentioned in the SOP. From the waste sent at the landfill site, 200 to 400 kg was sampled to assess and characterize plastic waste at the disposal point.

Characterization was carried out by reducing the sample size to 100 to 150 kg using the coning and quartering method as outlined in the SOP. Plastics were then manually segregated from the reduced sample, and the weights of total plastic waste and each category of plastic waste, including SUPs, were recorded.



Pic: Collection of waste by Kolkata Municipal Corporation at Ward level



Pic: Coning of waste before reduction



Pic: Quartering of waste for reduction



Pic: Segregation of waste as per category



Pic: Weighing of segregated waste

5. Conclusion

The study provides a summarized account of plastic waste generation, disposal, and processing in Kolkata, highlighting the probable scale of plastic waste management in the region.

As per Annual Reports of 2020-21 on Solid Waste and Plastic Waste published by CPCB, percentage of plastic waste generated in West Bengal is approximately 0.08% of solid waste generated. As per 'District Environment Plan 2021' of Kolkata, percentage of plastic waste generated is approximately 0.05% of solid waste generated.

From the above study of 18 Wards under KMC and about 9560 Kg of municipal solid waste at generation point and 13165 Kg at disposal point were assessed over the 6 days period at an average of 1,643.33 Kg per day of solid waste from generation point and 2,194.16 Kg per day of solid waste from disposal point.

It is observed that 249 Kg of plastic waste from solid waste of generation point and 261.83 Kg of plastic waste from solid waste of disposal point were segregated out of the total waste of 9560 Kg of generation point and 13165 Kg of disposal point respectively. Thus, plastic waste is found to be around 0.03% of total solid waste for generation point and 0.02% of total solid waste for disposal point respectively. SUPs are found to be 157.92 Kg out of total plastic waste at generation point and 161.46 kg out of total plastic waste at disposal point. Considering the category of plastic waste w.r.t generation point; Cat-I is 1.85%, Cat-II is 6.37% and Cat-III is 3.45% out of the total plastic waste. For disposal point; Cat-I is 1.09%, Cat-II is 5.79% and Cat-III is 3.87% out of the total plastic waste. Variation of quantities segregated w.r.t generation and disposal point is around 0.5%. Maximum quantity is for Category-II i.e. flexible plastics.

Details of characterization and assessment of plastic waste in the selected Wards of KMC are provided in Annexure - I.

Photographs taken on each day of the study are also attached as Annexure - II.

6. Annexure – I

6.1 Table 2A: Plastic Waste Characterization at Generation Point

Vehicle Load No.	Sorting Sample Size (Kg)	Total PW (kg)	Category 1 PW (Kg)	Category 2 PW (Kg)	Category 3 PW (Kg)	Category 4 PW (Kg)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	115	13.97	0.9	9.5	3.56	0.0
2	115	10.2	0.68	6.74	2.72	0.0
3	65	13.0	3.2	9.23	0.57	0.0
4	55	8.34	1.83	3.85	2.65	0.0
5	76	19.01	7.16	8.06	3.78	0.0
6	115	10.8	1.4	7.2	2.2	0.0
7	81	18.26	2.25	11.08	4.92	0.009
8	142	17.02	1.9	9.97	5.15	0.0
9	110	7.32	0.99	3.87	2.45	0.0
10	110	13.4	2.7	7.3	3.4	0.0
11	115	12.0	2.8	5.6	3.6	0.0
12	117	15.3	0.78	9.58	4.93	0.0
13	110	19.66	1.21	9.56	8.88	0.0
14	62	5.32	1.72	2.0	1.6	0.0
15	105	11.4	1.0	8.4	2.0	0.0
16	92	6.6	1.0	4.0	1.6	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0
18	110	9.05	1.1	4.35	3.6	0.0
19	110	8.86	1.62	2.24	5.0	0.0
20	90	10.16	2.21	5.04	2.91	0.0
21	100	8.3	1.07	2.36	4.87	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0
24	120	10.8	2.0	5.6	3.2	0.0
Total	2115	248.77	39.52	135.53	73.59	0.009

6.2 Table 2B: Plastic Waste Characterization at Disposal Point

Vehicle Load No.	Sorting Sample Size (Kg)	Total PW (kg)	Category 1 PW (Kg)	Category 2 PW (Kg)	Category 3 PW (Kg)	Category 4 PW (Kg)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	122	14.27	1.59	8.92	3.74	0.0
2	145	14.37	1.47	8.56	4.45	0.0
3	135	10.05	0.69	5.89	3.46	0.0
4	108	10.68	0.0	6.52	4.15	0.0
5	105	16.27	2.0	8.43	5.84	0.0
6	85	11.5	1.56	6.22	3.72	0.0
7	137	10.77	0.23	5.79	4.74	0.0
8	71	13.56	1.23	7.86	4.46	0.0
9	76	15.3	1.82	7.06	6.4	0.0
10	74	6.3	1.0	3.0	2.3	0.0
11	125	10.16	0.5	5.0	4.66	0.0
12	86	14.24	1.1	9.14	4.0	0.0
13	132	14.61	0.31	8.83	5.47	0.0
14	135	11.65	0.8	5.5	5.35	0.0
15	132	15.86	1.4	7.96	6.5	0.0
16	105	8.23	0.87	4.17	3.19	0.0
17	85	5.2	1.2	2.5	1.5	0.0
18	78	11.4	1.3	5.6	4.5	0.0
19	90	7.95	1.02	4.2	2.7	0.02
20	120	12.88	2.78	5.2	4.9	0.0
21	78	3.28	0.58	1.5	1.2	0.0
22	68	5.3	0.5	3.3	1.5	0.0
23	72	7.4	1.05	3.87	2.47	0.0
24	70	10.6	1.6	5.8	3.2	0.0
Total	2434	261.83	26.60	140.82	94.27	0.02

6.3 Table 3A: Characterization of Single Use Plastics (SUPs) at Generation Point

			Vehicle Load No.	Vehicle Load No.1	Vehicle Load No.2	Vehicle Load No.3	Vehicle Load No.4	Vehicle Load No.5	Vehicle Load No.6	Vehicle Load No.7	Vehicle Load No.8	Vehicle Load No.9	Vehicle Load No.10	Vehicle Load No.11
1		a	Sorting sample size (Kg)	115	115	65	55	76	115	81	142	110	110	115
		b	Plastic waste (Kg)	13.97	10.2	13.0	8.34	19.01	10.8	18.26	17.02	7.32	13.4	12.0
			SUPs											
2	Plastic Stick	a	Ear buds (Kg)	0	0	0	0	0	0	0	0	0	0	0
		b	Balloons (Kg)	0	0	0	0	0	0	0	0	0	0	0
		c	Candy (kg)	0	0	0	0	0	0	0	0	0	0	0
		d	Ice Cream(kg)	0	0	0	0	0	0	0	0	0	0	0
		e	Straws (Kg)	0	0	0.44	0	0	0.008	0	0.004	0	0	0
3	Cutlery Item	a	Plates (Kg)	0	0	0	0.098	0.026	0.085	0	0	0.145	0.124	0.017
		b	Cups (Kg)	0.224	0.04	0	0.026	0	0.045	0.044	0.6	0.088	0.277	0.221
		c	Glass (Kg)	0.075	0	0.038	0	0.015	0.114	0.05	0.047	0.07	0.046	0.028
		d	Forks (Kg)	0	0	0	0	0	0	0	0	0	0.057	0
		e	Spoons (Kg)	0.004	0	0.025	0	0	0.025	0	0.01	0.018	0.067	0.002
		f	Knives (Kg)	0	0	0	0	0	0	0	0	0	0	0
		g	Trays (Kg)	0	0.29	0	0	0.01	0.098	0	2.2	0.042	0.151	0.339
4	Packaging / Wrapping Films	a	Sweet box (Kg)	0	0	0	0.092	0	0	0.272	0.8	0.059	0.105	0.135
		b	Invitation Cards(Kg)	0	0	0	0	0	0	0.272	0	0.059	0.105	0.135
		c	Cigarette Packets (Kg)	0	0.02	0	0	0.042	0	0	0.56	0.051	0.31	0.101

5	Carry bags	a	<120 microns (Kg)	9.0	6.74	9.23	3.55	8.06	7.2	11.08	9.97	3.87	7.3	5.6
6	Plastic sheets	a	<50 microns (Kg)	0	0	0	2	0	0	0	0.37	0	0	0
7	Other Items	a	Plastics flags (Kg)	0	0	0	0	0	0	0	0	0	0	0
		b	PVC banners <100µm (Kg)	0	0	0	0	0	0	0	0	0	0	0
		c	Polystyrene for decoration (Kg)	0	0	0	0	0.68	0	0	0.134	0.076	0.12	0
			Total	9.303	7.09	9.733	5.766	8.833	7.575	11.718	14.695	4.478	8.662	6.578

Vehicle Load No.12	Vehicle Load No.13	Vehicle Load No.14	Vehicle Load No.15	Vehicle Load No.16	Vehicle Load No.17	Vehicle Load No18	Vehicle Load No.19	Vehicle Load No.20	Vehicle Load No.21	Vehicle Load No.22	Vehicle Load No.23	Vehicle Load No.24	Total	Average Kg/kg of Waste
117	110	62	105	92	0	110	110	90	100	0	0	120	2115	
15.3	19.66	5.32	11.4	6.6	0	9.05	8.86	10.16	8.3	0.0	0.0	10.8	248.77	0.1177
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0.018	0	0	0.009	0	0.003	0.002	0.001	0.033	0	0	0.003	0.521	0.00025
0	0.39	0	0.004	0	0	0	0	0	0	0	0	0.094	0.983	0.00046
0.046	0.082	0.174	0.04	0.082	0	0.258	0.21	0.13	0.17	0	0	0.104	2.861	0.00135
0.061	1	0.006	0.07	0.036	0	0.06	0.15	0.06	0.16	0	0	0.061	2.147	0.00102
0	0	0	0	0	0	0.002	0	0	0.014	0	0	0.002	0.075	0.00004
0.01	0.035	0	0.003	0.014	0	0	0.02	0.002	0	0	0	0.009	0.244	0.00012
0	0	0	0	0	0	0.1	0.02	0	0	0	0	0	0.12	0.00006
0.018	0.206	0.134	0.339	0.208	0	0.5	0.072	0.03	0	0	0	0.208	4.845	0.00229
0.137	0.103	0.03	0.18	0.05	0	0.5	0.108	0	0	0	0	0.12	2.691	0.00127
0.137	0.4	0.03	0.165	0.05	0	0.148	0.106	0	0	0	0	0.15	1.757	0.00083
0.099	0.7	0.105	0.106	0.03	0	4.35	0.158	0.063	0.026	0	0	0.05	6.771	0.00320
9.58	9.66	2	8.4	4	0	0	2.24	5.04	2.36	0	0	5.6	130.48	0.06169

0	0	0	0	0	0	0	0	0	0	0	0	0	2.37	0.00112
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0.307	0.035	0.039	0.006	0.204	0	0.081	0.37	0.01	0	0	0	0	2.062	0.00097
10.395	12.629	2.518	9.313	4.683	0	6.002	3.456	5.336	2.763	0	0	6.401	157.927	0.07467

6.4 Table 3B: Characterization of Single Use Plastics (SUPs) at Disposal Point

			Vehicle Load No.	Vehicle Load No.1	Vehicle Load No.2	Vehicle Load No.3	Vehicle Load No.4	Vehicle Load No.5	Vehicle Load No.6	Vehicle Load No.7	Vehicle Load No.8	Vehicle Load No.9	Vehicle Load No.10	Vehicle Load No.11
1		a	Sorting sample size (Kg)	122	145	135	108	105	85	137	71	76	74	125
		b	Plastic waste (Kg)	14.27	14.37	10.05	10.68	16.27	11.5	10.77	13.56	15.3	6.3	10.16
			SUPs											
2	Plastic Stick	a	Ear buds (Kg)	0	0	0	0	0	0	0	0	0	0	0
		b	Balloons (Kg)	0	0	0	0	0	0	0	0	0	0	0
		c	Candy (kg)	0	0	0	0	0	0	0	0	0	0	0
		d	Ice Cream(kg)	0	0	0	0	0	0	0	0	0	0	0.004
		e	Straws (Kg)	0	0	0.033	0	0.002	0	0	0.009	0.043	0	0
3	Cutlery Item	a	Plates (Kg)	0	0	0	0	0.059	0.102	0.488	0.012	0	0.2	0
		b	Cups (Kg)	0.03	0.106	0.236	0.099	0.04	0.068	0.079	0.006	0	0.114	0.019
		c	Glass (Kg)	0.333	0.15	0	0	0.17	0	0.067	0.008	0.1	0.137	0.011
		d	Forks (Kg)	0	0.01	0	0	0	0	0	0	0	0	0
		e	Spoons (Kg)	0.025	0.01	0.002	0	0.019	0.057	0.002	0	0.024	0.012	0
		f	Knives (Kg)	0	0	0	0	0	0	0	0	0	0	0
		g	Trays (Kg)	0.074	0	0	0.34	0.162	0.067	0	0.015	0.7	0.3	0.085
4	Packaging / Wrapping Films	a	Sweet box (Kg)	0	0.178	0	0.12	0	0	0.128	0	0.11		1.35
		b	Invitation Cards (Kg)	0	0	0	0	0	0	0.128	0	0.11	0	1.35
		c	Cigarette Packets (Kg)	0	0	0.052	0	0	0	0.133	0.012	0.049	0.092	0.134

5	Carry bags	a	<120 microns (Kg)	8.929	8.76	5.89	6.52	8.43	6.22	5.81	7.86	7.03	3	5
6	Plastic sheets	a	<50 microns (Kg)	0	0	0	0	0	0	0	0.12	0	0	0
			Total	9.391	9.214	6.213	7.079	8.882	6.514	6.835	8.042	8.166	3.855	7.953

Vehicle Load No.12	Vehicle Load No.13	Vehicle Load No.14	Vehicle Load No.15	Vehicle Load No.16	Vehicle Load No.17	Vehicle Load No18	Vehicle Load No.19	Vehicle Load No.20	Vehicle Load No.21	Vehicle Load No.22	Vehicle Load No.23	Vehicle Load No.24	Total	Average Kg/kg of Waste
86	132	135	132	105	85	78	90	120	78	68	72	70	2434	
14.24	14.61	11.65	15.86	8.23	5.2	11.4	7.95	12.88	3.28	5.3	7.4	10.6	261.83	0.1076
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00000
0	0	0	0	0	0	0	0	0	0	0	0	0	0.004	0.00000
0	0	0.002	0	0.014	0.001	0	0.002	0.002	0.007	0	0	0	0.115	0.00005
0	0	0	0	0.015		0.005	0.071	0.141	0.095	0	0	0	1.188	0.00049
0.09	0	0.177	0.156	0.12	0	0	0	0.29	0.085	0.2	0.145	0.176	2.236	0.00092
0.03	1.001	0.15	0.18	0.05	0.6	0.1	0.037	0.032	0.02	0.01	0.02	0.04	3.246	0.00133
0	0	0	0	0	0	0.08	0	0	0	0	0	0	0.09	0.00004
0.014	0.035	0.02	0.002	0.007	0.002	0.085	0	0.004	0	0.037	0.01	0	0.367	0.00015
0	0	0	0	0	0	0	0.028	0	0	0	0	0	0.028	0.00001
0.094	0.211	0.018	0	0	0.2	0.44	0.141	0.02		0.064	0.09	0.211	3.232	0.00133
0.121	0	0.211	0.2	0.09	0.075	0.15	0.105	0.15	0.1	0.1	0.2	0.19	3.578	0.00147
0.121	0	0.211	0.25	0	0.075	0.15	0.12	0.15	0.1	0.12	0.3	1.1	4.285	0.00176
0.065	0.018	0.192	0.118	0.122	0.1	0.091	0.07	0.038	0.01	0.014	0.03	0.07	1.41	0.00058
9.14	8.83	5.5	7.96	4.17	2.5	5.6	4.2	5.2	1.5	3.3	3.87	5.8	141.02	0.05794

0	0	0	0	0.042	0	0	0.5	0	0	0	0	0	0.662	0.00027
9.675	10.1	6.481	8.866	4.63	3.553	6.701	5.274	6.027	1.917	3.845	4.665	7.587	161.46	0.06634

6.5 Assessment of Plastic Waste

I. Quantity of Plastic Waste Generation

• Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

Q1= (ΣColumn 3) / (ΣColumn 2) = (249 / 2115) = 0.1177

• Considering Quantity of Mixed Waste generated in the town (TPA) (Q) = 1,95,030.85 Tons per Annum

• Quantity of Plastic Waste Generated (TPA) (Q_T) = Q1*Q
= 1,95,030.85 x (249 / 2115)
= 22,961.08 Tons per Annum

II. Quantity of Plastic Packaging Waste Generation

• Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste)

Q2 = (Σ (Column 4) +Σ (Column 5) +Σ (Column 6) + Σ (Column 7)) / (Σ (Column 2))
= (39.52 + 135.53 + 73.59 + 0.009) / 2115 = 248.65 / 2115
= 0.1175

• Quantity of Mixed Waste generated (TPA) = 1,95,030.85 Tons per Annum

• Quantity of Plastic Packaging Waste Generated (Q_{pack}) (TPA)
= (0.1175 x 1,95,030.85)
= 22,928.71 Tons per Annum

III. Quantity of SUP Waste Generation

• Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)
Q3 = (Σ (Row 2a… 7c) / (Σ (Row 1a)
Q3 =157.93/2115 = 0.0746

• Quantity of Mixed Waste generated (TPA) = 1,95,030.85 Tons per Annum

• Quantity of Plastic Packaging Waste Generated (TPA) (Q_{SUP}) = Q3*Q
= 14,563.23 Tons per Annum

IV. Quantity of Other (Non-packaging waste)

$Q_{other} = Q_T - Q_{pack}$ = 22,961.08 – 22,928.71
= 32.37 Tons per Annum

V. Quantity of Plastic Waste Disposed

• Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

$Q1_d$ = (Σ Column 3) / (Σ Column 2)

OR

$Q1_d$ = (Σ Row 1b) / (Σ Row 1a) = (261.83 / 2434) = 0.1076

• Considering Quantity of Mixed Waste Disposed (TPA) (Q_D)= 1,95,030.85 Tons per Annum

• Quantity of Plastic Waste Disposed (TPA) (Q_{TD}) = $Q1_d$*Q_D
= 1,95,030.85 x (261.83 / 2434)
= 20,979.84 Tons per Annum

VI. Quantity of Plastic Packaging Waste Disposed

• Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste)

$Q2_d$ = (Σ (Column 4) +Σ (Column 5) +Σ (Column 6) + Σ (Column 7)) / (Σ (Column 2))
= (26.60 + 140.82 + 94.27 + 0.02) / 2434
= 261.71 / 2434
= 0.1075

• Quantity of Mixed Waste Disposed (TPA) Q_D = 1,95,030.85

• Quantity of Plastic Packaging Waste Disposed ($Q_{pack\ D}$) (TPA) = $Q2_d$*Q_D
= 20,970.22 Tonnes per Annum

VII. Quantity of SUP Waste at Disposal

• Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

$Q3_d$ = (Σ (Row 2a… 7c) / (Σ (Row 1a) = 161.46/2434 = 0.0663

• Quantity of Mixed Waste Disposed (TPA) = 1,95,030.85 Tons per Annum

• Quantity of SUP Waste Disposed (TPA) (Q_{SUP}) D = $Q3_d$*Q_D
= 0.0663 x 1,95,030.85 = 12,937.42 Tons per Annum

VIII. Quantity of Other (Non-packaging waste) Disposed

$Q_{other\ D}$ = Q_{TD} - $Q_{pack\ D}$ = 20,979.84 – 20,970.22 = 9.62 Tons per Annum

7. Annexure – II



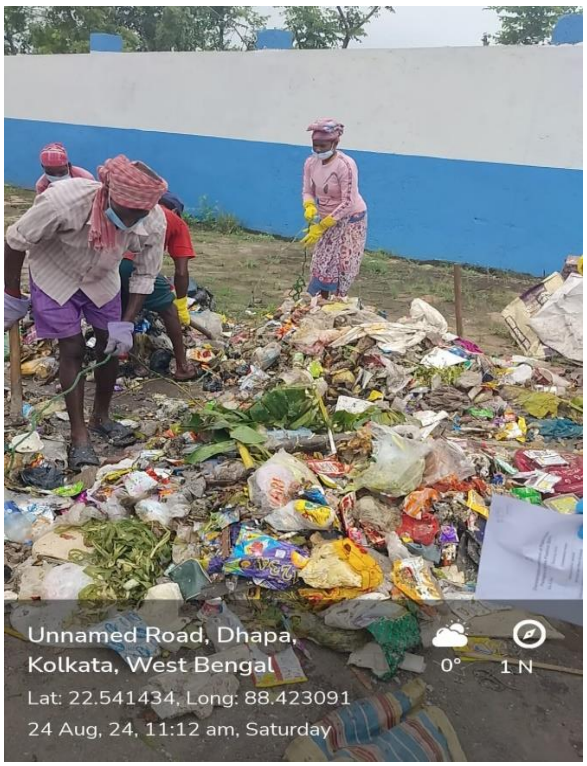
Day-1 at Generation Point



Day-1 at Disposal Point



Day-2 at Generation Point



Day-2 at Disposal Point



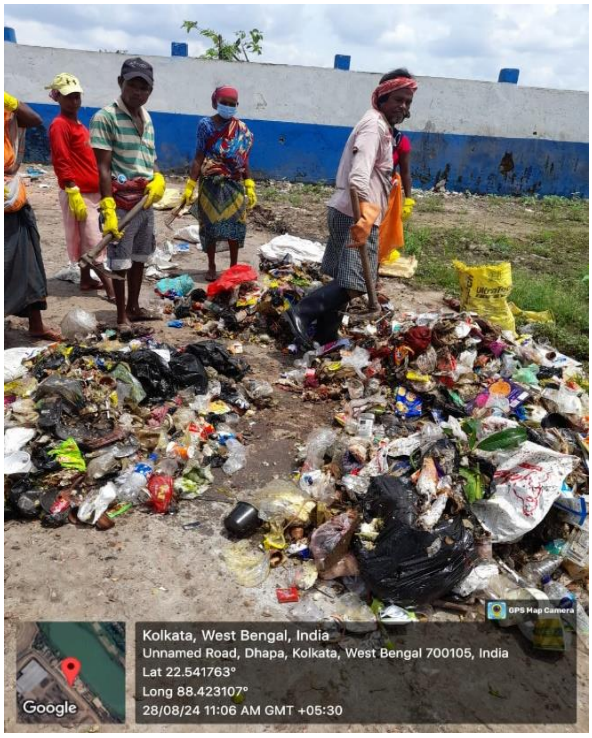
Day-3 at Generation Point



Day-3 at Disposal Point



Day-4 at Generation Point



Day-4 at Disposal Point



Day-5 at Generation Point



Day-5 at Disposal Point



Day-6 at Generation Point



Day-6 at Disposal Point





CPCB Officials with waste segregation personnel of KMC



Waste segregation personnel of KMC



Dhapa Landfill site office

Report On
Assessment and Characterization of Plastic Waste at Regional Directorate, Pune.

With reference to HO letter dated 03/07/2024 regarding the assessment and characterization of plastic waste, a study conducted under the jurisdiction of Pune Municipal Corporation from September 3, 2024, to September 10, 2024, at different garbage transfer stations and the final disposal site at different locations.

The main objectives of the study are as follows:

1. Assessment and Characterization of Plastic Waste.

2. Quantification of plastic in MSW.

Under the scope of the initiative "Assessment and Characterization of Plastic Waste in Pune city," the RD, Pune carried out study in Pune. The study entailed characterizing and assessment of plastic waste in Pune. In order to quantify, the amount of plastic waste generated from all the solid waste from the sites of generation and disposal, the ASTM procedure and the methodology including the quartering and coning process as per the CPCB SOP have been followed for sampling. This study aims to determine the present state of waste creation and composition in Pune as well as to comprehend the current plastic production, recycling, and waste management ecosystem. The Pune city has an excellent infrastructure for waste processing, waste segregation, and door-to-door collection.

To assess the management of plastic waste w.r.t. above points the Garbage Transfer Station and Material Recovery Facility (MRF) established by Pune Municipal Corporations were visited along with the officials of Municipal Corporation. The following team members took part for conducting the study:

1. Sh. Shashikant Lokhande, Scientist E
2. Sh. Abhishek Sharma, SLA.
3. Sh. Vishal Bhandare, (OA-Scientific)
4. Officials of Pune Municipal Corporation.

Pune is a city which has been rapidly growing and changing, transitioning from a city of elderly citizens to a center for education and government as well as an information technology base. Pune is the second-largest metropolis in Maharashtra and the sixth-largest city of India. The current population of the city is approximately 60 lakhs as per

recent data (as provided by Pune Municipal Corporation – PMC), with nearly one million households. The area of the Pune city is 519 sq. km. which covers up to 5 zones, 15 wards and 42 prabhagas.

Pune is renowned for its farming research Centre, industrial and automotive industries, as well as for its education, management, and training sectors. The result of this attracts students and industrialists also professional from the part of India also tourist from worldwide. Pune is also knowing as cultural city of Maharashtra. A dynamic urban landscape unfolds where the majority of residents belong to the middle-income group. Apart from residential areas there are few slum areas within the city with market hubs including wholesale and retail shops.

In December 2020 a notification had issued by the State government of Maharashtra to merge 23 villages into the Pune Municipal Corporation. So due to this addition of village excess burden of waste management falls on PMC.

Pune Municipal Corporation has signed MoU with Waste Management Agencies such as M/s. Bhumi Green Energy, M/s. NEPRA, M/s. Sairam Engineering, M/s. Nobel waste management etc. The generated and collected waste from different wards sent to the 07 different Garbage Transfer Station (GTS) through small vehicle like Ghanta Gadi, Chota Hatti, this generated waste loaded into the compactor vehicle after all this, compactor vehicle sent to the processing plants like Material Recovery Facility (MRF) / Residual derived Fuel (RDF).

The processing plants like Material Recovery Facility (MRF) / Residual derived Fuel (RDF) where the recyclable items including plastic etc. are being recovered. The recyclable materials are further segregated mechanically from where the hard plastic and other recyclable material sent for recycling, whereas other plastic material sent to the cement factories as Residual Derived Fuel (RDF) and remaining inert materials are being sent to the Scientific Landfill Facility (SLF).

During the characterization exercise, the waste was primarily categorized as dry and wet waste. The dry waste was further categorized into 4 categories as per EPR (LDPE, HDPE, MLP, PET, PVC, PP, PS, and packaging wrappers to get a clear understanding of the waste types obtained during the characterization.

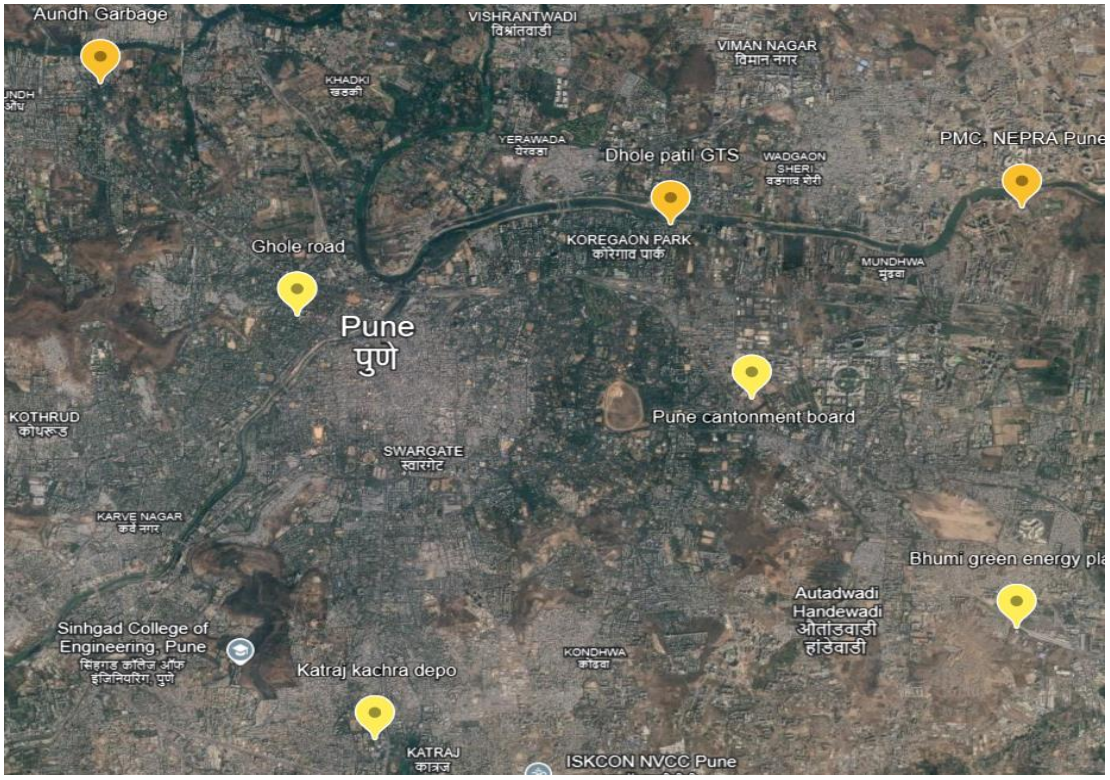
Step One: Determination of parameter for waste Characterization

01	No. of Vehicle to be sampled (n)	38
02	Duration of sampling (No of days) (k)	05
03	Vehicle load size:	900 to 1200 kg
04	Sorting Sample size	140 - 565 kg

Step Two: Distribution of the sampling locations

Pune City area is divided into four zones South, East, North, & West and subsequently various wards in the zone are divided into High-income residential wards, Middle-income residential wards, Economically Weaker Section (EWS) residential wards/slums and Commercial wards (Market Area) and others. Location distribution, Map & details are given below:

Sr.	Location	Zone Covered	Remark
01	Aundh Ramp(North)	Aundh-Baner	Include HIG, MIG and also S area
02	Ghole road (central)	Shivajinagar-Ghole road	Includes commercial establishment
03	Hadapsar ramp (East)	Wanwadi-Ram tekdi-Hadapsar-Mundwa	Include HIG, MIG and also S area
04	Uruli Devachi reject plant(South)	Fursungi-Devachi-Bekrai nagar	Include HIG, MIG and also S area
05	Dhole patil Ramp(East)	Koregaon park-Dhole patil ward office	Include HIG, MIG and also S area
06	Katrja Ramp(South)	Katraj-Bibewadi-Dhankwadi-Sahkar nagar_Yevlewadi	Include HIG, MIG and also S area



According, the present waste collection process in Pune, segregated waste is collected as dry waste and wet waste which goes to Garbage Transfer station GTS. Further, the said waste loaded into the Bulk Refuse Carrier (BRC) having capacity of 18 to 28 Tons and transported to the processing plants. At the processing plant, waste under goes serval process of segregation / separation of materials through conveyor belt and different sized trommels and rejected waste form 1st trommels segregated manually such as ferrous metal, thermocol, PVC & Nylon shoe soles, PET, HDPE, and mixed paper etc. The processing plants like Material Recovery Facility (MRF) / Residual derived Fuel (RDF) where the recyclable items including plastic etc. are being recovered. The light weight material separated via density separation using air blowers which further sent for the shredding. The recyclable materials are further segregated mechanically from where the hard plastic and other recyclable material sent for recycling, whereas other plastic material sent to the cement factories as Residual Derived Fuel (RDF) and remaining inert materials are being sent to the Scientific Landfill Facility (SLF). The separated organic waste sent for bio composting.

As per data provided by PMC,

Details of Municipal Solid Waste (MSW) generation of Pune City: 2300 – 2400 TPD		
01.	Daily Wet waste generation	950 – 1000 TPD
	Wet waste Processing Plants	15
	Mechanical Composting	03 (425 TPD)
	Bio - CNG	01 (100 TPD)
	Bio Gas	11 (55 TPD)
	Wet waste given to farmers (pre compost)	350 – 400 TPD
	Wet waste processed by the NGO & by individual societies / houses	150 TPD
02.	Daily Dry waste generation	1350 – 1400 TPD
	Dry waste Processing Plants	13
	RDF Plants	04 (1000 TPD
	MRF Plants	09 (940 TPD)
	Recycling of dry waste by NGO through rag pickers	150 TPD
	Garden waste processing plants	07 (about 125 – 130 TPD processed)
03.	Secured Landfill facility(SLF)	01 (about 300 TPD)
04	C & D waste Processing plant	01 (processing 250 TPD)
05	Biomedical Waste	10 TPD

Step Three: Sample Preparation

A total 6 locations (GTS & Dumping Site) were selected for the characterization of plastic waste generated within city, discharge of designated vehicle loads, manual sorting activities, and weighing operations. The location found to be flat, level, and away from the normal waste handling and processing areas.

- For the discharge of sample load the designated area was found flat and level and it was away from the waste handling and processing area.

- By using the coning and quartering method, the mixed sample reduced to ¼ part of taken sample.
- The sample load has been disposed on designated area and divided into the 4 equal parts. Two samples positioned diagonally opposite to each other were selected for the next step, the other two were discarded. The process was repeated to reduce the size of the sample from 100 % to 25 %.

Step Four.: Assessment of Plastic Waste is given below:

Sr.	Activity	Quantity
01	Quantity of Plastic Waste Generation	60197.57 TPA
02	Quantity of Plastic Packaging Waste Generation	53358.21 TPA
03	Quantity of SUP Waste Generation	90822.74 TPA
04	Quantity of Plastic Waste Disposed	837.13 TPA
05	Quantity of Plastic Packaging Waste Disposed	775.11 TPA
06	Quantity of SUP Waste Disposed	160.33 TPA
07	Quantity of Other (Non-packaging waste)	6839.36 TPA
08	Quantity of Other (Non-packaging waste) Disposed	62.02 TPA
09	Quantity of Other (Non-packaging waste) Disposed Quantity of Plastic Waste Utilized/Processed	62.02 TPA 59360.44 TPA

The average quantity of plastic waste generation has been estimated as 7.17 % of total mixed solid waste. The single-use plastics (SUP) with respect to total mixed solid waste is found approx. 10 %. The Pune Municipal Corporation is approximately processing the total mixed solid waste by means of MRF/RDF/Recycled is about 98.60 %. The details of statistic are enclosed as **Annexure – I.**

Challenges Faced During the Study

- Difficult to collect compostable waste.

- It's difficult to collect the rigid waste.
- Non-Woven bags not considered either in EPR or SUP during study.
- Quantity of plastic waste may vary during various seasons & during festivals.



Figure 1- Plastic Waste Characterization at Aundh Ramp



Figure 2- Plastic waste segregated into different categories at Ghole Road Ramp



Figure 3- Plastic Waste Characterization at Ghole Road Ramp

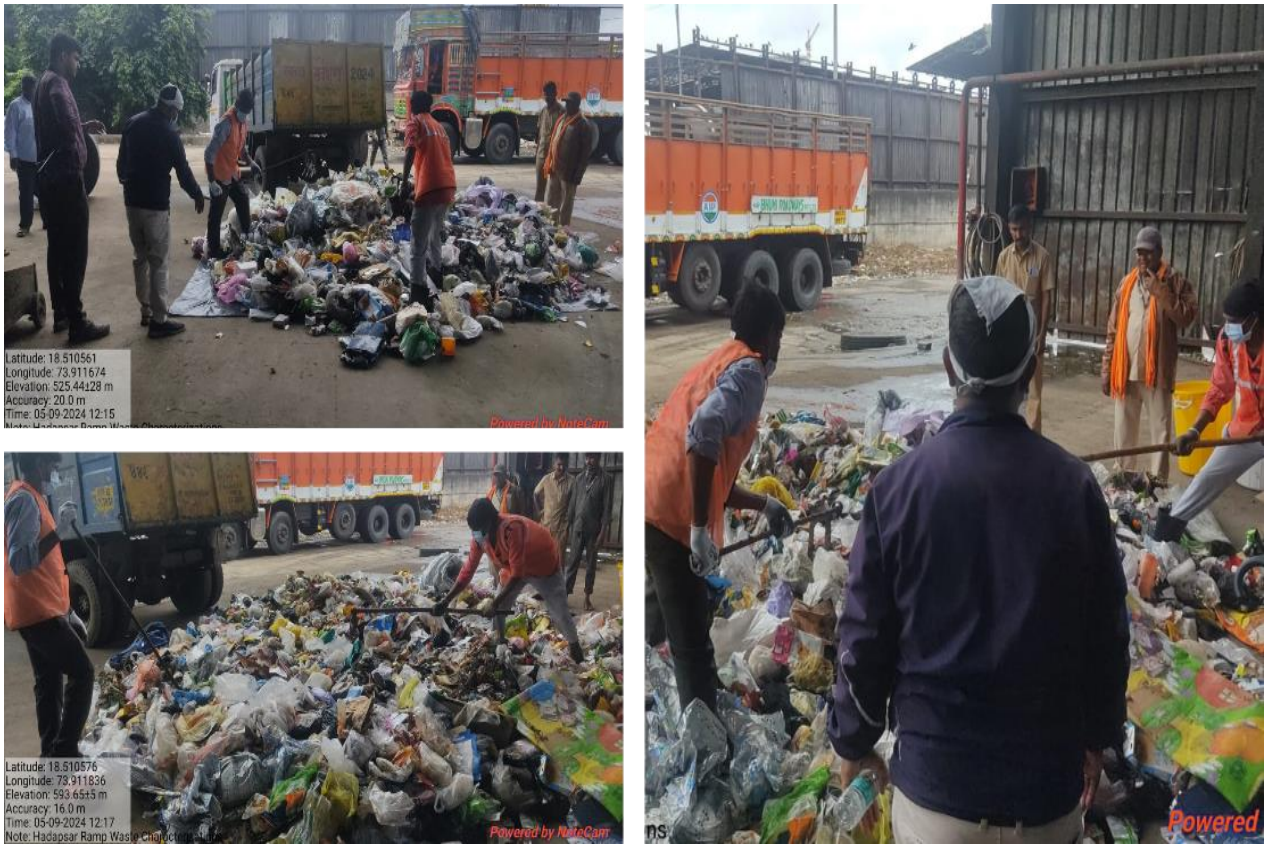


Figure 4- Plastic Waste Characterization at Hadapsar Ramp



Figure 5- Segregated Plastic waste into different categories as per the SOP

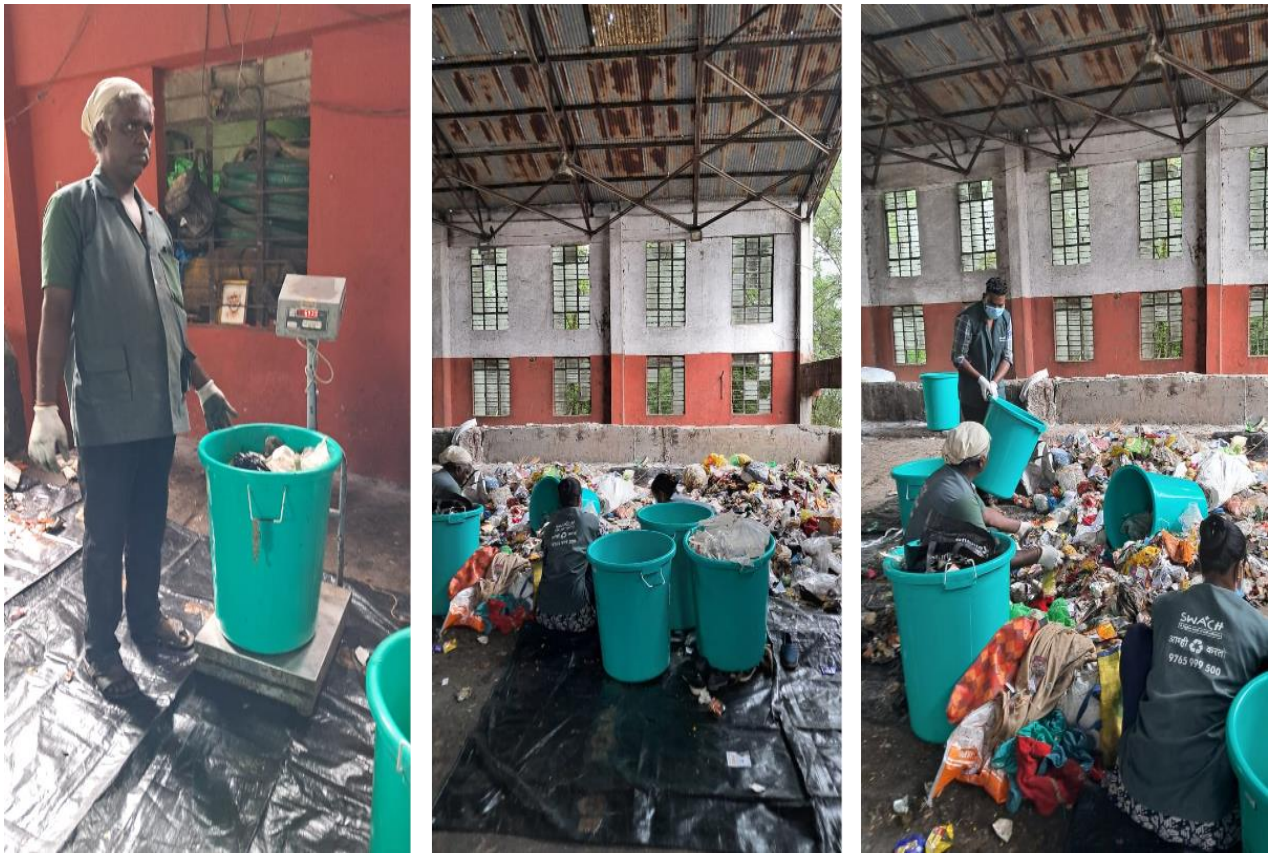
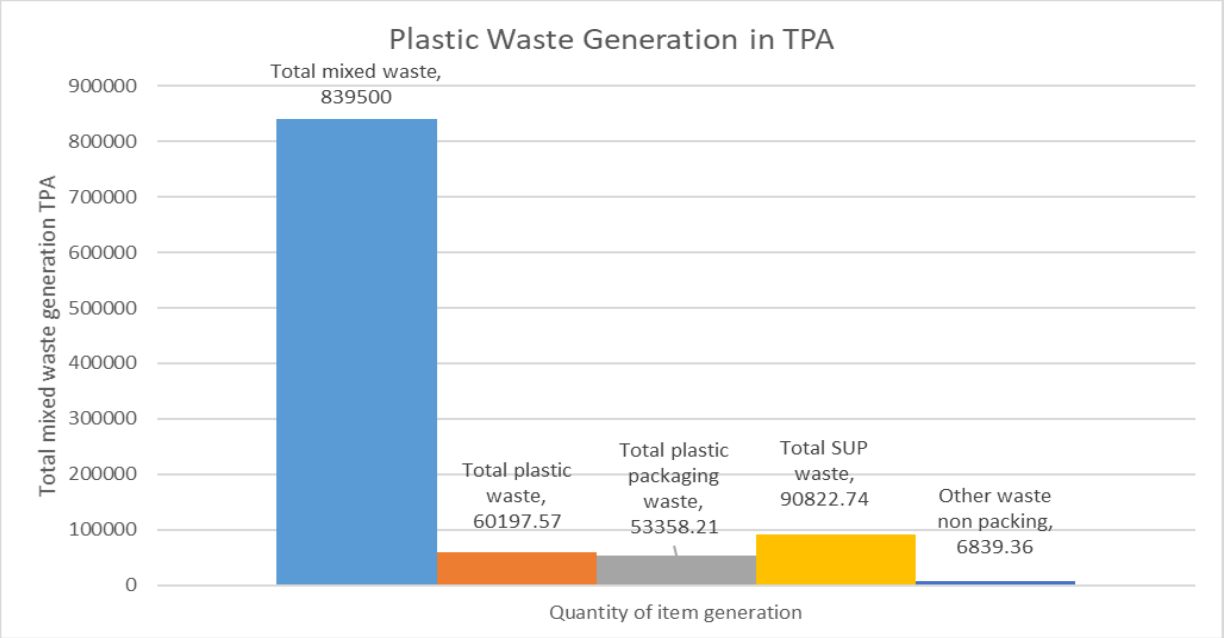


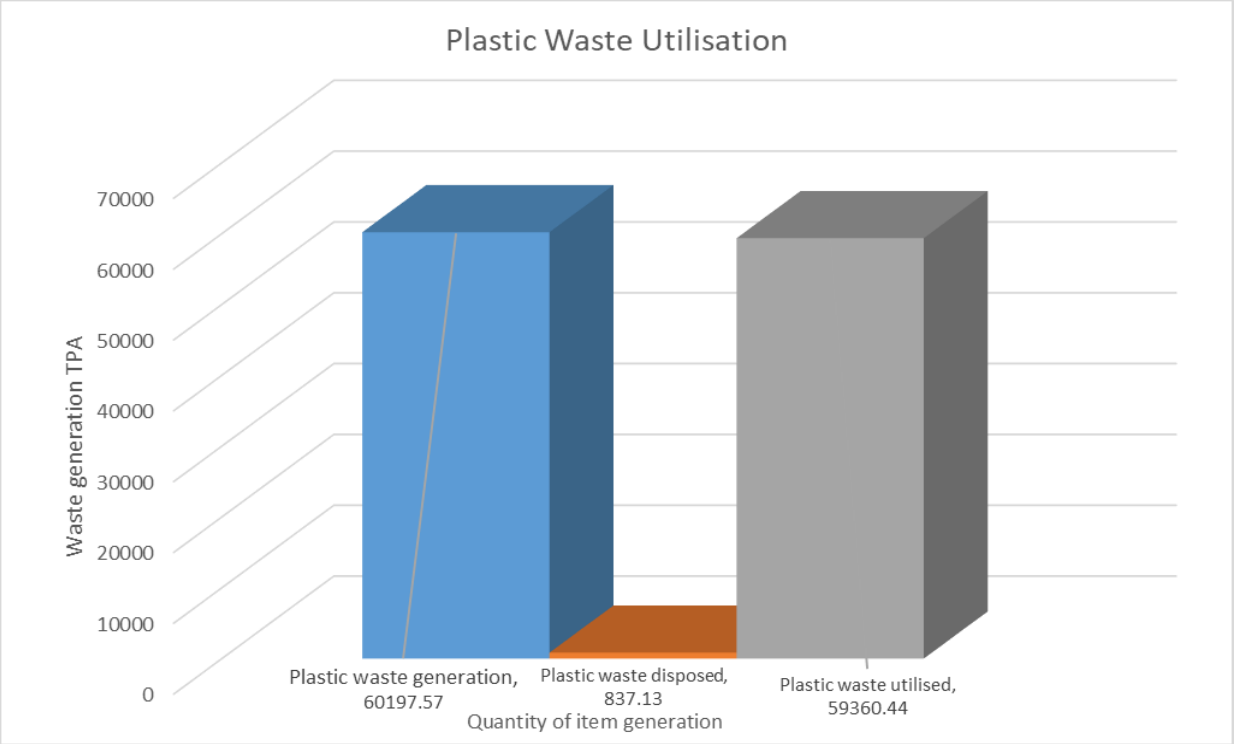
Figure 6- Plastic Waste Characterization at Dhole Patil Ramp



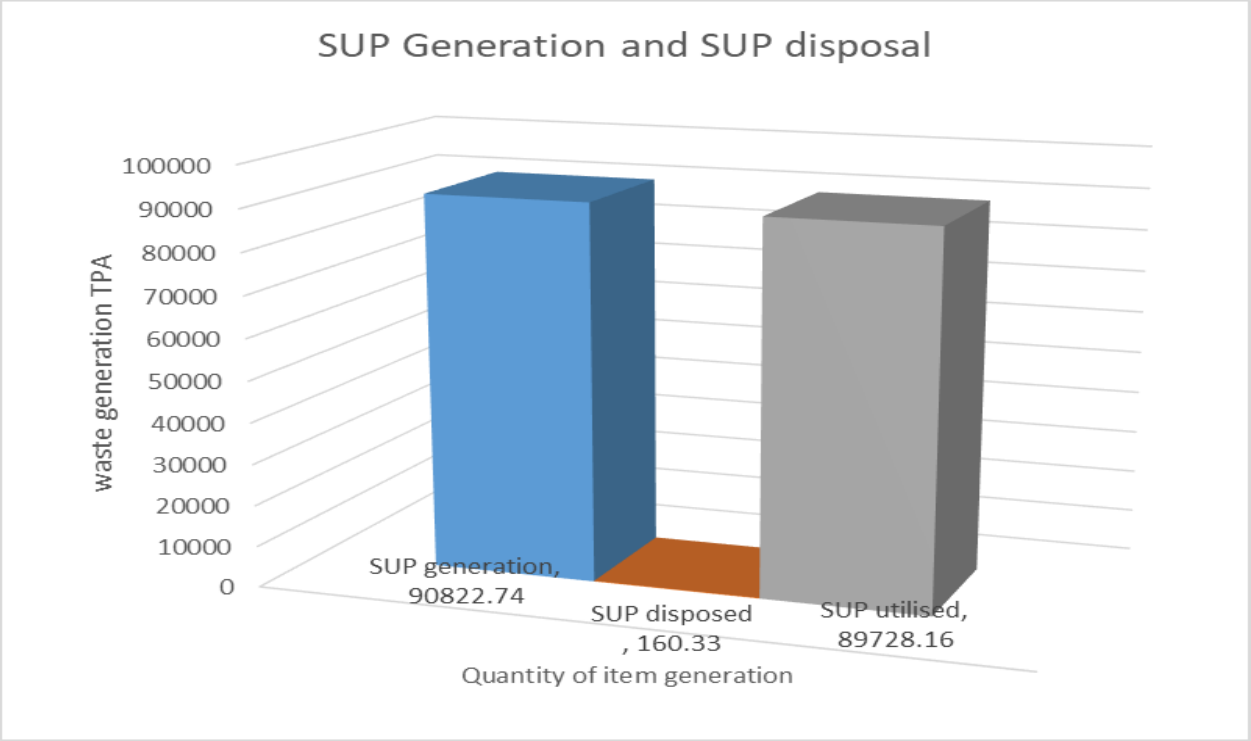
Plastic waste generation in TPA



Category wise plastic waste %



Plastic waste generation



SUP generation and SUP disposal

Annexure - I

Central Pollution Control Board, Regional Directorate, Pune

Plastic Waste Characterization of Pune City

Generation Points

Sr. No.	Date	Area	Vehicle No.	Sorting Sample Size	Total Plastic (KG)	Category of Plastic Waste (Qty. in KG)			
						Cat-1	Cat-2	Cat-3	Cat-4
1	3-Sep-24	Aundh ramp	MH 12 VF 2750	286	31.8	4.3	17.45	5.25	0.5
2	3-Sep-24	Aundh ramp	MH 12 VF 2748	87	20.5	1.5	14.2	1.5	0.3
3	3-Sep-24	Aundh ramp	MH 12 VF 2485	182	14.2	1.7	8.12	2.76	0.2
4	3-Sep-24	Aundh ramp	MH 12 VF 2475	184	13.16	2.65	6.67	1.91	0.35
5	3-Sep-24	Aundh ramp	MH 12 VF 2450	192	14.22	2.03	7.54	2.4	0.4
6	3-Sep-24	Aundh ramp	MH 12 VF 2475	197	12.49	1.63	8.04	1.73	0.1
7	3-Sep-24	Aundh ramp	MH 12 VF 2490	178	13.36	1.39	7.2	2.69	0.35
8	3-Sep-24	Aundh ramp	MH 12 VF 2485	183	12.98	1.86	8.15	1.48	0.2
9	3-Sep-24	Aundh ramp	MH 12 VF 2476	168	13.78	2.16	7.97	2.04	0.1
10	3-Sep-24	Aundh ramp	MH 12 VF 2490	195	13.83	1.83	7.26	2.31	0.5
11	4-Sep-24	Ghole road	MH 12 VF 2486	200	10.95	4.1	5.64	0.15	0.18
12	4-Sep-24	Ghole road	MH 12 VF 2471	257	10.45	2.53	4.25	1.85	0.47
13	4-Sep-24	Ghole road	MH 12 VF 2459	161	7.85	1.65	4.035	1.1	0.28
14	4-Sep-24	Ghole road	MH 12 VF 2483	184	13.03	1.37	7.55	2.7	0.1
15	4-Sep-24	Ghole road	MH 12 VF 2486	195	14.13	2.66	7.1	2.27	0.36
16	4-Sep-24	Ghole road	MH 12 VF 2506	188	14.05	2.08	7.61	2.17	0.51
17	4-Sep-24	Ghole road	MH 12 VF 2483	175	12.53	1.2	7.47	1.86	0.47
18	4-Sep-24	Ghole road	MH 12 VF 2486	188	13.77	1.22	7.84	2.74	0.31
19	5-Sep-24	Dhole Patil Road	MH 12 VF 2471	190	13.55	1.75	7.03	2.35	0.52
20	5-Sep-24	Dhole Patil Road	MH 12 5365	192	13.61	2.32	7.81	2.01	0.1
21	5-Sep-24	Dhole Patil Road	MH 12 6241	197	13.31	2.7	7.6	1.48	0.48
22	6-Sep-24	Dhole Patil Road	MH 12 MV 0847	222	15.77	1.5	10.3	1.24	0.4
23	6-Sep-24	Dhole Patil Road	MH 12 VF 2677	133	5.46	0.75	2.63	1.58	0.39
24	6-Sep-24	Dhole Patil Road	MH 12 RR 0559	290	6.32	0.87	3.1	1.9	0.2
25	6-Sep-24	Katraj Ramp	MH 12 RR 0749	22	2.9	0	0.61	2.01	0.1
26	6-Sep-24	Katraj Ramp	MH 12 VF 0950	165	12.89	1.88	7.8	1.36	0.43
27	6-Sep-24	Katraj Ramp	MH 12 VF 0951	165	14.21	2.45	7.15	2.61	0.51
28	6-Sep-24	Katraj Ramp	MH 12 VF 1084	182	13.35	2.03	8.5	1.67	0.35
29	6-Sep-24	Katraj Ramp	MH 12 VF 1114	173	13.79	2.26	8.2	1.08	0.43
30	6-Sep-24	Katraj Ramp	MH 12 VF 1103	185	12.96	1.56	6.43	2.56	0.12

31	6-Sep-24	Katraj Ramp	MH 12 VF 1083	180	13.24	1.8	7.79	2.65	0.14
Total				**5696**	**408.44**	**59.73**	**229.045**	**63.41**	**9.85**

Quantity of Plastic Waste Generation

1	Average quantity of plastic waste generated (kg of plastic waste/kg of mixed waste) Q1	0.0717
	Quantity of Mixed Waste Generated Q (TPA) =Q	839500
	Quantity of Plastic Waste Generated (TPA) (QT)= Q1*Q	60197.57

Quantity of Plastic Packaging Waste Generation

2	Average quantity of plastic packaging waste generated (kg of plastic packaging waste/kg of mixed waste) Q2	0.06
	Quantity of mixed waste generated (TPA) = Q	839500
	Quantity of Plastic Packaging Waste Generated (Qpack) (TPA) = Q2 * Q	53358.21

Column1	Vehicle load no	MH 12 VF 2750	MH 12 VF 2748	MH 12 VF 2485	MH 12 VF 2475	MH 12 VF 2450	MH 12 VF 24752	MH 12 VF 2490	MH 12 VF 24853	MH 12 VF 2476	MH 12 VF 24904	MH 12 VF 2486	MH 12 VF 2471	MH 12 VF 2459	MH 12 VF 2483	MH 12 VF 24865	MH 12 VF 2506	MH 12 VF 24836	MH 12 VF 24867	MH 12 VF 24718	MH 12 BF 5365	MH 12 NK 6241	MH 12 MV 0847	MH 12 VF 2677	MH 12 RR 0559	MH 12 RR 0749	MH 12 VF 0950	MH 12 VF 0951	MH 12 VF 1084	MH 12 VF 1114	MH 12 VF 1103	MH 12 VF 1083	Average (kg/Kg)
	Sorting sample size	286	87	182	184	192	197	178	183	168	195	200	257	161	184	195	188	175	188	190	192	197	222	133	290	22	165	165	182	173	185	180	
	Plastic waste (kg)	31.8	20.5	14.2	13.6	14.22	12.49	13.36	12.98	13.78	13.83	10.95	10.45	7.85	13.03	14.13	14.05	12.53	13.77	13.55	13.61	13.31	15.77	5.46	6.32	2.9	12.89	14.21	13.35	13.79	12.96	13.24	408.88
	SUP (Kg)																																
Plastic Sticks	Earbuds	0.01	0.002	0.01	0.001	0.013	0.002	0.004	0.01	0	0.001	0	0.008	0.007	0	0	0.002	0	0.001	0	0.002	0.001	0.002	0	0.0031	0.0001	0.001	0.00023	0	0.0021	0.0001	0	0.08263
	Balloons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Candy	0.0001	0	0.0001	0.00012	0	0	0.002	0.003	0	0.0001	0.002	0.005	0.0049	0.0021	0.0017	0.0001	0.0002	0.003	0.001	0	0	0	0	0	0	0	0	0	0	0.00068	0.002	0.001	0.0291
	Ice cream	0	0.001	0	0	0.0003	0.001	0.001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0033
	Straws	0.002	0.004	0.002	0.001	0.0035	0.0025	0.004	0.009	0.001	0.002	0	0.007	0.0068	0.0056	0.0039	0	0	0.0098	0.0089	0.0078	0	0.0023	0	0.0001	0	0.0029	0.0002	0.0001	0.0001	0.0001	0.0001	0.0867
Cutlery items	Plates	0.0001	0.0003	0.001	0.0015	0.003	0.0004	0.0008	0	0	0	0	0.003	0.0024	0	0	0	0.0025	0.004	0	0	0	0	0	0	0	0	0	0	0.0003	0.0025	0.001	0.0228
	Cups	0.0056	0.0049	0.003	0.004	0.002	0.001	0.002	0	0.003	0.002	0.001	0	0	0	0	0	0	0.003	0.004	0.002	0	0	0	0	0	0	0	0	0	0.002	0	0.0395
	Glass	0.004	0.009	0.001	0	0	0	0	0	0.001	0	0.002	0.008	0.007	0	0	0.004	0.003	0	0	0	0	0.0001	0	0	0	0.0001	0	0	0	0	0	0.0392
	Forks	0.0001	0	0	0	0	0	0.0001	0	0	0	0	0	0	0	0	0	0	0	0	0.001	0	0	0	0	0	0	0	0	0	0	0	0.0012
	Spoons	0.01	0.002	0.001	0.0015	0	0.001	0	0	0.0015	0.001	0	0.007	0.0036	0.0058	0.001	0	0.003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0384
	Knifes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trays	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Packing/Wrapping films	Sweet box	0	0.0025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0001	0	0	0	0	0	0	0	0	0	0.0026
	Invitation card	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cignate packet	0.1	0.18	0.015	0.098	0	0.0087	0.089	0	0	0	0	0.009	0.007	0.008	0	0	0	0.01	0.002	0	0	0	0	0	0	0	0	0	0	0	0	0.5267
Carry bags	<120 micron	1.5	1.1	0.69	0.98	0	1.2	0.8	0.7	0.86	0.75	0.65	1.35	1.98	1.65	1.58	1.2	0.98	1	1.85	1.87	1.98	2.15	0.69	1.38	1.78	2.14	1.45	0.8	1.25	1.78	1.78	39.87
Plastic sheets	<50 micron	0.3	0.01	0.02	0.01	0	0.001	0.001	0	0.15	0.001	0.001	0.008	0.006	0.005	0.003	0.003	0.0035	0	0	0	0.025	0.00015	0.0038	0.0079	0.0029	0.0098	0.0012	0.9	0.78	0.98	0.26	3.49325
Other items	Plastic flags	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PVC banner <100 micron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Polystyrene for decoration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		**1.93**	**1.32**	**0.74**	**1.10**	**0.02**	**1.22**	**0.90**	**0.72**	**1.02**	**0.76**	**0.66**	**1.41**	**2.02**	**1.68**	**1.59**	**1.21**	**0.99**	**1.03**	**1.87**	**1.88**	**2.01**	**2.15**	**0.69**	**1.39**	**1.78**	**2.15**	**1.45**	**1.70**	**2.03**	**2.77**	**2.04**	**44.24**

Quantity of SUP Waste Generation

3	Average quantity of SUP waste generated (SUP in kg/kg of mixed waste) Q3	0.1081
	Quantity of Mixed Waste Generated (TPA)	839500
	Quantity of SUP Waste Generated (TPA) (Q2)(Q1)= Q3 * Q	90822.74

Quantity of Other (Non-packaging waste)

4	Quantity of Other (Non-packaging waste) Qother= QT-Qpack	6839.36
	Quantity of Plastic Waste Generated (TPA) QT=	60197.57
	Quantity of Plastic Packaging Waste Generated (Qpack) (TPA)	53358.21

Central Pollution Control Board, Regional Directorate, Pune

Plastic Waste Characterization of Pune City

Disposal Points

Sr. No.	Date	Area	Vehicle No.	Sorting Sample Size Kg	Total Plastic (KG)	Category of Plastic Waste (Qty. in KG)			
						Cat-1	Cat-2	Cat-3	Cat-4
1	5-Sep-24	Hadapsar	MH 12 JF 3837	299	16.78	3.46	8.87	3	0.45
2	5-Sep-24	Uruli Devachi Reject Waste Plant	MX 5300 - Front Bucket Loader	169	17.1	3.47	7.06	4.45	0.3
3	5-Sep-24	Uruli Devachi Reject Waste Plant	MX 5300 - Front Bucket Loader	182	11.5	1.38	5.1	3.42	0.625
4	10-Sep-24	NEPRA processing plant	MX 5300 - Front Bucket Loader	128	9.98	1.9	3.97	2.61	0.5
5	10-Seo-24	NEPRA processing plant	MX 5300 - Front Bucket Loader	145	9.5	2.1	3.52	1.61	0.5
6	10-Sep-24	Sairam engg processing plant	3DX Front Bucket Loader	155	9	2.9	5.3	1.2	0.4
7	10-Sep-24	Sairam engg processing plant	3DX Front Bucket Loader	185	16.1	2.7	9.7	2.2	0.6
			Total	**1263**	**89.96**	**17.91**	**43.52**	**18.49**	**3.375**

Quantity of Plastic Waste Disposed

5	Average quantity of plastic waste generated (Kg of plastic/Kg of mixed waste) Q1d	0.0712
	Quantity of Mixed Waste Disposed (TPA) = QD	11753
	Quantity of Plastic Waste Disposed (TPA) (QTD)= Q1d*QD	837.13

Quantity of Plastic Packaging Waste Disposed

6	Average quantity of plastic packaging waste disposed (Kg of plastic waste/Kg of mixed waste) Q2d	0.065
	Quantity of Mixed Waste Disposed (TPA) = QD	11753
	Quantity of Plastic Packaging Waste Disposed (QpackD) (TPA)= Q2d* QD	775.11

Quantity of Other (Non-Packaging Waste) Disposed

7	Quantity of Other (Non-Packaging Waste) Disposed (TPA) QotherD= QTD-QpackD	62.02

Quantity of Plastic waste utilised/processed

8	Quantity of Plastic waste utilised/processed (TPA) Qutilised/processed=QT-QTD	59360.44

Central Pollution Control Board, Regional Directorate, Pune									
Plastic Waste Characterization (SUP)									
SUP Disposal Points									
	Vehicle load no	MH 12 JF 3837	MX 5300 - Front Bucket Loader	MX 5300 - Front Bucket Loader	MX 5300 - Front Bucket Loader	MX 5300 - Front Bucket Loader	3DX Front Bucket Loader	3DX Front Bucket Loader	Total
	Sorting sample size	299	169	182	128	145	155	185	1263
	Plastic waste (kg)	16.78	17.1	11.5	9.98	9.5	9	16.1	89.96
	SUP (Kg)								
Plastic Sticks	Earbuds	0.0012	0	0.0019	0.001	0.0012	0	0.006	0.0113
	Balloons	0	0	0	0	0	0	0	0
	Candy	0	0.001	0	0	0	0.0021	0	0.0031
	Ice cream	0	0	0	0	0	0	0	0
	Straws	0	0.00035	0.00042	0.00026	0.0065	0.0075	0.0087	0.02373
Cutlery items	Plates	0	0	0.002	0.0004	0	0.0003	0	0.0027
	Cups	0	0	0	0	0	0	0	0
	Glass	0	0	0.0003	0	0	0	0	0.0003
	Forks	0	0	0	0	0	0	0	0
	Spoons	0	0	0.003	0	0.0001	0.0001	0.00015	0.00335
	Knifes	0	0	0	0	0	0	0	0
	Trays	0	0	0	0	0	0	0	0
Packing/Wrapping films	Sweet box	0	0	0	0	0	0	0	0
	Invitation card	0	0	0	0	0	0	0	0
	Cigrate packet	0	0	0.005	0	0	0	0	0.005
Carry bags	<120 micron	1.68	2.4	1.87	2.1	1.89	1.88	2.5	14.32
Plastic sheets	<50 micron	0.68	0.24	0.68	0.34	0.18	0.35	0.39	2.86
Other items	Plastic flags	0	0	0	0	0	0	0	0
	PVC banner <100 micron	0	0	0	0	0	0	0	0
	Polystyrene for decoration	0	0	0	0	0	0	0	0
Total		**2.36**	**2.64**	**2.56**	**2.44**	**2.08**	**2.24**	**2.90**	**17.22948**

Quantity of SUP Waste Generation

9	Average quantity of SUP waste at disposal Q3d (SUP in kg/Kg of mixed waste)	0.01364
	Quantity of Mixed Waste Disposed (TPA) QD	11753
	Quantity of SUP Waste Disposed (TPA) (Qsup)D=Q3d*Q3	160.33

Annexure F

REPORT ON CHARACTERIZATION AND ASSESSMENT OF PLASTIC WASTE AT MYSURU CITY



SEPTEMBER, 2024

CENTRAL POLLUTION CONTROL BOARD

REGIONAL DIRECTORATE (BENGALURU)

Nisarga Bhawan, A-Block, 1st & 2nd floors, Thimmaiah Road

7th D main, Shivanagar, Bengaluru-560079

Executive Summary

Culture of a nation influences the culture of its sanitation practices. India as a society had a long-cherished tradition of cleanliness imbibed in its culture, beliefs and lifestyles. Due to rapid growth of plastics from 1970's, Plastic waste has become one of the most pressing environmental issues worldwide, posing significant challenges to ecosystems, wildlife, and human health. Plastic packaging is used in grocery to food & vegetable, fruits to cosmetics & consumer items. Plastics packages have its merits but due to its non-biodegradability and improper collection system pose environmental threat.

Effective management and mitigation of plastic waste require a thorough understanding of its characteristics, sources, and the scale of the problem. Single-use plastics, such as straws, bags, and cutlery, are banned in an effort to curb consumption and reduce waste. EPR policies hold PIBO's accountable for the entire lifecycle of their plastic packaging, including post-consumer plastic waste management. These two major initiatives i.e SUP ban and EPR policy have aimed to curb plastic pollution.

This study outlines the key aspects of plastic waste characterization and assessment in Mysore city in Karnataka. The quantum of plastic waste generated was carried out through physical assessment based on Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, American Society for Testing and Materials (ASTM) standard test method (D5231- 92) involving quartering & coning method. The total waste generated from Mysuru city is 550 TPD out of which 17.3% is plastic waste.

The characterization and assessment of plastic waste are essential for understanding the scope of the problem, effectiveness of SUP ban and utility of alternatives to plastic and developing effective methods to collect the waste and to channelize plastic waste to Recyclers/ End of Life disposal as per requirement. The development of a circular economy model, along with robust waste management strategies, is crucial to mitigating the long- term environmental impact of plastic pollution.

14/11/2023

(J. Chandra Babu)
Regional Director

Report on Characterization and Assessment of Plastic Waste at Mysuru city, Karnataka

I Background

The Plastic Waste Management Rules of 2016, along with subsequent amendments, laid out a statutory framework for effective plastic waste management in the country. Central Pollution Control Board has prepared Standard Operating Procedure (SOP) for the Characterization & Assessment of Plastic Packaging waste and single use plastics (SUP's). The SOP outlines the methodology to assess the quantity of plastic waste generation and its characterization specifically w.r.t Single Use Plastic and Categories of Plastic Packaging as per PWM Rules.

To create awareness and sensitize ULB's about the SOP, CPCB RD Bengaluru convened meeting with Environmental Engineers of 100 ULB's in Karnataka State and with officials with Karnataka SPCB on 30-05-2024 and explained as how to carry out the study. Meeting was convened with officials of 18 ULB's/ village panchayat of Goa and officials of Lakshadweep PCVC on 31-05-2024 through online mode. Subsequently, CPCB H.O vide letter dated 03-07-2024, Regional Directorate- Bengaluru requested all Regional Directorates to carry out the study in one city in the jurisdiction. In this connection, CPCB RD Bengaluru conducted the Study on Characterization & Assessment of plastic waste as per the SOP in Mysuru city during September, 2024.

II About Mysuru City

Mysuru is the second populous city in the state of Karnataka and is considered as one of the cleanest city. The city of Mysuru has been divided into 9 administrative zones and consists of 65 wards. The details of city are given in table 1.

Table 1: Population and waste generation details in Mysuru city

Population as per 2011 census	9,20,550
Population in 2024 (as per data provided by Mysuru City Corporation)	1316000 (In addition Mysuru receives large influx of tourists in weekends & during all festive season especially during Dasara).
Area in sq.km	128.42
Total Number of Wards	65 + 1(Vijayanagar 3rd stage)

Total households	2,15,061
No of Households covered under D2D collection	2,15,061
Commercial establishments	30,762
Institutes	742
Total Quantity of Waste Generated in the City	550 MT/day (2,00,750 TPA)

The study involved assessment and characterization of plastic waste in different wards of Mysuru covering residential commercial, residential zones. The study was conducted based on Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, American Society for Testing and Materials (ASTM) standard test method (D5231- 92) involving quartering & coning method. Study was conducted at both point of Generation and at point of Disposal during 09th to 12th September, 2024. The following officials from CPCB RD Bengaluru and Mysuru City Corporation conducted the study:

1. Smt. Mahima T, Sc-E, CPCB RD Bengaluru
2. Sh. Madhukar, State Nodal Officer for EPR & AEE (Environment)
3. Smt. Meenakshi, AEE (Environment)
4. Ms. Jyothi, Environment Engineer (Zone-1)
5. Ms. Mahadevamma, Environment Engineer (Zone-2)
6. Ms. Chinmai, Environment Engineer (Zone-7)
7. Sh. Harish Gowda, Plant Supervisor, MCC Waste to Compost Plant, Kesare, Mysuru
8. Sh. Sharath, Plant Supervisor, Sanitary Landfill, Vidyaranyapuram, Mysuru

On September 9, 2024, meeting was convened with ULB officials in the office of Mysuru city Corporation and relevant details were collected. Table 2 provides the details of solid waste processing facilities established in Mysuru City. However, during visit it was observed that most of vehicles (tractors, lorry tippers and compactors) carried mixed waste to dispose in open dump yard.

Table 2: Waste processing facilities existing in Mysuru

Facility	Type of Waste	Type of Plastic Waste	Plant Processing	Processing Methodology

	Handled	handled	Capacity	
M/s Jagruth Tech Pvt Ltd	Only Plastic Waste	Category - III	2 TPD	Converting PW to footpath interlock
Zero Waste Management Plant - Zone 1	All the category of Dry Waste	All category of plastics	5 TPD	Manual Sorting and Baling
Zero Waste Management Plant - Zone 2	All the category of Dry Waste	All category of plastics	5 TPD	Manual Sorting and Baling
Zero Waste Management Plant - Zone 5	All the category of Dry Waste	All category of plastics	5 TPD	Manual Sorting and Baling
Zero Waste Management Plant - Zone 6&7	All the category of Dry Waste	All category of plastics	10 TPD	Manual and Mechanical Sorting and Baling
Zero Waste Management Plant - Zone 8&9	All the category of Dry Waste	All category of plastics	5 TPD	Manual Sorting and Baling
Material Recovery Facility	All the category of Dry Waste	All category of plastics	15 TPD	Mechanical Sorting and baling, RDF sent to Co-processing
Dry Waste Collection Centres (43 Numbers)	All the category of Dry Waste	All category of plastics	1 TPD	Collection and Sorting
Composting Plant, Kesare	Wet Waste	-	200 TPD	Aerobic Windrow Composting, Mechanical Sorting
Composting Plant, Rayanakere	Wet Waste	-	150 TPD	Aerobic Windrow Composting, Mechanical Sorting
Composting Plant, Vidyaranyapuram	Wet Waste	-	200 TPD	Under Construction

Mysuru city has achieved 100% door to door collection in all 65 wards and city is made bin-less, road sweeping is done twice a day including night time mechanical sweeping. Mysuru City has deployed over 340 primary collection vehicle (Auto Tippers) for door to door waste collection,

65 Tractor Trailers for collection of road sweepings & silts, 25 Compactors for secondary collection of waste from Auto tippers & transporting to processing plant or open dump yard and 3 Truck mounted sweeping machines to sweep the streets.

III Characterization and Assessment of plastic waste at Generation point

The Assessment team collected 45 samples at point of generation covering all zones & different economic strata. The point of generation represents the segregated waste collected from door to door by primary collection vehicles diverted to ZWMPs for unloading the waste for processing before disposal. Since, the waste collected by the primary collection vehicle represents the waste generated at source, the waste collected by these vehicles were considered for source sampling.

The Vehicles used for D2D collection is provided with one partition in the main hopper and colour coded, Green for wet waste and Blue for dry waste. The segregated waste collected by Primary collection vehicle (Four Wheel Auto Tipper) from Door to Door is first taken to the nearest compactor stationary point for unloading the Wet Waste, then dry waste is taken to nearest Zero waste management plants (ZWMP) for unloading.

The wet waste collected in compactors is transported to centralized waste to compost plants for converting the same to organic compost. Whereas the dry waste received in ZWMPs are further sorted to valuable and non-valuable, Recyclable and Non-recyclable, Papers, Plastics, Leather, Glass etc., and sent to Authorized Recyclers. Completely segregated waste coming from vegetable market/ hotels/ canteens etc is used for composting. Samples (at point of generation) were collected in the primary collection vehicles that were brought to ZWMP centres. The major observation made during the study is, the city has one major open dump yard (at Sewage Farm, Vidyaranyapuram) which is receiving mixed waste collected across the city. In many areas segregation is observed to be below 25% and large vehicles such as tractors and lorry tippers are used for mixed waste collection from various sources (including commercials, street vendors etc.) and also to collect road sweepings.

The mixed wastes are commonly dumped by the public in vulnerable spots, due to lapses in Door to Door segregated waste collection. The mixed waste eventually ending up on the black spots is directly lifted without segregating and dumped in the open yard. It was observed that tractors,

lorry tippers and compactors carrying mixed waste dumping in the yard, which accounts to more than 90% of the mixed waste is ending up in open dump yard. Table 3 indicates the details of source sampling.

Table 3. Details of source sampling

No. of vehicles sampled from point of Generation(source sampling)	45
Duration of sampling	4 days from 09-09-2024 to 12-09-2024
Vehicle load size	290 Kg to 920 Kg (the vehicles are performing three rounds to cover the given area. During 1st batch in the morning between 6:00 AM to 9:00 AM, maximum waste is collected while in subsequent rounds comparatively lesser quantity of waste is collected.)
Sorting sample size	73 Kg to 230 Kgs



Fig 1: ZWMP 1 12°16'37.29"N 76°39'26.50"E



Fig 2: ZWMP 2, 12°15'20.97"N 76°38'22.75"E



Fig 3: ZWMP 5 12°20'47.78"N 76°37'28.78"E



Fig 4: ZWMP 6, 12°20'8.19"N 76°38'40.58"E



Fig 5: ZWMP 7 12°20'7.78"N 76°38'38.39"E



Fig 6: ZWMP 8 12°21'7.68"N 76°40'33.28"E



Fig 7: Dump Yard 12°16'7.48"N; 76°39'15.28"E



Fig 8: Compost Plant 12°21'8.62"N, 76°40'37.34"E

Samples were collected at ZWMP points (Fig 1 to 6) where the wastes were brought by primary collection vehicles from the source in segregated form. The segregated waste from the primary collection vehicle was unloaded on a flat clean surface. The entire waste was properly mixed either using JCB or manually based on feasibility. After mixing, the entire waste heap was divided into four parts on quartering & coning technique. Two samples diagonally opposite were selected for next step while the remaining two were given away for storage facility. Fig 7 indicates dumpyard and fig 8 indicates compost plant. Photos taken during the study at generation point is given in Fig 9 to Fig 18.

Subsequently, the two selected samples were thoroughly mixed and divided into four parts and two diagonally opposite portions were taken and mixed, which is then considered as sorting sample. For a vehicle load of 290 to 920 Kg of waste, sorting sample size taken was 73 to 230 Kg of waste, thereby, reducing the whole sample size, from 100 % to 25 %.

The sorting sample was spread evenly on flat surface, and entire plastic portion was sorted and weighed to obtain total plastic waste. Total plastic waste was then sorted into three fractions, plastic packaging waste, non-packaging waste and banned items. The banned plastic items was sorted into ear bud sticks, cups, plates etc and each fraction was weighed. The plastic packaging waste was then sorted into Cat-I, Cat-II, Cat-III and Cat-IV. Cat-V plastic packaging was not found. Due to cherry picking or due to public awareness, very less quantity/ Nil quantity of non-plastic packaging waste was found.

The characterization and assessment of waste conducted at point of Generation are presented in Tables 4 & 5. It is observed that the dry waste generation/ plastic waste generation from slum & densely populated area is less than affluent localities for similar quantity of mixed waste generated. At point of generation where waste segregation is practiced, dry waste constitutes 17.95 % of total mixed waste while total plastic waste constitutes 9.38% of total mixed waste.

It was evident that plastic waste constituted more than 50% of the dry waste. And the total plastic waste had 78% of plastic packaging waste, 18% of banned items and less than 4% of non-plastic packaging waste. Less quantity of non-plastic packaging waste observed viz., may be due to

cherry picking. In spite of ban on carry bags since 2016, carry bags was extensively found and constitutes 70% of total banned SUP items. Category 4 plastic packaging (compostable products) was also found to be less than 1% of the total packaging waste. Graphical illustrations of the characterization study at Generation point at Mysuru city is presented in Chart 1 to 4.



Fig 9: Sorting of PW in various category done by the ZWMP workers



Fig 10: dry waste at ZWMP points



Fig 11: Instruction given to ZWMP-1 workers about sorting of plastic waste



Fig 12: Unloading of waste on flat surface at ZWMP-2



Fig 13: ZWMP-1 Operator details and staff quarters



Fig 14: Primary collection vehicle provided with partition for segregated waste collection



Fig 15: Greenery maintained at ZWMP-5



Fig 16: PW sorting activity at ZWMP-5



Fig 17: Waste to Composting Plant at Kesare



Fig 18: Waste dumped on flat surface at ZWMP-8

Chart 1 to 4: Graphical illustrations of the characterization study at Generation point at Mysuru



Chart 1: Percentage of plastic waste in total mixed waste at Generation point



Chart 2: Quantity of Plastic packaging, non-packaging & banned items in total plastic waste in Kgs at Generation point

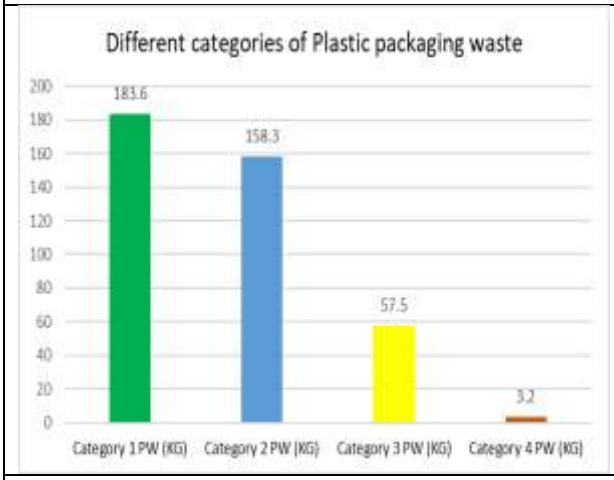


Chart 3: Quantity of different categories of plastic packaging in Kgs at Generation point

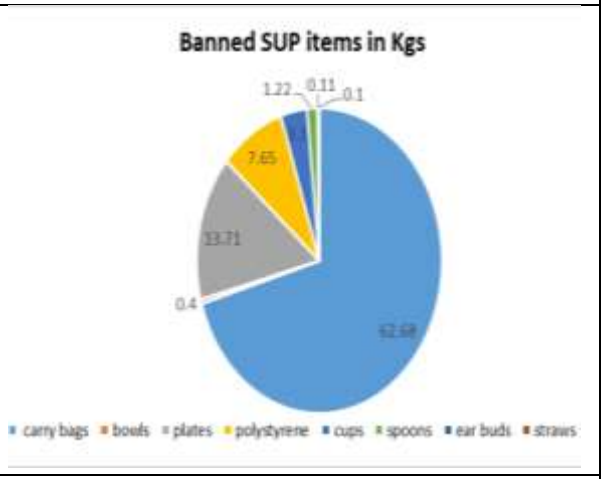


Chart 4: Quantity of various Banned SUP items in Kgs at Generation point

IV Characterization and assessment at Disposal point

Mysuru city has one dump yard at Vidyaranyapuram with total area of 18-20 Acres. Legacy waste dumpsite is also located close by and currently bio-mining of legacy waste is underway. Road sweepings, un-segregated waste from city and inert material from processing are disposed in Dump yard. Currently, as per the field observation, more than 90% of waste is ending up in dump yard due to poor segregation and lapse in achieving waste collection. The dump yard is located adjacent to major pilgrimage place Chamundi Hill and also SH33 Mysuru – Nanjangud Road. Sanitary Landfill located well within the sewage farm is not operated due to reasons unknown, hence the assessment was not carried out at SLF.

The characterization and assessment results at Disposal point i.e., Dump yard are presented in Tables 6 & 7. Nine samples were collected from dump yard from the vehicles coming from all 9 zones. The samples were completely mixed without any segregation. Plastic waste constitutes about 25% of the total mixed waste. Banned items contribute to around 30.92% of plastic waste. Among various categories of plastic packaging waste, 74% is Cat-II. Photos taken during the study at disposal is given in Fig 19 to Fig 26. Graphical illustrations of the characterization study at Disposal point at Mysuru city is presented in Chart 5 to 8.



Fig 19: Dumping of Mixed waste in Open Dump Yard



Fig 20: Rag pickers in Open Dump Yard



Fig 21: Hand Picking of Valuables in Mixed Waste at Open Dump Yard



Fig 22: Mixed Waste dumped by Tractors Open Dump Yard



Fig 23: Sample preparation as per SOP



Fig 24: Sample preparation as per SOP



Fig 25: Banned items found during the Assessment



Fig 26: Banned items found during the Assessment

Chart 5 to 8: Graphical illustrations of the Study on characterization and assessment of plastic waste at disposal point of Mysuru city

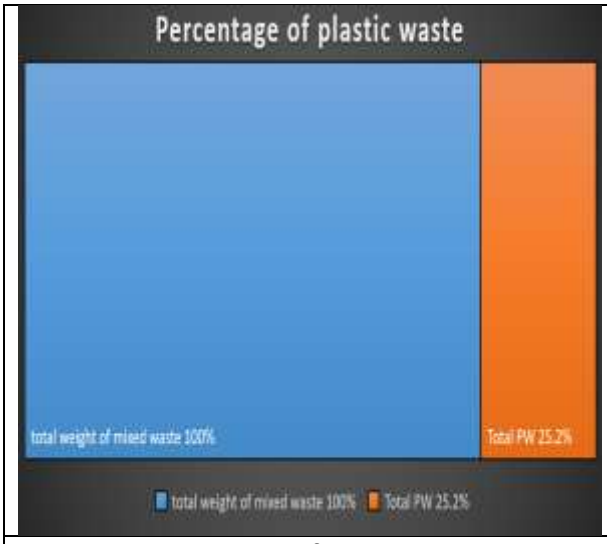


Chart 5: Percentage of plastic waste in total mixed waste at Disposal point



Chart 6: Quantity of Plastic packaging, non-packaging & banned items in total plastic waste in Kgs at Disposal point

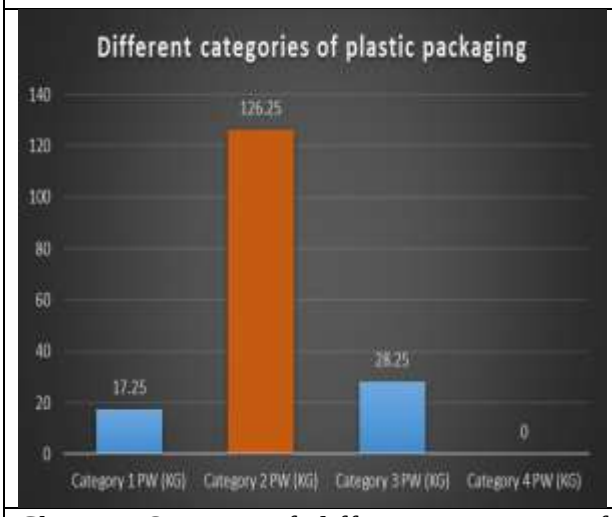


Chart 7: Quantity of different categories of plastic packaging in Kgs at Disposal point

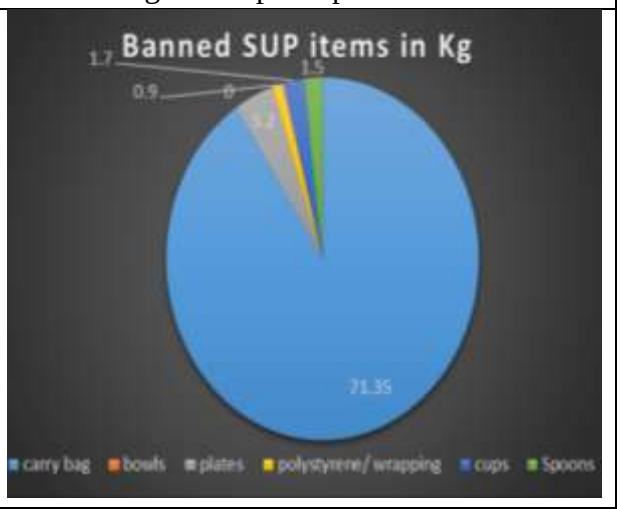


Chart 8: Quantity of various Banned SUP items in Kgs at Disposal point

V Observations

1. Mysuru city has achieved 100% D2D collection as reported by City Corporation and SBM reports, but as per the field observations there are vulnerable black spots where waste is being dumped. The current segregation of waste at source is less than 25%.
2. The city has established ZWMP (zero waste management plants) for decentralized solid waste processing but however it was observed during the study that ZWMP plants were

functioning as sorting centres for dry waste while wet waste processing was concentrated at centralized composting plant.

3. The city has 43 Dry waste collection centres which are operated by the informal waste pickers and it receive the valuable dry waste collected from the rag pickers and citizens of the locality. Currently only 10 DWCC are operated remaining are utilized as tools and equipment storage points by safai mithras.
4. Based on the characterization assessment study in Mysuru city at point of generation (where waste is segregated in wet & dry), in total mixed waste, 18% is dry waste and out of total dry waste collected, 52.2% is plastic waste. The percentage of plastic waste in total waste is 9.4% at generation point i.e., ZWMPs.
5. At Disposal point, Plastic waste constitutes about 25% of the total mixed waste. Banned items contribute to around 30.92% of plastic waste.
6. It is observed that, at both Generation & disposal points, carry bags were the major banned SUP item found in all the samples. Hence, it can be conferred that ban on SUP is not implemented effectively across the city.
7. In many cases, the Category-I, rigid plastic (considered as high value plastic) do not reach the Generation (ZWMP/MRF) and disposal point (dump yard) due to picking and selling to scrap dealers by the waste collection labours. Whereas, the Low value plastics constituting Cat-II & III are ending in Generation (ZWMP/MRF) and disposal point (dump yard). As per the MCC officials, since it was instructed to all the collection staff about the assessment, the cherry picking was partially avoided. Hence, during the assessment, at Generation point, Category-I, is major plastic packaging found contributing 46% of the total packaging while at disposal point, it was only 10%.
8. While little efforts are made to separate Cat-II & III and to process the same at ZWMP and MRFs. Cat-II & III around 0.5 to 1 tonne is processed and made to footpath interlocking tiles at in house plastic processing plant (M/s Jagruth Tech Pvt Ltd).
9. As a ULB, Mysuru City Corporation is registered in CPCB EPR portal and has obtained EPR certificate/ credits through various PWPs. CAT-I EPR certificate from SAB plastics and CAT-III EPR certificate from M/s Jagruth Tech Pvt Ltd who are registered as PWPs on Centralized EPR portal for plastic packaging.

10. Mysuru City Corporation has mandated that all the service providers operating ZWMPs have to channelize the Plastic waste to KSPCB Authorized PWP who is registered on Centralized EPR portal for plastic packaging.
11. Till date, MCC has accumulated 12 CAT-I EPR certificate and 150 CAT-III EPR certificate in its wallet and has taken steps to trade the certificates with PIBOs.
12. Mysuru City Corporation has opportunity to segregate & channelize the CAT-II & III plastic waste to PWP for Recycling or for its EOL disposal instead of dumping in the yard. EPR certificates can be gained for each tonne of PW channelized to PWP for Recycling or for EOL disposal (Co-processing, Waste to Energy or Waste to Oil) and EPR certificates so gained can be monetized by trading with PIBOs for recovering the cost incurred for its management (collection, segregation & transportation).
13. According to the Current Assessment the total generation of plastic waste in City of Mysuru is estimated and given in table 8 & table 9:

A. Point of Generation:

I Plastic waste in Kgs/ Total waste in kgs, Generation point→ 0.094 or 9.4 %

1. % of Packaging waste in total plastic waste → 77.6%
    a. Category – I (Rigid Plastic)→ 46%
    b. Category – II (Flexible Plastic)→ 39%
    c. Category – III (Multi Layered Plastic)→14%
    d. Category – IV (Compostable)→ 1%
    e. Category – V (Bio degradable)→ Nil
2. % of non-packaging plastic waste in total plastic waste, Generation point→ 3.9%
3. % of Banned SUP items in total plastic waste, Generation point→ 17.4%
    a. % of Carry bags in banned items→ 70.26%
    b. % of plates in banned items→ 15.36%
    c. % of plastic sheet/ wrapping covers in banned items→ 8.57%
    d. % of others in banned items→ 5.81%

Table 8: Estimation of Plastic Waste in Mysuru City Generation point

SI No.	Particulars	Qty (TPD)	Qty (TPA)
1	Total waste generated from Mysuru city	550.00	200750
2	Total quantity of Plastic waste, generation point	51.70	18871

3	Quantity of Packaging waste, generation point	40.12	14644
	a. Category – I (Rigid Plastic)	18.45	6736
	b. Category – II (Flexible Plastic)	15.65	5711
	c. Category – III (Multi Layered Plastic)	5.62	2050
	d. Category – IV (Compostable)	0.40	146
	e. Category – V (Bio degradable)	0	0
4	Quantity of Non-Packaging waste, generation point	2.02	736
5	Quantity of Banned SUP items from generation point	9.00	3283
	a. Carry bag	6.32	2308
	b. Laminated Plate	1.38	505
	c. Plastic Sheets	0.77	282
	d. other banned items	0.52	191

B. **Disposal Point**:

I Plastic waste disposed from Mysuru city in Kgs/ Total waste disposed in kgs→ 25.2%

1. % of Packaging waste in total plastic waste, Disposal point→ 68%
    a. Category – I (Rigid Plastic)→ 10%
    b. Category – II (Flexible Plastic)→ 74%
    c. Category – III (Multi Layered Plastic)→16%
    d. Category – IV (Compostable)→ 0%
    e. Category – V (Bio degradable)→ Nil
2. % of non-packaging plastic waste in total plastic waste, disposal point→ 1%
3. % of Banned SUP items in total plastic waste, Disposal point→ 31%
    a. % of Carry bags in banned items→ 91%
    b. % of plates in banned items→ 4%
    c. % of spoons in banned items→ 2%
    d. % of cups in banned items→ 2%
    e. % of others in banned items→ 1%

Table 9: Estimation of Plastic Waste in the Mysuru City, Disposal Point

SI No	Type of Plastic Waste	Qty (TPD)	Qty (TPA)
1	Total waste generated from Mysuru city	550	200750
2	Total quantity Plastic waste	138.6	180675
3	Quantity of Packaging waste disposal point	94.25	30961
	a. Category – I (Rigid Plastic)	9.42	3440
	b. Category – II (Flexible Plastic)	69.74	25456
	c. Category – III (Multi Layered Plastic)	15.07	5504.1

	d. Category – IV (Compostable)	0.00	0.00
	e. Category – V (Bio degradable)	0	0.00
4	Quantity of Non-Packaging waste disposal point	1.39	505.89
5	Quantity of Banned SUP items disposal point	42.97	15682.6
	a. carry bags	39.1	14271.16
	b. plates	1.72	627.3
	c. spoons	0.86	313.65
	d. Cups	0.86	313.65
	e. other banned items	0.43	156.83

14. As per the current assessment it may be observed that the Plastic waste estimated at the disposal point is greater compared to plastic waste at point of generation. This may be due to plastic waste collected from the points of littering, street sweepings and waste collected from drains and commercial establishments. Therefore, recovery of plastic waste (irrespective of category of PW and level of contamination) from the source is essential to reduce the quantity of plastic waste ending up in disposal point, which may be achieved by setting the targets at micro level.

15. Therefore the quantity of plastic waste generated from the city can be assessed by considering the average of waste at Generation point & Disposal point. **Average Quantity of Plastic Waste Generated from Mysuru city is estimated and presented in Table 10.**

C. **Average quantity of plastic waste Generated from Mysuru city**

I **Plastic waste in Kgs/ Total waste in kgs generated→ 17.3%**

1. **% of Packaging waste in total plastic waste generated→ 72.8%**
   a. Category – I (Rigid Plastic)→ 28%
   b. Category – II (Flexible Plastic)→ 56.5%
   c. Category – III (Multi Layered Plastic)→15%
   d. Category – IV (Compostable)→ 0.5%
   e. Category – V (Bio degradable)→ Nil
2. **% of non-packaging plastic waste in total plastic waste generated→2.45%**
3. **% of Banned SUP items in total plastic waste generated→24.2%**
   f. % of Carry bags in banned items→ 80.63%
   g. % of plates in banned items→ 9.68%
   h. % of plastic sheet/ wrapping covers in banned items→ 4.28%
   i. % of spoons in banned items→ 1%

j. % of cups in banned items→ 1%

k. % of others in banned items→ 3.41%

Table 10: Estimation of Plastic Waste generated in the Mysuru City

SI No.	Type of Plastic Waste	Point of Generation		Point of Disposal		**Average quantity of plastic waste generated in Mysuru city**	
		Qty (TPD)	Qty (TPA)	Qty (TPD)	Qty (TPA)	**Qty (TPD)**	**Qty (TPA)**
1	Total waste generated from Mysuru city	550	200750	550	200750	**550**	**200750**
2	Total quantity Plastic waste generated	51.70	18871	138.6	180675	**95.15**	**99773**
3	Quantity of Packaging waste generated	40.12	14644	94.25	30961	**67.19**	**22802.5**
	a. Category – I (Rigid Plastic)	18.45	6736	9.42	3440	**13.94**	**5088**
	b. Category – II (Flexible Plastic)	15.65	5711	69.74	25456	**42.70**	**15583.5**
	c. Category – III (Multi Layered Plastic)	5.62	2050	15.07	5504.1	**10.35**	**3777.05**
	d. Category – IV (Compostable)	0.40	146	0.00	0.00	**0.2**	**73**
	e. Category – V (Bio degradable)	0	0	0	0.00	**0**	**0**
4	Quantity of Non-Packaging waste generated	2.02	736	1.39	505.89	**1.71**	**620.95**
5	Quantity of Banned SUP items generated	9.00	3283	42.97	15682.6	**25.99**	**9482.8**
	a. carry bags	6.32	2308	39.1	14271.16	**22.71**	**8289.58**
	b. plates	1.38	505	1.72	627.3	**1.55**	**566.15**
	c. plastic sheets	0.77	282			**0.39**	**141**
	c. spoons	-	-	0.86	313.65	**0.43**	**156.83**
	d. Cups	-	-	0.86	313.65	**0.43**	**156.83**
	e. other banned items	0.52	191	0.43	156.83	**0.48**	**173.92**

16. Table 10 provides the comparison of the Plastic waste estimated at point of generation and disposal point. It can be observed that quantity of CAT-I plastic waste has reduced from 18.45TPD to 9.42TPD which indicates that picking of valuable plastics is predominant in the waste collection system in Mysuru City. This may be overcome by

conducting awareness campaign and behaviour change activities to the waste collection staff. And also by setting targets, incentivizing and appreciating the staffs achieving the targets to encourage staffs to carry out the activities on continuous basis.

17. In contrast, it can be observed that CAT-II & III plastic waste quantity is more compared to CAT-I, which indicates these plastic wastes, has less value in the market and consumes more man hours for sorting, hence ending up at both point of generation and disposal point. Further, banned SUP contribution is observed to be more than 30% which is contributing to total quantity of plastic waste ending at the disposal point. If the strict enforcement on banned SUP is implemented the total quantity of plastic waste ending at disposal point may be reduced gradually. Recovery of all categories of plastic waste and channelizing to dry waste management centres and material recovery facility is very much recommended for reducing the plastic waste reaching the open dump yard.
18. Since, the total sample taken at the point of generation was only 10% of the total vehicles deployed across the city (covering all the 9 Zones), as a result, the estimated quantity of plastic waste is found to be less compared to plastic waste at disposal point. Further, approximately 10% of the total waste was assessed during the current study in both the cases. The total plastic waste contributed 9.4% and 25.2% at point of generation and disposal point respectively. Hence, it can be concluded that total plastic waste can be estimated by considering an average contribution of **17.3% for total quantity of waste generated by the City of Mysuru**.

Characterization and Assessment of Plastic waste at Generation point

Table 4: Plastic waste characterization- Plastic Packaging at Generation point

Zone	Vehicle No	Ward No	Total Qty of waste in Kgs	Qty of dry waste in total waste in Kgs	sorting sample size in Kgs	Total plastic waste in Kgs	Total plastic packaging waste in Kgs	Total banned items in Kgs	Total plastic non-packaging waste in Kgs	Category 1 PW (KG)	Category 2 PW (KG)	Category 3 PW (KG)	Category 4 PW (KG)
	KA09AA1965	50 (slum)	290	60	72.5	5.8	3.7	2.1	0	0.4	2.3	0.85	0.15
	KA09AA7664	55 (Res)	312	63	78.0	6.6	3.9	2.7	0	0.4	3.2	0.3	0.05
	KA09AA3012	54 (M)	365	73	91.3	14.4	3.7	7.1	3.7	0.4	2.9	0.4	0.05
	KA09D7689	51(Com+ Res)	396	92	99.0	6.7	4.8	1.9	0	0.9	3.5	0.4	0.05
Zone 1	KA09D9704	55 (M)	555	100	138.8	19.2	6.9	2.8	9.5	2.5	3.3	1.05	0.05
	KA09D7666	65 (Slum+DP)	490	91.9	122.5	4.9	3.7	1.2	0	1.4	1.3	1.1	
	KA09D7719	56 (Slum+DP)	465	86.9	116.3	5.1	4.8	0.3	0	3.0	1.4	0.4	0.05
	KA09AA1972	63 (semi comm+Res)	410	80.3	102.5	8.8	7.4	1.4	0	6.5	0.6	0.3	
	KA09 AA1969	60 (DP)	460	87.9	115.0	7.7	5.7	2.0	0	4.9	0.2	0.69	
Zone 2	KA09D9712	56 (Res)	530	92.3	132.5	7.8	6.5	1.3	0	4.8	1.2	0.55	
	KA09 D7672	58 (Res)	380	58	95.0	8.0	7.2	0.8	0	3.9	1.8	1.45	0.03
	KA09D9717	45 (Res)	580	74.7	145.0	5.7	4.9	0.8	0	2.5	2.2	0.2	
	KA09AA7537	46 (Res)	380	81	95.0	3.6	3.2	0.4	0	1.5	1.4	0.35	
	KA09D9714	42 (M)	480	43.6	120.0	6.7	6.1	0.7	0	3.1	2.9	0.1	0.01
Zone 3	KA09D9719	47 (M)	510	78.95	127.5	7.0	6.8	0.2	0	6.0	0.7	0.15	
	KA09AA1938	18 (M)	395	128	98.8	8.8	6.1	1.6	1.1	1.7	3.2	1.05	0.15
	KA09AA1986	22 (M)	400	118	100.0	11.1	9.2	2.0	0	3.0	5.1	1.1	
	KA09AA1944	6 (M)	510	126	127.5	16.6	13.0	3.7	0	3.4	8.2	1.35	
	ka0969906	19 (M)	365	92.2	91.3	11.4	8.7	2.2	0.5	2.8	5.1	0.75	
Zone 4	KA09 D7698	21 (M)	710	43	177.5	6.6	5.4	1.2	0	1.1	3.6	0.65	
	KA09AA7525	20 (Res+ Comm)	820	117	205.0	9.0	7.0	1.1	0.9	5.1	1.9	0.9	0.01
Zone 5	KA09AA1937	2 (M)	920	225	230.0	22.6	18.9	3.7	0	8.4	5.5	5	0.005

	KA09D9731	5 (M)	590	140	147.5	27.5	22.6	4.9	0	6.8	10.2	5.6	0.001
	KA09AA1988	3 (M)	530	125	132.5	25.8	20.5	2.2	3.1	11.2	8.8	3.6	0.01
	KA09D7679	7 (M)	430	106	107.5	22.3	17.7	3.2	1.4	9.4	6.8	2.8	0.1
	KA09D9734	23 (Comm)	585	105	146.3	17.7	15.7	2.0	0	5.4	6.1	3.7	0.5
	KA09 AA 1992	24 (M)	480	89	120.0	8.7	6.7	2.0	0	2.9	2.3	1.4	0.15
	KA09 D 7712	41 (M)	655	48	163.8	16.3	11.7	4.7	0	2.6	6.3	1.85	0.95
	KA09D9737	25 (M)	520	89	130.0	19.1	16.7	2.4	0	10.6	3.3	2.6	0.2
Zone 6	KA09AA1993	40 (M)	585	76	146.3	19.8	16.2	3.6	0	9.8	4.6	1.5	0.3
Zone 7 industrial + residential good standard of living	KA09 9740	17 (In+Res)	560	75	140.0	13.4	11.7	1.7	0	5.5	4.5	1.6	0.05
	KA09AA1991	8 (In+Res)	490	90	122.5	4.7	4.3	0.4	0	3.7	0.5	0.1	0.1
	KA09AA1936	27 (In+Res)	515	57	128.8	13.5	12.8	0.8	0	11.3	1.3	0.25	
	KA09D9744	9 (In+Res)	570	63	142.5	7.9	7.3	0.6	0	5.5	1.6	0.1	0.1
	KA09AA1951	26 (In+Res)	570	72	142.5	19.5	18.8	0.7	0	14.1	3.7	0.9	0.1
	KA 09D9755	10 (M)	560	48	140.0	6.6	4.4	2.2	0		3.6	0.75	
	KA09 D7702	11(M)	490	76.4	122.5	6.2	4.7	1.5	0	0.7	1.8	2.2	
	KA09D7722	15(M)	570	56	142.5	5.8	5.2	0.6	0	3.3	1.3	0.7	
	KA09AA1995	29(M)	270	110	67.5	5.3	4.1	1.3	0	0.9	2.4	0.75	
Zone 8	KA 09 D7684	14(M)	325	105	81.3	6.5	4.9	1.6	0	0.6	3.4	0.9	
	KA09 AA7531	53(M)	240	60	60.0	13.9	9.4	4.5	0	1.3	5.8	2.4	
	KA09AA1935	38(M)	142	32	35.5	5.1	3.6	1.5	0	0	2.6	1.05	
	KA09 C9910	31(M)	760	131.8	190.0	5.7	3.8	1.9	0	0.7	3.1		
	KA09AA3008	37(M)	270	85	67.5	24.5	17.1	7.4	0	3.1	11.0	3	
Zone 9	KA093047	53(M)	410	68	102.5	12.9	10.5	2.4	0	7.1	2.8	0.7	
		Total in Kgs	3920	5460	511.9	397.2	94.6	20.2	183.6	158.3	57.5	3.2	

Slum: poor standard of living, Res- majorly Residential zone, Comm-Commercial zone, In- Industrial zone, M-Mixed zone, DP-Densely populated

Kg of Dry waste/ Kg of mixed waste= 0.18

Kg of plastic waste/ Kg of Dry waste= 0.522

Kg of plastic waste/Kg of mixed waste= 0.094

Table 5: Plastic waste characterization- Banned SUP items at Generation point

Zone	Vehicle No	Ward No	carry bag	bowls	plates	polystyrene	cups	spoons	ear buds	straws	plastic wrapping paper
	KA09AA1965	50 (slum)	1.55	0.15	0.2	0.2	0	0	0	0	0
	KA09AA7664	55 (Res)	1.1	0.15	0.5	0.75	0.15	0	0	0	0
	KA09AA3012	54 (M)	1.2	0	0.4	0.05	0.05	0	0	0	0
	KA09D7689	51(Com+ Res)	1.5	0	0.2	0.15	0	0	0	0	0
Zone 1	KA09D9704	55 (M)	2.55	0	0.015	0.25	0	0	0	0	0
	KA09D7666	65 (Slum+DP)	0.65	0	0	0.4	0.1	0	0	0	0
	KA09D7719	56 (Slum+DP)	0	0	0.2	0.05	0	0	0	0	0
	KA09AA1972	63 (semi comm+Res)	0.45	0	0.9	0	0	0	0	0	0
	KA09 AA1969	60 (DP)	0.15	0	1.85	0	0	0	0	0	0
Zone 2	KA09D9712	56 (Res)	0.3	0	1	0	0	0	0	0	0
	KA09 D7672	58 (Res)	0.78	0		0	0	0	0	0	0
	KA09D9717	45 (Res)	0.8	0	0	0	0	0	0	0	0
	KA09AA7537	46 (Res)	0.4	0	0	0	0	0	0	0	0
Zone 3	KA09D9714	42 (M)	0.65	0	0	0	0	0	0	0	0

	KA09D9719	47 (M)	0.2	0	0	0	0	0	0	0	0
	KA09AA1938	18 (M)	1.5	0	0	0.1	0	0	0	0	0
	KA09AA1986	22 (M)	1.95	0	0.02	0	0	0.02	0	0	0
	KA09AA1944	6 (M)	3.1	0	0.55	0	0	0	0	0	0
	ka0969906	19 (M)	1.6	0	0.6	0	0	0	0	0	0
Zone 4	KA09 D7698	21 (M)	0.95	0.1		0.15	0	0	0	0	0
	KA09AA7525	20 (Res+ Comm)	1.1	0	0.01	0	0	0		0	0
	KA09AA1937	2 (M)	1.1	0	0.5	2	0.1	0	0.01	0	0
	KA09D9731	5 (M)	2.8	0	0.8	1.2		0.1	0	0	0
	KA09AA1988	3 (M)	2.1	0	0.01	0	0.1	0	0	0	0
Zone 5	KA09D7679	7 (M)	2.8	0	0.1	0	0.1	0	0.1	0.1	0
	KA09D9734	23 (Comm)	1.5	0	0.1	0.1	0.1	0.2	0	0	0
	KA09 AA 1992	24 (M)	1.55	0	0.1	0	0.1	0.2	0	0	0
	KA09 D 7712	41 (M)	2.45	0	0.7	0.7	0.7	0.1	0	0	0
	KA09D9737	25 (M)	2.1	0	0.1	0	0.1	0.1	0	0	0
Zone 6	KA09AA1993	40 (M)	3.3	0	0.1	0.1	0	0.1	0	0	0
Zone 7	KA09 9740	17 (In+Res)	1.1	0	0.5	0	0	0.1	0	0	0

industrial + residential good standard of living	KA09AA1991	8 (In+Res)	0.1	0	0.1	0	0.1	0.1	0	0	0
	KA09AA1936	27 (In+Res)	0.35	0	0.3	0.1	0		0	0	0
	KA09D9744	9 (In+Res)	0.1	0	0.4	0	0	0.1	0	0	0
	KA09AA1951	26 (In+Res)	0.15	0	0.35	0.1	0	0.1	0	0	0
	KA 09D9755	10 (M)	2.2	0	0	0	0	0	0	0	0
	KA09 D7702	11(M)	0.55	0	0	0	0.95	0	0	0	0
	KA09D7722	15(M)	0.1	0	0.5	0	0	0	0	0	0
	KA09AA1995	29(M)	0.95	0	0	0.3	0	0	0	0	0
Zone 8	KA 09 D7684	14(M)	1.6	0	0	0	0	0	0	0	0
	KA09 AA7531	53(M)	3.15	0	1.3	0	0	0	0	0	0
	KA09AA1935	38(M)	1.45	0	0	0.05	0	0	0	0	0
	KA09 C9910	31(M)	1.4	0	0	0	0.45	0	0	0	0
	KA09AA3008	37(M)	5	0	1.25	0.9	0	0	0	0	0.25
Zone 9	KA093047	53(M)	2.3	0	0.05	0	0	0	0	0	0
Total in Kgs= 89.215			62.68	0.4	13.71	7.65	3.1	1.22	0.11	0.1	0.25
Percentage Distribution			70.26%	0.45 %	15.36%	8.57%	3.47%	1.37%	0.12%	0.11%	0.28%

Out of the total banned SUP items available at generation point, more than 70% is comprised of carry bags.

Characterization and Assessment of Plastic waste at Disposal point

Table 6: Plastic waste characterization- Plastic packaging at Disposal point

Sl. No	Vehicle No.	Zone	total weight of waste Kg	sorting sample size Kg	Total PW Kg	plastic packaging waste Kg	plastic non packaging waste Kg	Banned SUP items Kg	Category 1 PW (KG)	Category 2 PW (KG)	Category 3 PW (KG)	Category 4 PW (KG)
1	KA09AA3232	Zone 1 Ward 52	532	133	27.5	17.4	0	10.1	1	14	2.4	0
2	KA09AA3225	Zone 2 ward 64	412	103	28.3	16.4	0	11.9	0.8	13	2.6	0
3	KA09AA3417	Zone 3 Ward 44	404	101	19.6	14.1	0	5.5	2.3	10.55	1.25	0
4	KA09AA0036	Zone 4 ward 22	430	107.5	25.6	18.6	0	7	2.35	14.95	1.3	0
5	KA09AA3236	Zone 5 ward 5	540	135	46.9	34.4	0	12.5	3.4	21.05	9.95	0
6	KA09C3587	zone 6 ward 23	424	106	9.55	7.75	0	1.8	0.3	6.7	0.75	0
7	KA09AA0030	zone 7 ward 8	408	102	16.25	11.2	0	5.05	0.8	9.75	0.65	0
8	KA09C3593	zone 8 ward 12	444	111	43.85	26.85	0.6	15.8	4.1	17.25	5.5	0
9	KA09AA0039	zone 9 ward 34	436	109	36.8	25.05	2.75	9	2.2	19	3.85	0
Total in Kgs			**4030**	**1007.6**	**254.35**	**171.75**	**3.35**	**78.65**	**17.25**	**126.25**	**28.25**	**0**

Kg of plastic waste/Kg of mixed waste =0.25

Kg of banned SUP items/Kg of total plastic waste=0.31

Table 7: Plastic waste characterization- Banned SUP items at Disposal point

Sl. No	Vehicle No.	Zone	carry bag	bowls	plates	polystyrene/ wrapping	cups	Spoons
1	KA09AA3232	Zone 1 Ward 52	10	0	0	0	0.1	0
2	KA09AA3225	Zone 2 ward 64	11.3	0	0.45	0.1	0.05	0
3	KA09AA3417	Zone 3 Ward 44	4.9	0	0.3	0.3	0	0
4	KA09AA0036	Zone 4 ward 22	7	0	0	0	0	0
5	KA09AA3236	Zone 5 ward 5	11.8	0	0.5	0.1	0	0.1
6	KA09C3587	zone 6 ward 23	1.8	0	0	0	0	0
7	KA09AA0030	zone 7 ward 8	4.95	0	0	0.1	0	0
8	KA09C3593	zone 8 ward 12	11.6	0	1.95	0	0.95	1.3
9	KA09AA0039	zone 9 ward 34	8	0	0	0.3	0.6	0.1
Total			71.35	0	3.2	0.9	1.7	1.5

REPORT ON CHARACTERIZATION & ASSESSMENT OF PLASTIC WASTE IN VADODARA, GUJARAT

Background

Regional Directorate, Vadodara received a communication from UPC-II Division to carry out characterization and assessment of plastic waste in one city of RD Vadodara jurisdiction. Accordingly, Vadodara city of Gujarat was selected to carry out the said activity. Following officials of RD Vadodara carried out the activity during 7th and 8th August 2024.

1. Smt. Kavitha B.V., Sc. E
2. Dr. N. Semwal, Sc. C
3. Shri Goipidesi Srinu, Sr. Technician
4. Shri Mayank Nimbark, JLA

The details of activities carried out, observations and findings of the study are given in the subsequent paragraph, tables and photographs.

Methodology / Approach

The above mentioned team of RD Vadodara first convened a formal meeting with concerned officials of Vadodara Municipal Corporation (VMC) on 06th August, 2024 to apprise them about the objective of the study (in accordance with the SOP for characterization and assessment of plastic waste developed by CPCB) and to understand their routine of Municipal Solid Waste (MSW) management practices and related infrastructure facilities provided in Vadodara city. After discussions on the said issues and considering the availability of required infrastructure, manpower availability, solid waste transfer routine etc., it was decided to carry out the activity at Atladara waste transfer station of VMC.

In accordance of provisions of SOP, it was decided to collect total six samples from following zones of the city for sample sorting and characterization of plastic waste.

I. High income group residential zone
II. Mid income group residential zone
III. Low income group residential zone
IV. Mix of residential and commercial zone
V. Pure commercial zone
VI. MSW Disposal site

The sample sorting size, segregation and categorization of plastic waste was carried out as outlined in the SOP. The findings of the study are summarized in the tables below.

Table-1: Plastic Waste Assessment & Characterization (packaging category wise)

	Residential			**Residential + Commercial**	**Commercial**	**MSW Disposal Site**
Name of the area	Alkapuri , Ward No. 08, Vadodara **(High Income)**	Bhayali, Ward No. 11, Vadodara **(Middle Income)**	Akota Slum Vistar, Ward No. 12, **(Low Income)**	Majhalpur, Ward 18	Sayajiganj, Kala Ghoda, Ward No.	Jambua
Vehicle load no.	990 Kg (GJ06BT6008)	820 Kg (GJ06BT 2213)	1060 Kg (Newly registered vehicle)	1530 Kg GJ06JT-0659	670 Kg (GJ06BT9084)	1220 kg (J06AZ7400)
Sorting sample size	130 Kg	120 Kg	123 Kg	121 Kg	129 Kg	121 kg
Total plastic waste (PW)	19 .0 Kg	12. 8 Kg	8.7 Kg	15.85 Kg	10.72 Kg	5.3 Kg
Cat. I PW	2.80 Kg	2.60 Kg	1.25 Kg	1.60 Kg	2.82 Kg	0.4 kg
Cat. II PW	13.80 Kg	7.40 Kg	5.05 Kg	12 .0 Kg	6.80 Kg	4.15 Kg
Cat. III PW	2.40 Kg	2.8 Kg	2.40 Kg	2.25 Kg	1.10 Kg	0.75 Kg
Cat. IV PW	0	0	0	0	0	0

Table-2: Plastic Waste Characterization for Single Use Plastic (SUP)

Name of area	Alkapuri, Ward No. 08, Vadodara **(High Income)**	Bhayali , Ward No. 11, Vadodara **(Middle Income)**	Akota Slum Vistar, Ward No. 12, (**Low Income)**	Majhalpur, Ward 18 **(Res. + Comm.)**	Sayajiganj , Kala Ghoda, Ward No. **(Commercial)**	MSW Disposal site, Jambua
	Vehicle Load No. 1	Vehicle Load No. 2	Vehicle Load No. 3	Vehicle Load No. 4	Vehicle Load No. 5	Vehicle Load No. 6
Sorting Sample Size	130 (kg)	120 (kg)	123 (kg)	121 (kg)	129 (kg)	121 (kg)

Total Plastic Waste	19.0 (kg)	12.8 (kg)	8.70 (kg)	15.85 (kg)	10.72 (kg)	5.3 (kg)
Composition of SUPs in Plastic Waste	**SUPs were segregated from Cat. I and Cat. II Plastic Waste**					
Plastic sticks (earbuds, balloons, candy, ice cream)	0	0	0	0	0	0
Cutlery items (plates, cups, glasses, forks, spoons, knives, trays, straw)	< 50 (gm)	< 50 (gm)	< 50 (gm)	< 50 (gm)	70 (gm)	< 50 (gm)
Packaging/ wrapping films(sweet box, invitation cards, cigarette packets)	0	0	0	0	0	0
Carry bags (<120 micron)	12.4 (Kg)	6.30 (Kg)	4.4 (Kg)	10.7 (Kg)	6.1 (Kg)	3.5 (Kg)
Other items (Plastic Flags, PVC banners < 100 micron, Polyestyrene for decoration)	0	0	0	0	0	0

Table 3: Composition of Plastic Waste in MSW

	Quantity of MSW	Quantity of Plastic Waste	Percentage composition of Plastic Waste
City Waste	623 (Kg)	67.07 (Kg)	10.76 (%)
Disposal Site	121 (Kg)	5.3 (Kg)	4.38 (%)

Table 4: Composition of Different Category of Plastic Packaging Waste in Total Plastic Waste

	Quantity of Plastic Waste	Percentage composition of Cat-I	Percentage composition of Cat-II (%)	Percentage composition of Cat-III (%)	Percentage composition of Cat-IV (%)

City Waste	67.07 (Kg)	16.50 (%)	67.17 (%)	16.33 (%)	0 (%)
Disposal Site	5.3 (Kg)	7.55 (%)	78.30 (%)	14.15 (%)	0 (%)

Table 5: Composition of SUPs in Plastic Waste

	Quantity of Plastic Waste	Quantity of SUPs	Percentage composition of SUPs
City Waste	67.07 (Kg)	40.17 (Kg)	59.89 (%)
Disposal Site	5.3 (Kg)	3.55 (Kg)	66.98 (%)

Highlights of the Findings

- Plastic waste content found high in waste from high income group residential areas and lowest in waste from low income group residential areas.
- Category-II of plastic waste is dominant among all four categories.
- Carry bags are predominantly present among waste falling under SUPs.
- Percentage of plastic waste in city waste is more than waste at disposal site.
- Percentage of Category-II is highest followed by Category-III in the total plastic waste of city as well as found at dump site.
- Percentage of SUPs in total plastic waste from city is close to 60% and about 67% in dump site.

Photographs taken during the study

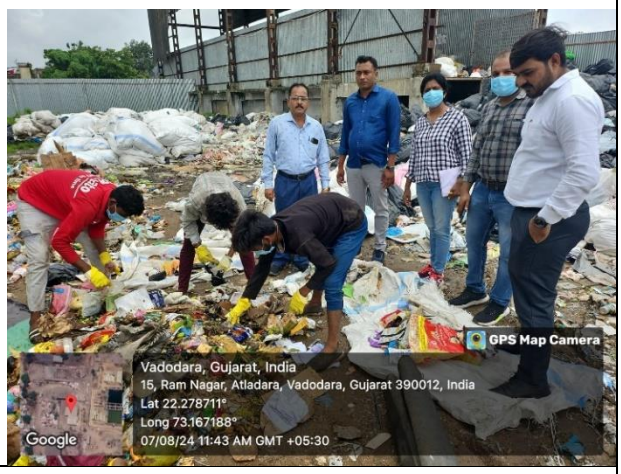




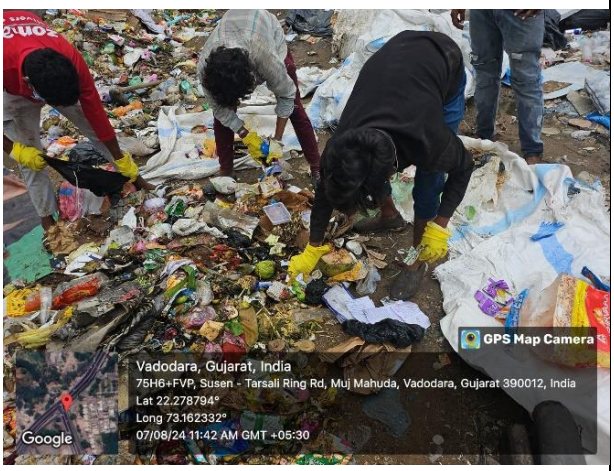
Waste carrying vehicle stationed at Weigh Bridge and digital display of weight



MSW sample unloaded at site



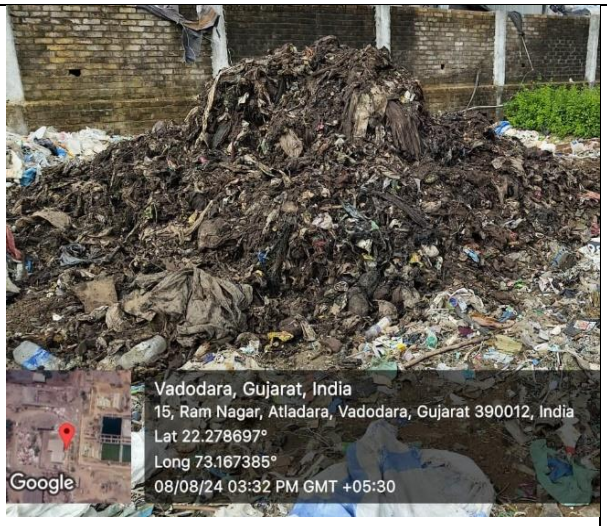
Sorting of sample at Atladra site



Plastic waste segregation



Segegation of Category I PW

<table>
<tr><td> 
</td><td>  </td></tr>
<tr><td>Solid waste sample of disposal site</td><td>Segregation of PW from sample of disposal site</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Weighing of segregated PW componenent at site</td></tr>
</table>

Central Pollution Control Board Regional Directorate, Lucknow

Report on Assessment and Characterization of Plastic Waste at Lucknow U.P.

Background:

With reference to HO letter dated 03.07.2024 regarding the assessment and Characterization of Plastic Waste, study carried out at Lucknow during 11.09.2024 to 18.09.2024 at various Garbage Transfer Stations and final disposal sites in the area of Municipal Corporation Lucknow.

The RD, Lucknow has conducted study in Association with Lucknow Municipal Corporation & Lucknow Swachhata Abhiyan Pvt Ltd under 'Assessment and Characterization of Plastic Waste in MSW of Lucknow'. The study involved assessment and characterization of plastic waste in different areas/Zones of Lucknow. The protocol of ASTM as well as methodology involving quartering and coning process as per SOP of CPCB has been followed for sampling for quantification of plastic waste from the total solid waste from generation and disposal sites.

Objective of the Study: -

The objective of this study is to identify the current status of the waste composition, and generation, and also to understand the existing ecosystem of plastic production, plastic waste recycling, and its management in Lucknow. Lucknow is having a door-to-door collection, good waste segregation, and waste processing infrastructure. The main objectives of the study are as follows:

i. Assessment and Characterization of Plastic Waste.
ii. Quantification of plastic in MSW.
iii. Characterization of plastic waste under EPR categories.
iv. Characterization and quantification of banned SUP items in MSW.

To assess the management of plastic waste w.r.to above points the Garbage Transfer Station and material recovery facility (MRF) established by Lucknow Municipal Corporations were visited along with the officials of Municipal Corporation and Lucknow Swachhata Abhiyan Pvt Ltd (LSAPL) The following team members conducted the study:

1. Shri A.K. Tripathi, Scientist C
2. Sh. Sanjeev Pradhan, E.E (L.M.C)
3. Sh. Jitendra Verma, S.F.I(L.M.C)
4. Mr. Avanish Tiwari, Assistant Manager, Lucknow Swachhata Abhiyan

Locations for Sampling in Lucknow Municipal Corporation Area:

1. Basmandi Portable Compactor Transfer Station (P.C.T. S)
2. Mithai Wala Portable Compactor Transfer Station (P.C.T. S)
3. Paper Mill Portable Compactor Transfer Station (P.C.T. S)
4. Gwari Material Recovery Facility (M.R. F)
5. Avadh Chauraha Portable Compactor Transfer Station (P.C.T. S)
6. Balda Portable Compactor Transfer Station (P.C.T. S)
7. Kailash Kunj Portable Compactor Transfer Station (P.C.T. S)

Name of Locations for Sampling Lucknow				
Sr. No	**Locations Name**	**Ward No**	**Zone Name**	**Co-ordinates**
1	Basmandi P.C.T. S	57 & 88	1	26.837447, 80.925538
2	Mithai Wala P.C.T. S	62 & 70	4	26.862131, 80.993725
3	Paper Mill P.C.T. S	59 & 37	4	26.864272, 80.96284
4	Gwari M.R. F	14,100	4	26.842825, 80.99778
5	Kailash Kunj	37	4	26.872051, 80.979682
6	Avadh Chauraha P.C.T. S	41,60,25	5	26.802715, 80.894142
7	Balda P.C.T. S	105,106	6	26.802709, 80.894177

About Management of MSW in Municipal Corporation Area of Lucknow: -

The population of Lucknow is approximately 3,945,000 as per census 2011. To efficiently manage the generated waste, Nagar Nigam Lucknow has signed MOU with waste management agency Lucknow Swachhata Abhiyan Pvt Ltd. (L.S.A) All generated waste is collected by Nagar Nigam Lucknow & Concern Agency (Zone1.3.4.6.7) from Approx 35 Garbage Transfer Stations (GTS) located in different areas. The MaterialRecovery Facility has been in Zone 4 & Zone3 and rest of M.R.F is in under Constructions and doing manually in all the GTS to recover the recyclable items including Plastic, Craft, Metals, Aluminums. Recyclable material is Mechanically separated and dispatch to recyclers remaining are being sent to the disposal site of the city i.e. Shivari Processing and disposal plant for further recovery of RDF& Scientific Disposal.

During the characterization exercise, the waste was primarily categorized as dry and wet waste. The dry waste was further categorized into dry waste other than plastic (cardboard; paper and millboard; shoes-leather and rubber separately; cloth; metal; glass; domestic Hazardous waste; compostable bags) and plastic waste further categorized in 4 categories as per EPR (PET; HDPE; LDPE; PVC; PP; PS; MLP and packaging wrappers) and SUP to get a clear understanding of the waste types obtained during the characterization.

Study of SOP For Assessment and Characterization of Plastic Waste

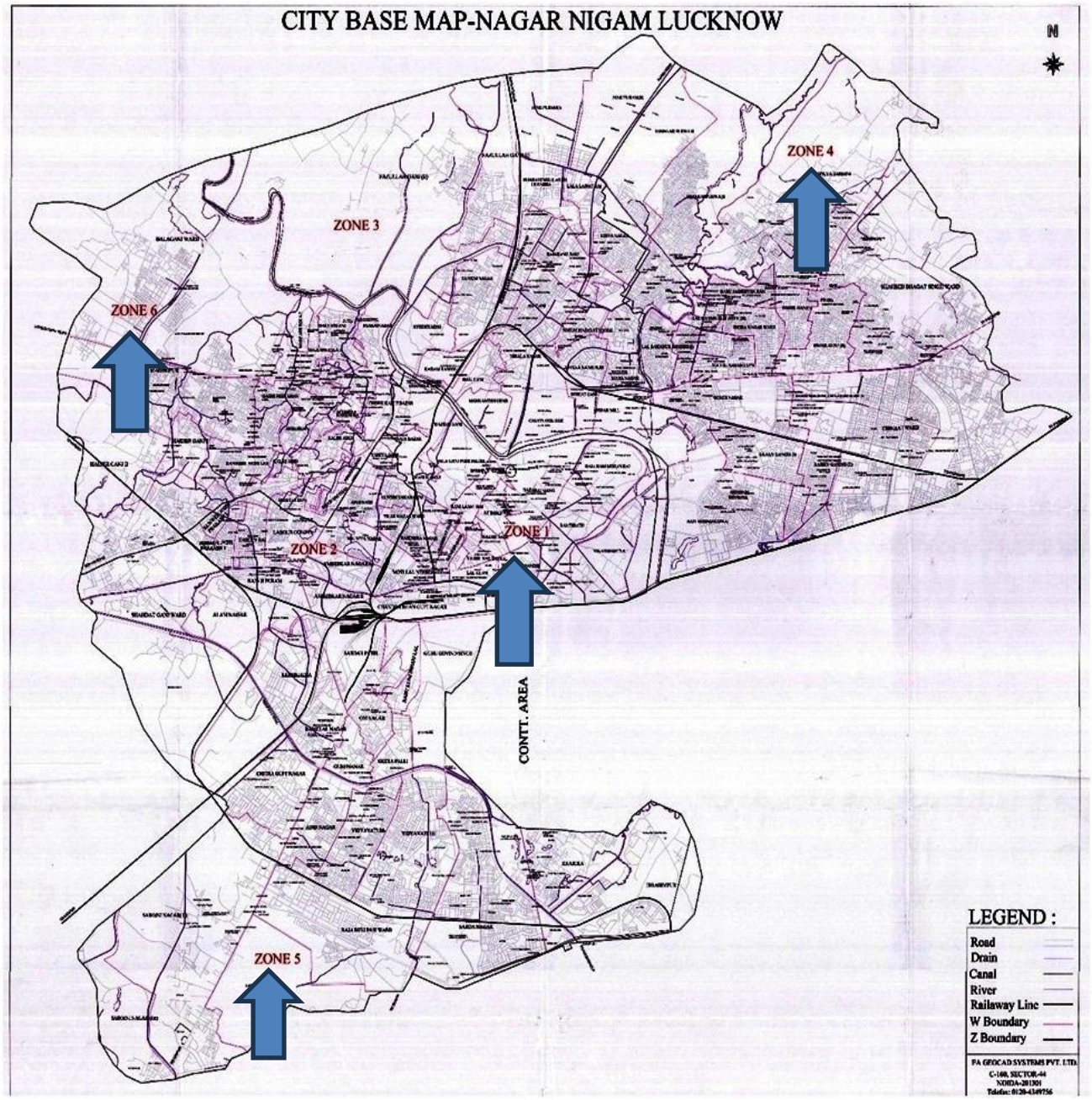
Step One: Determination of parameter for waste Characterization

- No. of Vehicle to be sampled (n): 45 (7 vehicle Approx in a day)
- Duration of sampling (No of Days) (k): 7
- Vehicle load size: 360 to 530 kg
- Sorting Sample size: 100 to 140 kg

Step Two: Distribution of the sampling locations

City area is divided into Eight zones 1,2,3,4,5,6,7,8 and subsequently various wards in the zone are divided into Middle-income residential wards, Economically Weaker Section (EWS) residential wards/slums and Commercial wards (Market Area) and others. In addition, one disposal pointis also identified in each Zone and centralized disposal site of city.

0



Indicated Zones of Study in L.M.C Area of Lucknow

According to the present waste collection process in Lucknow Municipal Corporation, plastic is collected with dry waste and from there it goes to a GTS for further sorting of recyclable material in Material Recovery Facility and sent to disposal site through big size capsule containers having the capacity of 12 to 18 Ton. The MRF is a facility that receives materials and then uses a combination of equipment and mechanically & manually labor to separate and densify materials in preparation for shipment downstream to recyclers of the particular materials recovered. Typical materials recovered at MRFs includes ferrous metal, thermocol, PVC & Nylone shoe soles, PET, HDPE,P.P and mixed paper etc. after preliminary sorting of the plastic and doing the bales of Pet Bottles and grind the H.D,P.P Materials after that collected waste sent to Authorized Recyclers and main disposal site for further conversion of remaining waste material into Recycling Process for Granules and Disposal. The RDF bales are then sold to local cement manufacturers unit or Waste to Energy Plants.

As per information in Lucknow Municipal Corporation approx. 1600 TPD mixed solid waste generated From City and 100 TPD approx. inert sent for final disposal after recovery of material, composting and RDF.

Step Three: Sample Preparation

A total 7 locations in 4 Zones (Zone-1,4,5,6) (M.R.F, GTS & Dumping Site) were selected for discharge of designated vehicle loads, manual sorting activities, and weighing operations. The location found to be flat, level, and away from the normal waste handling and processing areas.

- The entire vehicle load was discharged in a designated area.
- The sampled waste was mixed and using the Quartering and coning, the vehicle load size (360-530 kg) reduced to Sorting sample size (100-140 kg).
- The entire vehicle load has been disposed on the ground and divided into four parts. Two samples positioned diagonally opposite to each other wereselected for the next step, the other two were discarded. The process was repeated to reduce the size of the sample from 100 % to 25 %.

Assessment of Plastic Waste in Municipal Corporation Lucknow:

Quantity of Plastic Waste Generation:

1. **Average quantity of plastic waste generated** (kg of plastic waste/ kg of mixed waste from study and Assessment and Characterization of Plastic Waste in Lucknow Municipal Corporation Area is presented at Table-1.
   - Total Mixed waste: 3072 Kg (From data collected and analyzed at Table-1)
   - Out of which plastic waste generated : 350.5 kg

- Hence % of Plastic waste generation is = 11.4%

As per nagar nigam information in Lucknow Municipal Corporation approx. 1600 TPD mixed solid waste generated From City: 1600 TPD

- Quantity of Mixed Waste generated (TPA) = 1600 TPD X 365
  = 584000 TPA
- Hence Quantity of Plastic Waste Generated (TPA) =584000 /100 X 11.4 =**66576 TPA**

2. **Quantity of Plastic Waste Generated (TPA**) =**66,576 TPA**
3. **Quantity of Plastic Packaging Waste Generation:**
   Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste, from study of Assessment and Characterization of Plastic Waste in Lucknow Municipal Corporation Area presented at Table-1 is 2.8%.
   - Quantity of Mixed Waste generated (TPA) = 584000 TPA (Approx 1600 TPD X 365=584000/100 X 2.8%)
   - **Hence Quantity of Plastic Packaging Waste Generated = Generation 16352TPA** (@2.8%)
4. **Quantity of SUP Waste Generation 36208 TPA** (@6.2%)
   - From study of Assessment and Characterization total Quantity of SUP Waste generation (Single Use Plastic) is :77.54Kg (Table-3)
   - Approx 1600 TPDX365=584000/100X6.2% =36208 TPA
   - **Hence % of SUP waste generation is = 6.2%**

5. **Quantity of Other (Non-packaging** waste) 5256 TPA (@0.9%)
   - From study of Assessment and Characterization of plastic waste generation category -3 is 0.9 % (Table 1) .
   - (Approx 1600 TPDX365=584000/100X 0.9%)
   - **Hence Quantity of Other (Non-packaging waste) : 5256 TPA**

6. **Quantity of Plastic Waste Disposed** 63247.2 TPA
   - Total Quantity of Plastic Waste Generated (TPA) =66,576 TPA
   - The single use plastic (SUP) With respect to total mixed solid waste is found approx. 2.8% and after collection by Nagar Nigam Lucknow 95% of plastic either processed in MRF/RDF/Recycled
     (66576÷100×95 %)= 63247.2 TPA
   - **Hence Quantity of Plastic Waste Disposed: 63247.2 TPA**

1. **Quantity of Plastic Packaging Waste Disposed**:

- Total Quantity of Plastic Packaging Waste generation: 16352 TPA
- Since in Lucknow 95% of plastic either processed in MRF/RDF/Recycled (16352÷100×95 %)=15534.4 TPA
- **Hence Quantity of Plastic Packaging Waste Disposed: 15534.4 TPA**

2. **Quantity of SUP Waste Disposed**
   (36208÷100×95 %) =34397.6 TPA
3. **Quantity of Other (Non-packaging waste) Disposed**
   - Since Quantity of Other (Non-packaging waste :5256 TPA (5256÷100×95 %) =4993.2 TPA
   - **Hence Quantity of Other (Non-packaging waste) Disposed 4993.2 TPA**
4. **Quantity of Plastic waste Utilized/Processed** 63247.2 TPA
   - Since total Quantity of Plastic Waste Generated (TPA) = (66576÷100×95 %) =66,576 TPA
   - **Hence Quantity of Plastic waste Utilized/Processed: 63247.2 TPA**

Step Four.: Assessment of Plastic Waste is given below in table:

Sr .No.	Assessment of Plastic Waste	Quantity of Plastic Waste Generation
1.	Quantity of Plastic Waste Generation	66576 TPA
2.	Quantity of Plastic Packaging Waste Generation	16352 TPA
3.	Quantity of SUP Waste Generation	36208 TPA
4.	Quantity of Other (Non-packaging waste)	5256 TPA
5.	Quantity of Plastic Waste Disposed	63247.2 TPA
6.	Quantity of Plastic Packaging Waste Disposed	15534.4 TPA
7.	Quantity of SUP Waste Disposed	34397.6 TPA
8.	Quantity of Other (Non-packaging waste) Disposed	4993.2 TPA
9.	Quantity of Plastic waste Utilized/Processed	63247.2 TPA

Summary Of the Characterization of Plastic Waste: -

The Average quantity of plastic waste generation has been estimated as 11.4% of total mixed solid waste. The single use plastic (SUP) With respect to total mixed solid waste is found approx. 2.8% and after collection by Nagar Nigam Lucknow 95% of plastic either processed in MRF/RDF/Recycled.

Challenges Faced During the Study

a. Cherry Picking of the waste especially category-1 is common issue in all the GTS.
b. Waste collection and segregation/sorting at MRF center is integral part of GTS. After segregation of valuable materials, remaining waste sent to landfill site for making of RDF. Hence finalization of end disposal point was found to be difficult.
c. Non-Woven bags not considered either in EPR or SUP during study.
d. The quantity of inert waste disposed at landfill site was taken from Form-V i.e. annual report of PWM.
e. Quantity of plastic waste may vary during festive seasons etc.

The plastic waste characterization and quantification data for both generation and disposal points are enclosed in the Annexures as given below.

Annexure-I: Plastic Waste Generation Data

Annexure II: Plastic Waste Disposal Data

Annexure III: Single Use Plastic Generation Data

Annexure IV: Single Use Plastic Disposal Data



(A.K. Tripathi Sc."C")

ANNEXURE-1

A- Generation Point

Table-1 Generation Point							
Sr. No.	Vehicle No./Load	Sorting Sample Size (Kg.)	Total PW (Kg.)	Catg-1 PW (Kg.)	Catg-2 PW (Kg.)	Catg-3 PW (Kg.)	Catg-4 PW (Kg.)
"(1)	"(2)	"(3)	"(4)	"(5)	"(6)	"(7)	"(8)
1	UP32VN7372	106.9	22.8	18.2	2.4	1.95	0.25
2	UP32VN1803	128.2	16.86	13.1	2.2	1.1	0.18
3	UP32VN0015	110.8	14.9	10.2	3.1	0.98	0.22
4	UP32WN8706	120.7	11.8	5.3	4.8	1.4	0.3
5	UP32VN0846	132.8	12.8	7.1	3.8	1.5	0
6	UP32WN1152	141.4	15.9	8.2	4.7	2.2	0.5
7	UP32WN0028	104.4	16.2	11.9	2.2	1.8	0.8
8	UP32VN7366	128.6	15.8	12.1	2.6	0.6	0.2
9	UP32VN7369	120.3	9.7	5.1	3.1	0.6	0.1
10	UP32VN8289	130.7	22.8	14.2	5.3	2.5	0.6
11	UP32WN0023	110.4	14.6	11.1	2.2	0.9	0
12	UP32VN0024	127.6	15.8	10.1	3.8	1.4	0.5
13	UP32WN1318	119.7	14.8	9.6	4.2	0.7	0.2
14	UP32WN0775	118.9	11.6	6.1	4.9	0.2	0
15	UP32WN0173	123.2	8.7	3.5	4.1	0.9	0.2
16	UP32WN7097	140.8	9.6	4.2	3.9	1.1	0.1
17	UP32WN7072	110.4	9.5	5.2	2.8	0.8	0.3
18	UP32VN8445	145.6	18.5	11.8	5.2	1.1	0.4
19	UP32WN0019	120.2	12.5	9.1	2.7	0.4	0
20	UP32VN0832	124.8	7.2	3.7	2.9	0.3	0
21	UP32WN8450	121.2	12.9	9.1	2.1	1.5	0.1
22	UP32VN8696	132.6	22.5	17.1	3.8	1.1	0.2
23	UP32VN7370	113.9	10.7	7.9	2.1	0.2	0.3
24	UP32WN0812	118.1	13.9	8.1	4.2	1.3	0.1
25	UP32WN0580	119.7	8.1	4.8	2.7	0.4	0
		∑ (3) =	∑ (4) =	∑ (5) =	∑ (6) =	∑ (7) =	∑ (8) =
	Wt. in Kg	3072	350.5	226.8	85.8	26.93	5.55
Total	Value in %		11.4	7.4	2.8	0.9	0.2

Catg-1: Rigid plastic, Catg. -2: Flexible plastic (Multilayer plastic), Catg. -4 Plastic sheet, carry bags

ANNEXURE-2

B- Disposal Point

Table-2 Disposal Point							
Sr. No.	Vehicle No./Load	Sorting Sample Size (Kg.)	Total PW (Kg.)	Catg-1 PW (Kg.)	Catg-2 PW (Kg.)	Catg-3 PW (Kg.)	Catg-4 PW (Kg.)
"(1)	"(2)	"(3)	"(4)	"(5)	"(6)	"(7)	"(8)
1	UP32WN8713	123.6	12.1	6.4	3.2	1.6	0.9
2	UP32WN8295	127.8	18.2	14.1	3.3	0.6	0.2
3	UP32VN7495	109.7	12.2	6.1	4.2	1.2	0.7
4	UP32VN8261	141.8	14.3	4.6	6.8	2.7	0.2
5	UP32VN0168	160.7	17.2	8.2	6.1	2.8	0.1
6	UP32VN7095	126.2	11.7	5.2	4.7	1.8	0
7	UP32VN0522	138.7	9.7	4.7	3.5	1.2	0.3
8	UP32VN1258	122.1	15.8	7.1	5.2	3.1	0.4
9	UP32NN5553	156.5	18.2	9.7	5.8	1.8	0.9
10	UP32NN5540	165.4	22.9	13.7	5.7	3.2	0.3
11	UP32NN5519	148.9	7.48	5.1	1.5	0.58	0.3
12	UP32NN5515	170.7	20.4	14.6	3.5	2.2	0.1
13	UP32PN9032	121.9	14.6	5.9	7.2	1.53	0
14	UP32PN9040	130.2	16.92	5.1	8.4	3.2	0.2
15	UP32NN5440	148.2	17.7	7.1	8.1	2.1	0.4
16	UP32NN4262	110.8	13.2	4.3	6.9	1.7	0.3
17	UP32NN2263	125.7	15.1	6.4	6.5	2.2	0
18	UP32NN2272	138.5	16.62	7.3	7.4	1.8	0.12
19	UP32HN5132	141.2	18.35	8.9	6.2	3	0.25
20	UP32HN5136	161.7	19.4	6.2	10.1	2.7	0.4
	Total	$\sum$ (3) =	$\sum$ (4) =	$\sum$ (5) =	$\sum$ (6) =	$\sum$ (7) =	$\sum$ (8) =
		2770	**312.1**	**150.7**	**114.3**	**41.01**	**6.07**

ANNEXURE-3

Plastic Waste characterization (Single Use Plastic) -

A. Generation Point Table-3

			Vehicle LoadNo.	Vehicle LoadNo.1	Vehicle LoadNo.2	Vehicle LoadNo.3	Vehicle LoadNo.4	Vehicle Load No.5	Vehicle Load No.6	Vehicl eLoadNo. 7	Vehicle LoadNo.8	Vehicl eLoadNo. 9	Vehicl eLoad No.10	Total
1		a	Sortingsample size(Kg)	106.9	128.2	130.5	132.7	110.5	125.4	127.6	130.2	125.5	129.8	**1247.3**
		b	Plasticwaste(Kg)	22.8	16.48	17.25	24.4	18.55	22.3	19.25	16.3	18.2	21.8	**197.33**
			SUPs											
2	PlasticSticks	a	Earbuds(Kg)	0	0	0.27	0	0.10	0.4	0.36	0.4	0	0.18	**1.71**
		b	Balloons(Kg)	0.1	0	0	0.25	0.15	0	0	0	0	0.20	**0.7**
		c	Candy(kg)	0	0.1	0.12	0	0	0	0	0	0	0.10	**0.32**
		d	IceCream(Kg)	0	0.2	0	0.1	0	0	0	0	0	0	**0.3**
		e	Straws(Kg)	0.15	0.1	0.60	0.45	0.38	0	0	0	0.1	0.75	**2.53**
3	CutleryItems	a	Plates(Kg)	0	0	0.15	0.85	1.5	0	0	0.10	0	0.15	**2.75**
		b	Cups(Kg)	0.12	0.35	0	0.28	0	0.36	0.9	0.18	0.11	0.78	**3.08**
		c	Glass(Kg)	0	0	0	1.1	0.65	0	0	0	0	0	**1.75**
		d	Forks(Kg)	0	0.2	0	0	0	0.2	0.25	0.2	0	0	**0.85**
		e	Spoons(Kg)	0.2	0	0.70	0.35	0.20	0.9	0	0.36	0.2	0.50	**3.41**
		f	Knives(Kg)	0	0	0	0	0	0	0	0	0	0	**0**
		g	Trays(Kg)	0	0	0	0	0.15	0	0	0	0	0	**0.15**
4	/Wrapp	a	Sweetbox(Kg)	0	0	0	0.2	0	0	0.15	0	0	0	**0.35**

		b	InvitationCards (Kg)	0	0.1	0	0	0	0	0	0	0	0.15	**0.25**
		c	CiggratteP ackets(Kg)	0.20	0.32	0.56	0.15	0.25	0	0.55	0.96	0.25	1.1	**4.34**
5	Carrybags	a	<120microns(Kg)	3.12	2.75	4.12	6.2	3.76	4.51	2.8	5.37	5.1	3.8	**41.53**
6	Plasticsheets	b	<50microns(Kg)	0.50	0.80	1.1	0.95	0.87	2.43	1.6	2.18	2.1	1.9	**14.43**
7	OtherItems	a	Plasticsflags(Kg)	0	0	0	0	0	0	0	0	0.2	0	**0.2**
		b	PVCbanners <100um.(Kg)	0	0	0	0	0	0	0.15	0		0	**0.15**
		c	Polystyrenefo rdecoration(K g)	0	0.2	0.1	0	0	0.1	0	0	0.25	0	**0.65**
				4.39	**5.12**	**7.72**	**10.88**	**8.01**	**6.99**	**6.76**	**9.75**	**8.31**	**9.61**	**77.54**

ANNEXURE-4.

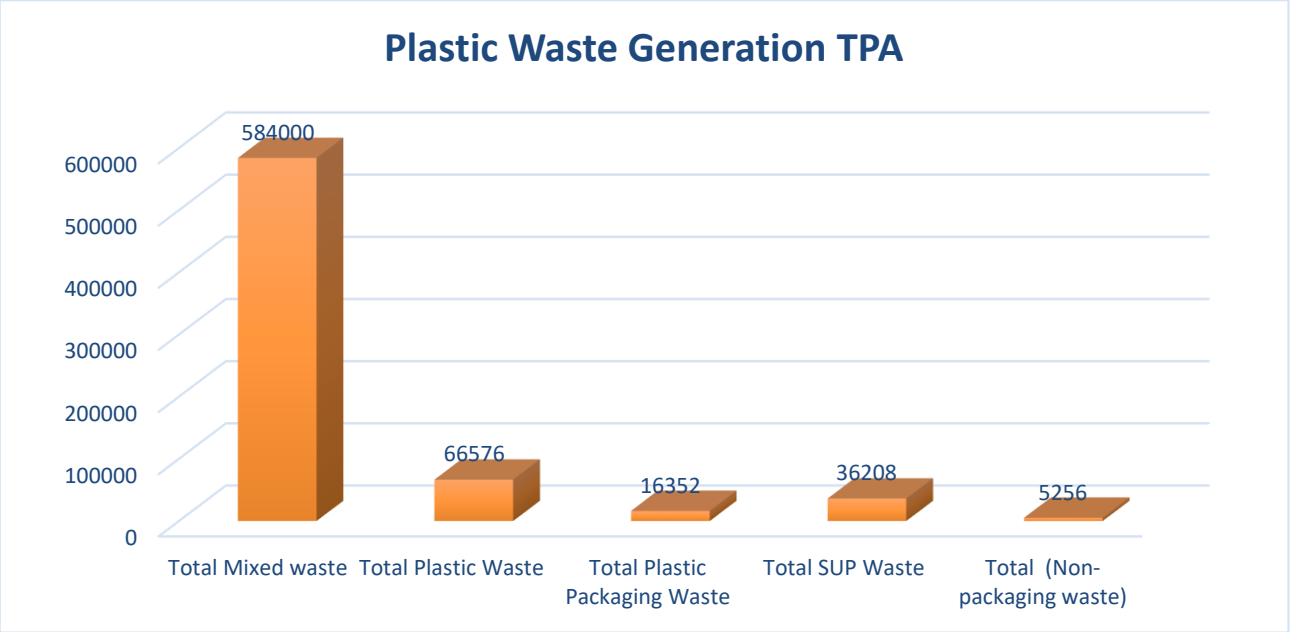
Disposal Point

Table-4

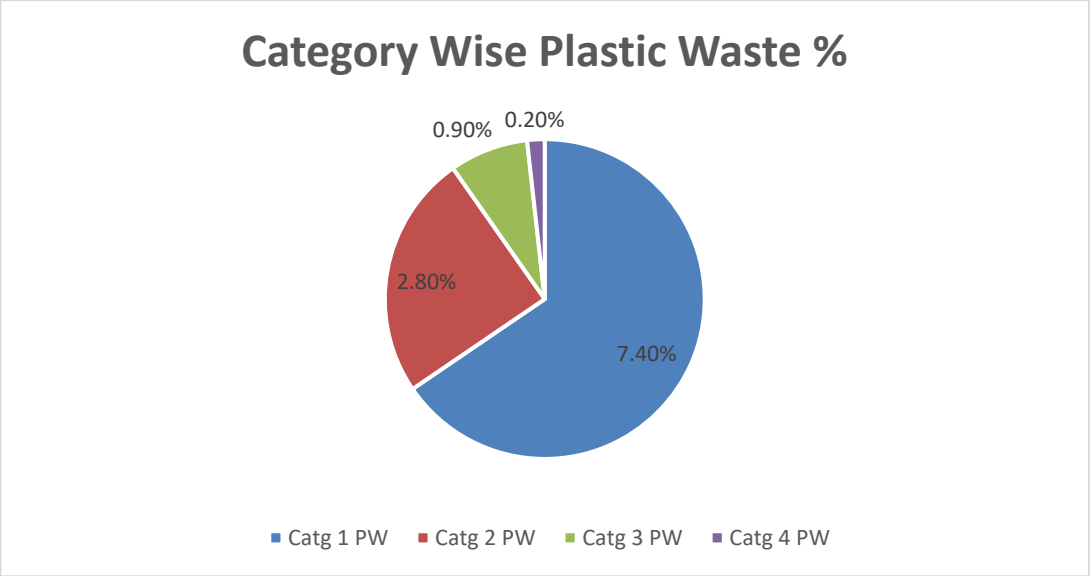
			Vehicle LoadNo.	VehicleLoadNo.1	VehicleLoadNo.2	VehicleLoadNo.3	VehicleLoadNo.4	Total
1		a	Sorting sample size (Kg)	126	130.5	128	135.6	**520**
		b	Plastic waste(Kg)	27.5	25.2	32.4	33.1	**118**
	SUPs							
2	PlasticSticks	a	Earbuds (Kg)	0.25	0.3	0.25	0	**0.8**
		b	Balloons (Kg)	0.1	0.15	0	0.2	**0.45**
		c	Candy(kg)	0	0	0	0	**0**
		d	Ice-cream(Kg)	0	0	0	0.1	**0.1**
		e	Straws(Kg)	0	0.15	0.18	0.1	**0.43**
3	CutleryItems	a	Plates(Kg)	0.15	0	0	0	**0.15**
		b	Cups(Kg)	0.98	1.1	0.5	0	**2.58**
		c	Glass(Kg)	0	0	0	0	**0**
		d	Forks(Kg)	0	0	0.1	0	**0.1**
		e	Spoons(Kg)	0.28	0.15	0	0.22	**0.65**
		f	Knives(Kg)	0	0	0	0	**0**
		g	Trays(Kg)	0	0.1	0	0	**0.1**
	Packaging /Wrapping Films	a	Sweetbox(Kg)	0	0	0	0	**0**
		b	Invitation Cards(Kg)	0.18	0	0	0	**0.18**

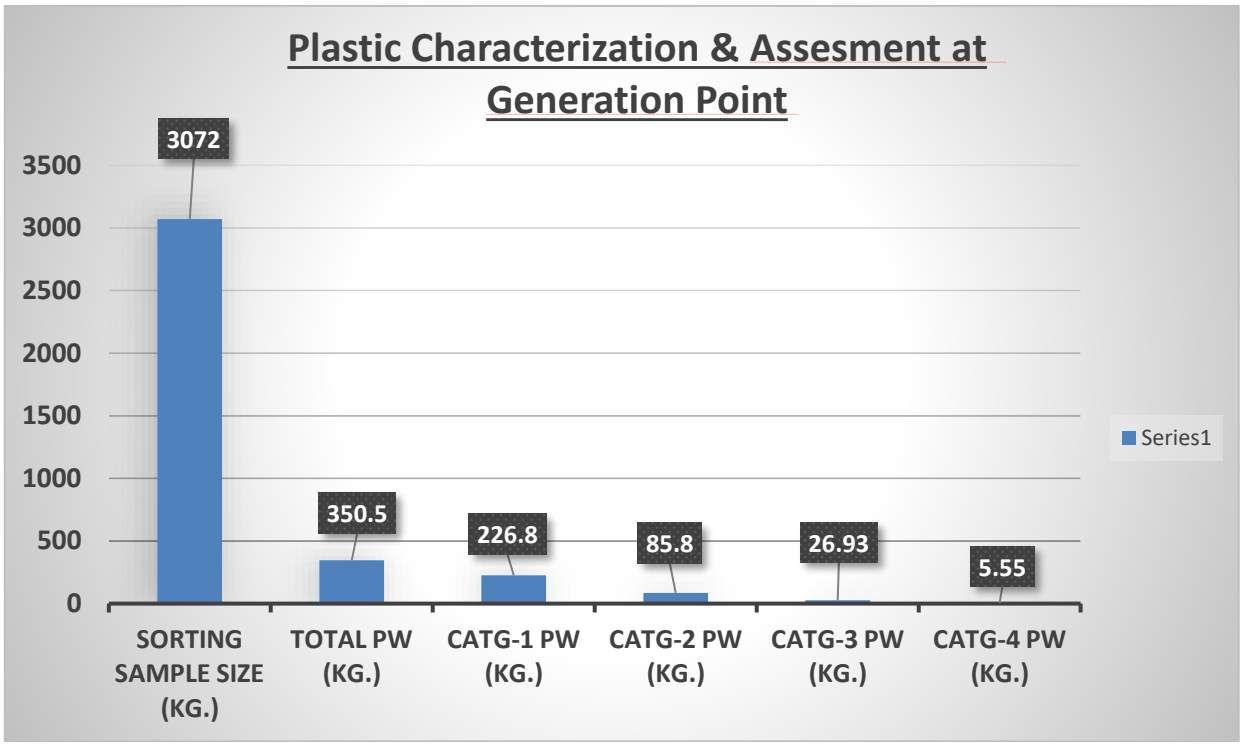
4		c	Ciggratte Packets(Kg)	0.95	0.88	0.65	0.97	**3.45**
5	Carry bags	a	<120microns(Kg)	4.5	4.1	3.9	6.2	**18.7**
6	Plasti cshee Ts	b	<50microns(Kg)	2.6	2.2	1.9	3.1	**9.8**
7	OtherItems	a	Plastics flags(Kg)	0	0	0	0	**0**
		b	PVCbanners <100um.(Kg)	0	0	0	0	**0**
		c	Poly styrene for decoration (Kg)	0	0	0	0	**0**
				9.99	**9.13**	**7.5**	**10.89**	**37.5**

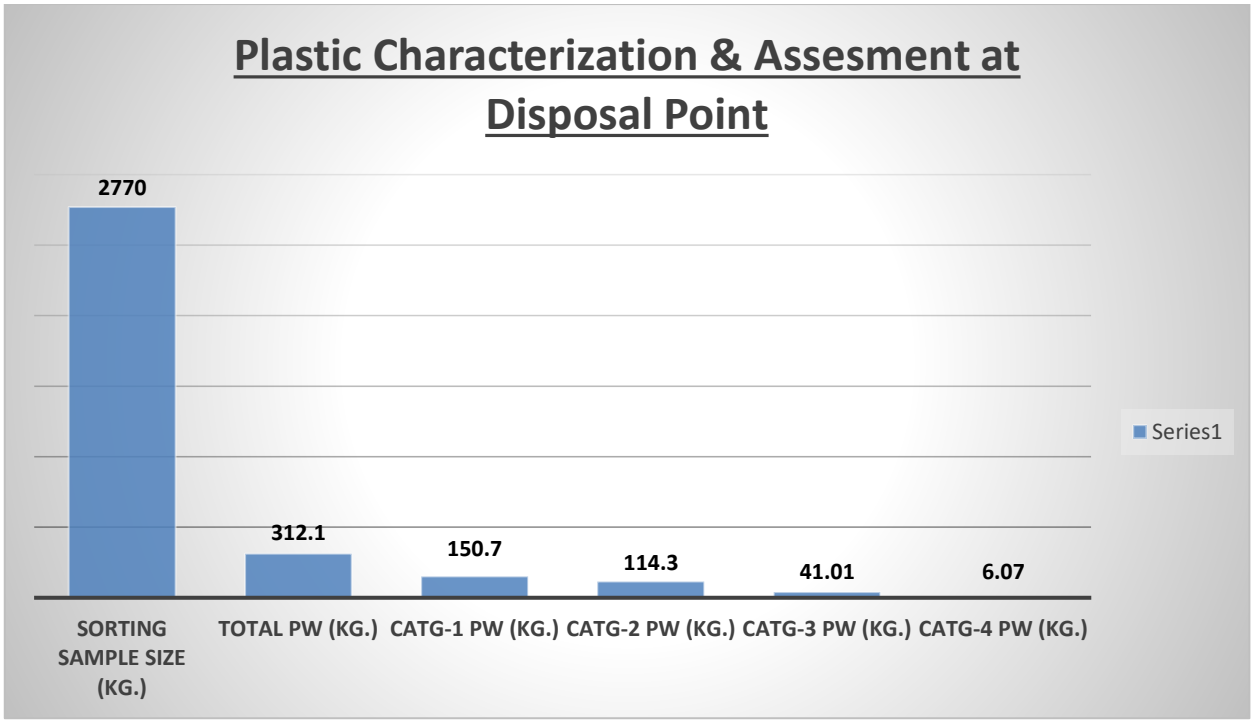
Plastic Waste Generation TPA



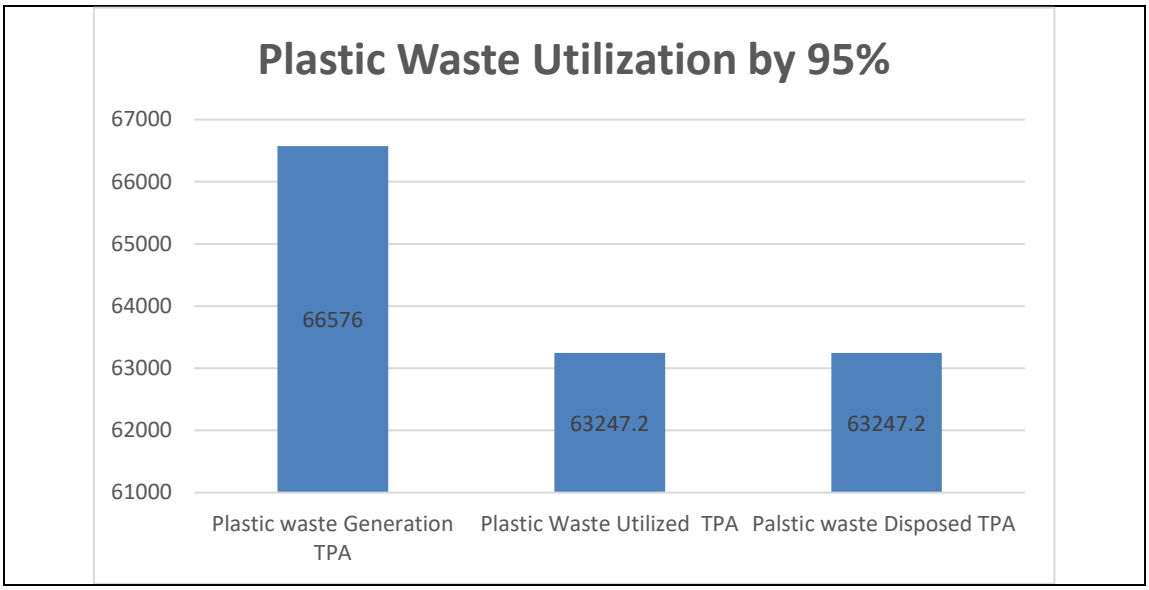
Category Wise Generated Plastic Waste %



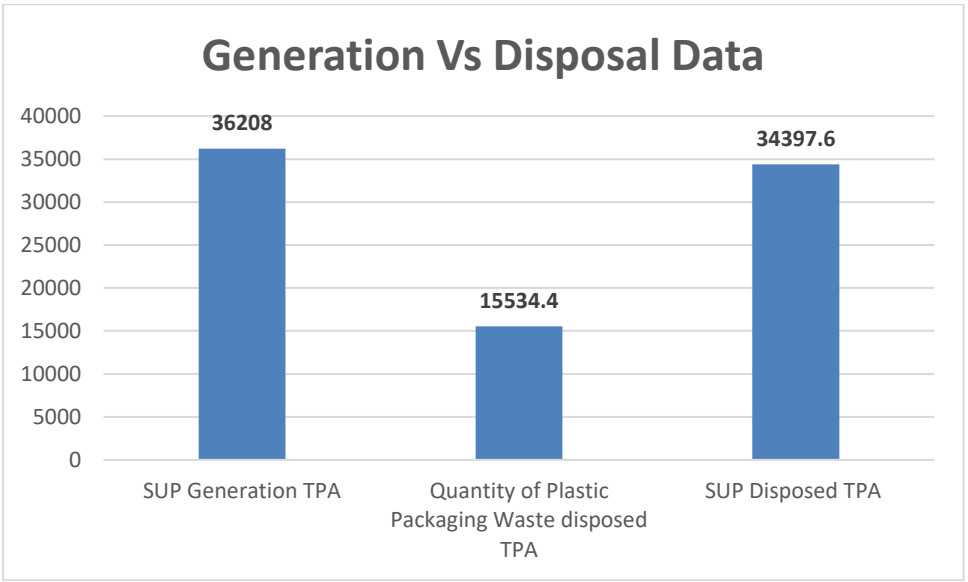

Plastic Characterization & Assesment at Generation Point
3072
350.5
226.8
85.8
26.93
5.55
3500
3000
2500
2000
1500
1000
500
0
SORTING SAMPLE SIZE (KG.)
TOTAL PW (KG.)
CATG-1 PW (KG.)
CATG-2 PW (KG.)
CATG-3 PW (KG.)
CATG-4 PW (KG.)
Series1


Plastic Characterization & Assesment at Disposal Point
2770
312.1
150.7
114.3
41.01
6.07
SORTING SAMPLE SIZE (KG.)
TOTAL PW (KG.)
CATG-1 PW (KG.)
CATG-2 PW (KG.)
CATG-3 PW (KG.)
CATG-4 PW (KG.)
Series1

Plastic Waste Utilization



Generation Vs Disposal Data



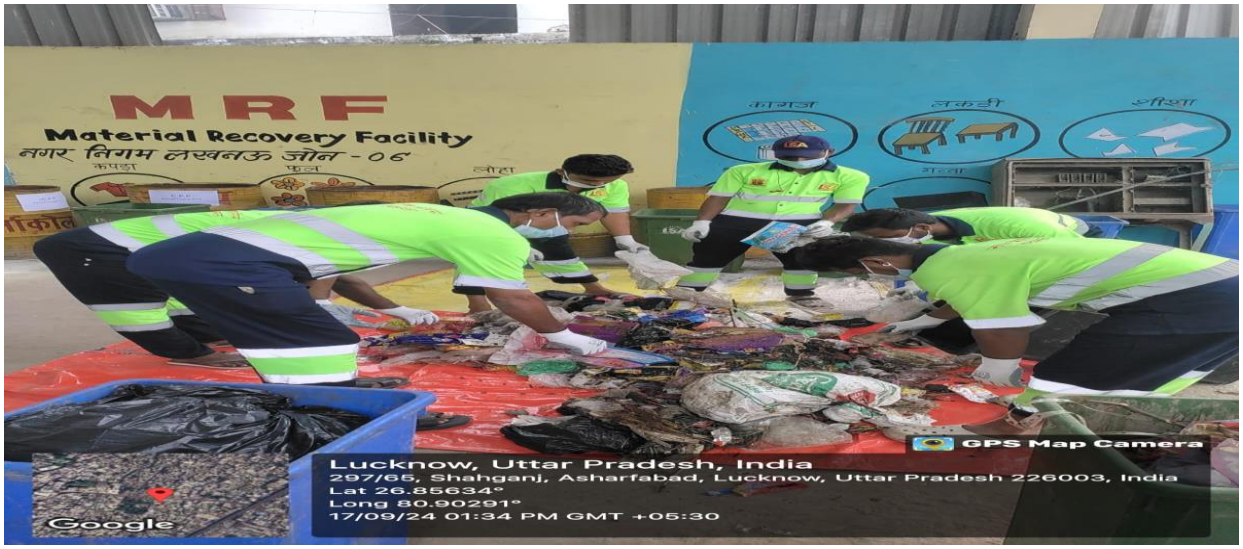
Photograph of Study







Characterization of plastic Waste Team at GTS, MRF



Sorting of Plastic Waste at Zone-6

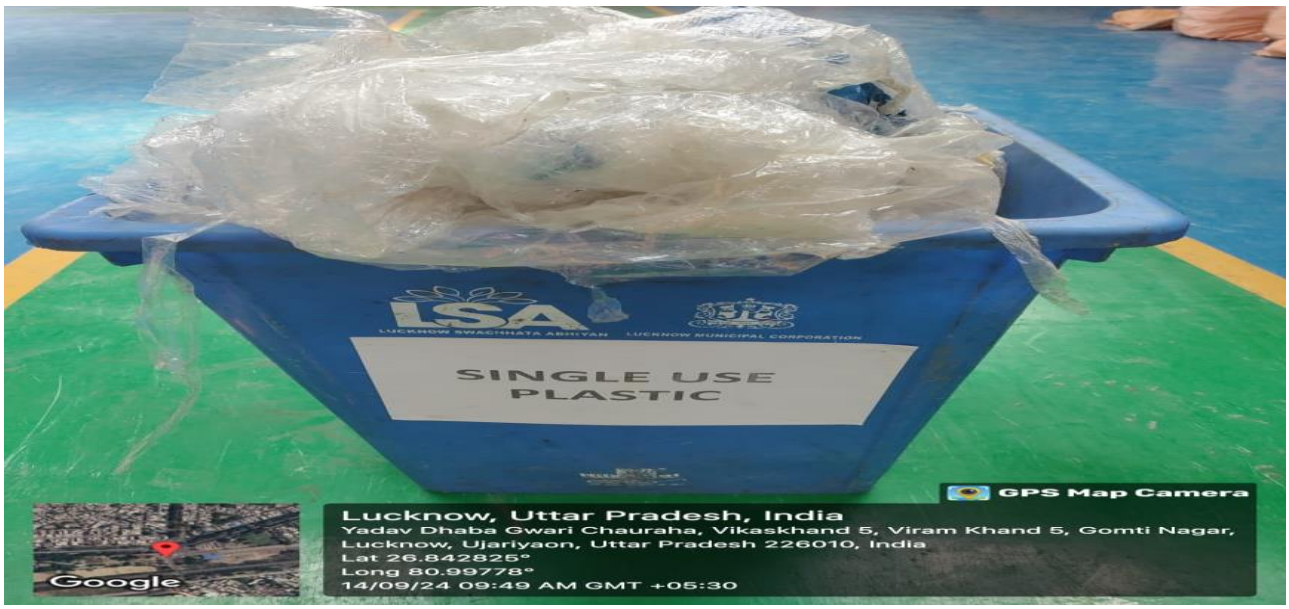






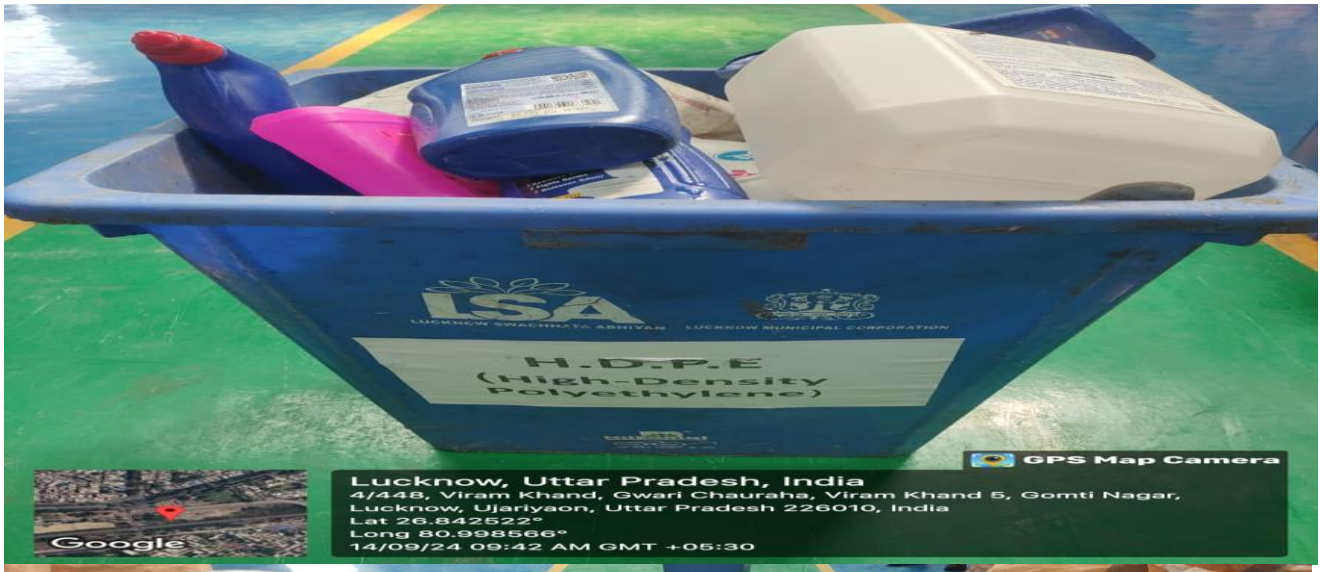
Mixed Waste Sorting at M.R.F Zone-4 Gwari Chowk Lucknow





Sorted Plastic Categories









Mixed Waste Sorting at Zone-4 Garbage Transfer Station Mithaiwala Lucknow

Annexure K

Standard Operating Procedure

for

Assessment & Characterization of Plastic Waste

June, 2024

Central Pollution Control Board, Delhi

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Annexures:

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- **Annexure II:** Amendment to PWM Rules dated February 16, 2022- Extended Producer Responsibility Guidelines
- **Annexure II A:** Amendment to PWM Rules dated March 14, 2024
- **Annexure III:** Report on Study conducted by GIZ
- **Annexure IV:** ASTM D 5231-92 Standard
- **Annexure V:** Determination of Sorting Sample size, number of vehicle loads, Vehicle load size and no. of days for sampling
- **Annexure VI:** Illustrative Example
- **Annexure VII:** SOP for testing compostable plastics developed by CPCB
- **Annexure VIII:** Pictorial representation of banned SUP items

1.0 Background & Legal Framework

In the last couple of decades, India has experienced rapid urbanization, industrialization, and economic growth, which has led to a substantial increase in plastic waste generation. The burgeoning population, along with improvements in living standards, has further exacerbated the quantum of plastic waste generation. The widespread use of plastics, especially single-use items and its indiscriminate disposal, poses a serious threat to the environment.

The Plastic Waste Management Rules of 2016, along with subsequent amendments, laid out a statutory framework for effective plastic waste management in the country. As per the provision of PWM Rules, the local bodies are required to assess the quantum of plastic waste generated in their jurisdiction and report the same in the Annual Report to be submitted to the concerned SPCB/PCC, which in turn compiles the same and submits it to CPCB.

Further, vide Amendment to PWM Rules dated August 12, 2021 (**Annexure I**) - import, production, sale, stocking and use of identified single-use plastic items like ear buds with plastic sticks, plastic flags, plates, cups, cutlery, and other similar disposable plastic products, has been banned w.e.f July 01, 2022. Also, vide Amendment to PWM Rules dated February 16, 2022- Extended Producer Responsibility Guidelines (**Annexure II**) with thrust on processing of plastic packaging waste has been notified by MoEFCC. Various measures have been taken across the country to ensure effective implementation of the said Amendments. It is required to periodically assess the impact of these measures on plastic waste management to strengthen implementation of EPR Guidelines and enforcement of SUP ban.

Further, MoEFCC vide Amendment dated March 14, 2024 (**Annexure IIA**) has included the following in the PWM Rules

- Rule 6 (5) The local body shall undertake assessment of plastic waste generated, including plastic waste existing in dump sites, by the 30th June of every year and also estimate the quantity of plastic waste to be generated in following five-year period.

- Rule 6 (8) The local body shall include in the annual report the following details on plastic waste management, namely:- (i) plastic waste generated, including plastic waste existing in dump sites, in a year; (ii) plastic waste management infrastructure available for collection, segregation, processing; (iii) projection of plastic waste to be generated; (iv) status on framing and implementation on byelaws; (v) actions taken action to prevent stocking, distribution, sale and usage of prohibited Single Use Plastic items.
- Rule 7A.: Responsibility of Panchayat at District level. - (1) The Panchayat at District level shall undertake assessment of plastic waste generated, including plastic waste existing at dump sites, by the 30th June of every year for rural areas of the district and also estimate the quantity of plastic waste to be generated in following five-year period.
- Rule 7A (3) The Panchayat at District Level shall include in the annual report the following details on plastic waste management, namely:- (i) plastic waste generated, including plastic waste existing at dump sites, in a year; (ii) plastic waste management infrastructure available for collection, segregation, processing; (iii) projection of plastic waste to be generated; (iv) status on framing and implementation on byelaws; (v) actions taken action to prevent stocking, distribution, sale and usage of banned Single Use Plastic items.
- Rule 17 (4) Every urban local body and Panchayat at District Level shall prepare and submit online an annual report in Form–V to the Urban Development Department and to Rural Development Department, respectively, and also to the State Pollution Control Board or Pollution Control Committee concerned by the 30th June every year.
- Rule 17 (5) The State Pollution Control Board or Pollution Control Committee concerned shall cause the report submitted by the urban local body and Panchayat at District level to be audited by itself or through a designated agency and copy of the report of such audit and the annual report shall be made available on website of State Pollution Control Board or Pollution Control Committee concerned.

- Rule 17 (6) The State Pollution Control Board or Pollution Control Committee shall prepare and submit online an annual report in Form VI to the Central Pollution Control Board on the implementation of these rules by the 31st July of every year.
- As per Form V A (Format of Annual Report by Local Bodies) (Section B (1 & 2)), Form V B ((Format of Annual Report by Village Panchayats) (Section B (3 & 4)) the Local Bodies / Village Panchayats are required to carry out the assessment related to plastic waste generation as per the methodology developed by CPCB, the details of which are to be included in the Annual Report which is to be submitted online.
- As per Form VI (Format of Annual Report to be submitted by SPCBs/PCCs) (Section C 8 -13), the SPCBs/PCCs are required to assess the Plastic waste generated in their jurisdiction as per methodology developed by CPCB

This SOP has been prepared incorporating the aforementioned provision of PWM Rules. The SOP outlines the methodology to assess the quantity of plastic waste generation and its characterization specifically w.r.t Single Use Plastic and Categories of Plastic Packaging as per PWM Rules. A study conducted by GIZ on the matter (**Annexure III**) has been referred to for preparing this document. Further, methodology for validation of data reported by the Local Bodies in the Annual Report, by the SPCBs/PCCs has also been included in this document. All concerned stakeholders including the local bodies and the SPCBs/PCCs shall follow the methodology delineated in this SOP for compliance of PWM Rules, 2016 (as amended).

2.0 Characterization & Assessment of Plastic Waste by Local Bodies

2.1 Determination of parameter for waste Characterisation

The plastic waste characterization method is based on the Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, American Society for Testing and Materials (ASTM) standard test method (D5231- 92) (**Annexure IV**). As per methodology, the following parameters are to be decided prior to initiation of the Waste Characterization:

a. **Number of Vehicles to be sampled (n)**: It refers to the number of vehicles transporting municipal waste from which the waste sample for characterization is to be collected.

b. **Sorting sample size (kg) (s)** : It is the quantum of sample extracted for further analysis, from each vehicle load, using cone and quarter method (Refer Annexure IV). It is to be in the range of 91-135 Kg

c. **Vehicle load Size (kg) (v)**: It is the quantum of waste which the aforementioned vehicles can transport in one trip. It is four times the size of the sorting samples i.e 360- 540 kg

d. **Duration of sampling (No of Days) (k)**: It is the number of days during which waste samples for analysis have to be collected.

The steps to be followed for determination of Sorting Sample size, number of vehicle to be sampled, Vehicle load size and no. of days for sampling in a particular Local body's jurisdiction as per ASTM D 5231-92 are detailed at **Annexure V**. Wide variation in quantum of waste generation in the country, depending upon the population, has been observed in the country. Further, sampling and analysis capacity also varies significantly with the type of the local body, being higher for large cities as compared to smaller cities. Further, higher Confidence level and lower precision level in the Assessment is required for the larger cities (refer **Annexure V**). Accordingly, the various parameters (n, v, s & k as per (a-d above) have been computed using ATM D 5231-92 assigning value of Confidence & Precision values proportionate to the population size of city /town/village panchayat and are given in **Table 1.**

Table 1: Sorting Sample size, number of vehicle loads, Vehicle load size and no. of days for sampling for Cities, Towns & Villages:

S. No.	Category	Min Population	Max Population	Confidence level	Precision Level	Vehicle Load Size (kg)	Sorting Sample size (Kgs)(s)	Total no. of Samples To be collected (n)	Sampling Days (k)
1.	Village Panchayat	1000 (avg.)	4999	0.9	0.2	360#	90	7	5
2.	Cities & Towns	5000	99999	0.9	0.15	400	100	14	6
3.	Cities & Towns	>100000		0.95	0.1	480	120	45	7

Note #: ***In hilly regions where movement of heavy vehicles is difficult, the Vehicle Load size of "360 Kg" applicable for "Village Panchayats" can be considered for Cities and Towns (Category 2&3 of Table 1)***

2.2 Distribution of the sampling locations:

Three stage random sampling method is to be followed to ensure full coverage of the geographical area as well as to include impact of socio-economic variation of the population on the waste generation.

Stage 1: Division of the city area into five zones East, West, North, south and central zone

Stage 2: Classification of the various wards in the zone under the following five major categories based on its socio-economic attributes of the ward as given below

- High-income residential wards (HI)
- Middle-income residential wards (MI)
- Economically Weaker Section (EWS) residential wards/slums
- Commercial wards (CW)
- Mixed commercial and residential wards (MX)

It is to be noted that the class assignment as per aforementioned details, should be based on the predominant feature of the ward. In addition to above, one disposal point should be identified in each Zone.

The number of vehicle loads to be collected from each zone would be distributed amongst the wards, to ensure adequate representation of the socio-economic attributes of the population in the Assessment. The number of samples from each economic category and zone should be uniformly distributed throughout the assessment duration (k days). Example illustrating the distribution of sampling locations is given at **Annexure VI** (Example 1)

2.3 Sample preparation:

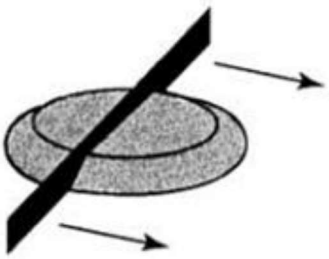
One Sorting sample is to be selected using the Cone & Quarter method from each vehicle load following the given steps:

- A location is to be selected for discharge of designated vehicle loads, manual sorting activities, and weighing operations. The location should be flat, level, and away from the normal waste handling and processing areas.
- The entire vehicle load of waste should be discharged in a designated area.
- The waste should be mixed and using the Quartering and coning, the vehicle load size (400-500 kg) shall be reduced to Sorting sample size (100-125 kg) method to reduce the size of the sample to the range of 100-125 kg.
- The entire vehicle load is to be disposed on the ground and divided into four parts. Two samples positioned diagonally opposite to each other are to be selected for the next step, the other two have to be discarded. The process is to be repeated to reduce the size of the sample from 400-500 kg to 100- 125 kg.

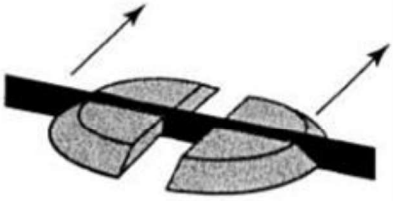
Pictorial representation of the same is given in Figure 1.0. For further details, Section 8 of the ASTM Standard is to be referred to.



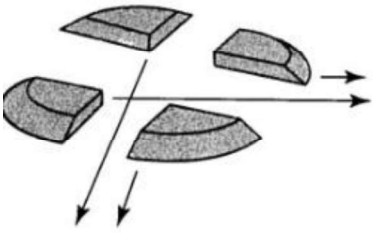
Step 1: Preparation of Cone

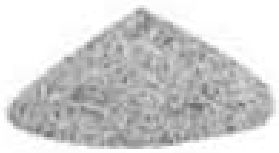


Step 2: Flattening & partitioning of the cone into two parts



Step 3: Partitioning of the Cone into four parts



Step 4: Select two opposite quarters & discard the remaining two

Step 5: Mix the two selected quarters for further analyis
Figure 1: Cone & Quarter Method for sampling of Waste

2.4 Waste Characterization

The EPR guidelines categorize plastic packaging into four groups: rigid, flexible, multi-layered, and compostable plastics. PET Water bottles, HDPE bottles used for packaging shampoo, detergent etc. are categorized into Rigid plastics (Category I).

Carry bags, plastic packaging etc. are categorized as flexible plastics (Category II). Multilayered plastic packaging (Category III) has at least one layer of plastic and at least one layer of material other than plastic is used for packaging products like chips packets, tea, coffees etc. Compostable plastic packaging (Category IV) under degradation by biological process and have a feel and texture (matt finish) different from the conventional plastics. Various laboratory methods, including the "Quick Verification Test," are available to differentiate between compostable and conventional plastics. SOP for testing compostable plastics developed by CPCB is placed at **Annexure VII**. Further, as per PWM Rules & SOP developed by CPCB, Compostable Plastics are required to be labelled giving details such as the name of its manufacturer.

Pictorial representation of various categories of packaging and SUP items is enclosed at **Annexure VIII.**

Helpers and sorters to be engaged in characterization are to be identified and properly trained for identification of different categories of Single Use Plastic Items and Category of Plastic Management.

Quantity of waste categorized shall be determined as given below:

The findings of the sorted sample in Kg/ Metric Ton-(MT) shall be reported as per format given in Table 2 & 2A (Plastic Packaging Category) (Generation & Disposal Point) and Table 3 & 3A (SUP Category) (Generation & Disposal Point) respectively.

Table 2A: Plastic Waste characterization (Plastic Packaging category wise): Generation points

Vehicle Load No. (1)	**Sorting Sample Size (Kg) (2)**	**Total PW(Kg) (3)**	**Category 1 PW (kg) (4)**	**Category 2 PW (kg)(5)**	**Category 3 PW (kg) (6)**	**Category 4 PW (kg) (7)**
1						
2						
..						
…						
n						
Total	**∑ Row 1..n**	**∑ Row 1..n**	**∑ Row 1..n**	**∑ Row 1..n**	**∑ Row 1..n**	**∑ Row 1..n**
Average (kg/kg)		**∑ (Column 3/ ∑ Column 2**	**∑ (Column 4/ ∑ Column 2**	**∑ (Column 5/ ∑ Column 2**	**∑ (Column 6/ ∑ Column 2**	**∑ (Column 7/ ∑ Column 2**

Table 2B: Plastic Waste characterization (Plastic Packaging category wise): Disposal points

Vehicle Load No. (1)	**Sorting Sample Size (Kg) (2)**	**Total PW(Kg) (3)**	**Category 1 PW (kg) (4)**	**Category 2 PW (kg)(5)**	**Category 3 PW (kg) (6)**	**Category 4 PW (kg) (7)**
1						
2						

Vehicle Load No. (1)	**Sorting Sample Size (Kg) (2)**	**Total PW(Kg) (3)**	**Category 1 PW (kg) (4)**	**Category 2 PW (kg)(5)**	**Category 3 PW (kg) (6)**	**Category 4 PW (kg) (7)**
..						
…						
n						
Total						
Average (kg/kg)		**∑ (Column 3/ ∑ Column 2**	**∑ (Column 4/ ∑ Column 2**	**∑ (Column 5/ ∑ Column 2**	**∑ (Column 6/ ∑ Column 2**	**∑ (Column 7/ ∑ Column 2**

Table 3A: Plastic waste characterization (Single Use Plastic) – Generation point

				Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**…**	**…**	**…**	**Vehicle Load NoN(kg)**	**Total ∑**	**Average (kg /kg)**
1		a	Sorting Sample Size (kg)								
		b	Plastic Waste (kg)								∑ (Row 1b/ ∑ Row 1a
			SUPs								
2	Plastic Sticks	a	Earbuds(kg)								∑ (Row 2a/ ∑ Row 1a

				Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**…**	**…**	**…**	**Vehicle Load NoN(kg)**	**Total ∑**	**Average (kg /kg)**
		b	Balloons(kg)								∑ (Row 2b/ ∑ Row 1a
		c	Candy(kg)								∑ (Row 2c/ ∑ Row 1a
		d	Ice-cream(kg)								∑ (Row 2d/ ∑ Row 1a
		e	Straws(kg)								∑ (Row 2e/ ∑ Row 1a
3	Cutlery items	a	Plates(kg)								∑ (Row 3a/ ∑ Row 1a
		b	Cups(kg)								∑ (Row 3b/ ∑ Row 1a
		c	Glass(kg)								∑ (Row 3c/ ∑ Row 1a
		d	Forks(kg)								∑ (Row 3d/ ∑ Row 1a
		e	Spoons(kg)								∑ (Row 3e/ ∑ Row 1a
		f	Knives(kg)								∑ (Row 3f/ ∑ Row 1a
		g	Trays(kg)								∑ (Row 3g/ ∑ Row 1a

				Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**…**	**…**	**…**	**Vehicle Load NoN(kg)**	**Total ∑**	**Average (kg /kg)**
4	Packaging / Wrapping Films	a	Sweet box(kg)								∑ (Row 4a/ ∑ Row 1a
		b	Invitation (kg) cards								∑ (Row 4b/ ∑ Row 1a
		c	Cigarette (kg) Packets								∑ (Row 4c/ ∑ Row 1a
5	Carry bags	a	<120 microns(kg)								∑ (Row 5a/ ∑ Row 1a
6	Plastic sheets	b	<50 microns(kg)								∑ (Row 6a/ ∑ Row 1a
7	Other items	a	Plastic flags(kg)								∑ (Row 7a/ ∑ Row 1a
		b	PVC banners < 100 µm, polystyrene for decoration(kg)								∑ (Row 7b/ ∑ Row 1a
		c	Polystyrene for decoration(kg)								∑ (Row 7c/ ∑ Row 1a

Table 3B: Plastic waste characterization (Single Use Plastic) – Disposal point

				Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**…**	**…**	**…**	**Vehicle Load No N(kg)**	**Total ∑**	**Average (kg/kg)**
1		a	Sorting Sample Size (kg)								
		b	Plastic Waste (kg)								∑ (Row 1 b/ ∑ Row 1 a
			SUPs								
2	Plastic Sticks	a	Earbuds(kg)								∑ (Row 2 a/ ∑ Row 1 a
		b	Balloons(kg)								∑ (Row 2 b/ ∑ Row 1 a
		c	Candy(kg)								∑ (Row 2c / ∑ Row 1 a
		d	Ice-cream(kg)								∑ (Row 2 d/ ∑ Row 1 a
		e	Straws(kg)								∑ (Row 2 e/ ∑ Row 1 a
3	Cutlery items	a	Plates(kg)								∑ (Row 3 a/ ∑ Row 1 a

				Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**…**	**…**	**…**	**Vehicle Load No N(kg)**	**Total ∑**	**Average (kg/kg)**
		b	Cups(kg)								∑ (Row 3 b/ ∑ Row 1 a
		c	Glass(kg)								∑ (Row 3 c/ ∑ Row 1 a
		d	Forks(kg)								∑ (Row 3 d/ ∑ Row 1 a
		e	Spoons(kg)								∑ (Row 3 e/ ∑ Row 1 a
		f	Knives(kg)								∑ (Row 3 f/ ∑ Row 1 a
		g	Trays(kg)								∑ (Row 3 g/ ∑ Row 1 a
4	Packaging / Wrapping Films	a	Sweet box(kg)								∑ (Row 4 a/ ∑ Row 1 a
		b	Invitation (kg) cards								∑ (Row 4 b/ ∑ Row 1 a
		c	Cigarette (kg) Packets								∑ (Row 4c / ∑ Row 1 a

				Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**…**	**…**	**…**	**Vehicle Load No N(kg)**	**Total ∑**	**Average (kg/kg)**
5	Carry bags	a	<120 microns(kg)								∑ (Row 5 a/ ∑ Row 1 a
6	Plastic sheets	b	<50 microns(kg)								∑ (Row 6 a/ ∑ Row 1 a

2.5 Assessment of Plastic Waste by Local Bodies

2.5.1. Quantity of Plastic Waste Generation

- Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

  Q1= (∑Column 3) / (∑ Column 2) – *refer Table 2A*
  OR
  Q1= (∑Row 1b) / (∑ Row 1a) – *refer Table 3A*

- Quantity of Mixed Waste generated (TPA) = Q
- Quantity of Plastic Waste Generated (TPA) (QT) = Q1*Q

2.5.2 Quantity of Plastic Packaging Waste Generation

- Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste)

  (Q2) = (∑ (Column 4) +∑ (Column 5) +∑ (Column 6) + ∑ (Column 7)) / (∑ (Column 2) --- *refer Table 2A*

- Quantity of Mixed Waste generated (TPA) = Q
- Quantity of Plastic Packaging Waste Generated (Q_{pack}) (TPA) = Q2*Q

2.5.3 Quantity of SUP Waste Generation

- Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

  (Q3) = (∑ (Row 2a… 7c) / (∑ (Row 1a) --- *refer Table 3A*

- Quantity of Mixed Waste generated (TPA) = Q
- Quantity of SUP Waste Generated (TPA) (Q_{SUP}) = Q3*Q

2.5.4 Quantity of Other (Non-packaging waste)

$Q_{other} = Q_T - Q_{pack}$

2.5.5 Quantity of Plastic Waste Disposed

- Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)
- $Q1_d$= (∑Column 3) / (∑ Column 2) – *refer Table 2B*

  OR

  $Q1_d$= (∑Row 1b) / (∑ Row 1a) – *refer Table 3B*
- Quantity of Mixed Waste Disposed (TPA) = Q_D
- Quantity of Plastic Waste Disposed (TPA) (Q_{TD}) = $Q1_d$*Q_D

2.5.6 Quantity of Plastic Packaging Waste Disposed

- Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste)

  ($Q2_d$) = (∑ (Column 4) +∑ (Column 5) +∑ (Column 6) + ∑ (Column 7)) / (∑ (Column 2) ----(*refer Table 2B*)
- Quantity of Mixed Waste Disposed (TPA) = Q_D
- Quantity of Plastic Packaging Waste Disposed ($Q_{pack\ D}$) (TPA) = $Q2_d$*Q_D

2.5.7 Quantity of SUP Waste at Disposal

- Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

  ($Q3_d$) = (∑ (Row 2a… 7c) / (∑ (Row 1a) ---(*refer Table 3B*)
- Quantity of Mixed Waste Disposed (TPA) = Q_D

- Quantity of SUP Waste Disposed (TPA) $(Q_{SUP})_D = Q3_d * Q_D$

2.5.8 Quantity of Other (Non-packaging waste) Disposed

$$Q_{other\ D} = Q_{TD} - Q_{pack\ D}$$

2.5.9 Quantity of Plastic waste Utilised/Processed

$$Q_{\ utilised/processed} = Q_T - Q_{TD}$$ (refer point 2.5.1 and point 2.5.5)

Example illustrating the above calculations is at **Annexure VI**

3.0 Validation, Assessment and Characterization of PW Data by SPCB/PCC

Urban Local Bodies (ULBs) shall follow the methodology detailed in Section 2.0 for Assessment & Characterization of Plastic Waste Generation in their jurisdiction. They shall inform the schedule of Assessment to the SPCBs/PCCs well in advance. SPCBs/PCCs shall join the Assessment to be carried out by the Local Bodies, as required by them to validate the methodology adopted for the Assessment as well as the data reported by the Local Bodies.

3.1 Validation of PW data reported by Local Bodies

The SPCBs/PCCs shall validate the PW data as per the format given in Table 5

Table 4: Validation of PW Data

Sl. No.	Item	Remarks
1	Total No. of Local Bodies in State/ UT	
2	Number of Local Bodies which have confirmed adoption of CPCB Assessment & Characterization Methodology	
3	No. of Local bodies in which SPCB/PCC joined the Assessment for confirmation of Point (2) above	
4	No. of Local Bodies in which SPCB/PCC joined the Assessment , confirming Point (2) above	
5	Number of Local Bodies in which of Quantity Plastic waste reported was verified by SPCB/PCC.	

Sl. No.	Item	Remarks
6	Number of Local Bodies found in compliance as per Point (5) above	
7	Number of non-complying Local Bodies as per Point (5) above, in which reported data was reconciled by SPCB/PCC	

3.2 Assessment and Characterization of PW Data

The SPCBs/PCCs shall carryout Assessment and Characterization of PW Data in their respective State/UT as per format given in **Table 5**

Sl. No	Local Body	Total Plastic Waste generated QTstate (TPA)	Qty of SUP in PW generated QSUPstate (TPA)	Qty of Plastic Packaging in PW generated Qpackstate (TPA)	Quantity of Other PW (Non-Packaging PW) Waste generated QTother	Quantity of plastic waste disposed (Q Dstate (TPA)	Qty of Plastic Packaging in PW disposed Q Dpackstate (TPA)	Quantity of SUP waste disposed QDSUPstate (TPA)	Qty of Plla stic wast process ed Qprocess (TPA)
					state (TP				
					A)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

Sl. No	**Local Body**	**Total Plastic Waste generated QTstate (TPA)**	**Qty of SUP in PW generated QSUPstate (TPA)**	**Qty of Plastic Packaging in PW generated Qpackstate (TPA)**	**Quantity of Other PW (Non-Packaging PW) Waste generated QTother**	**Quantity of plastic waste disposed (Q Dstate (TPA)**	**Qty of Plastic Packaging in PW disposed Q Dpackstate (TPA)**	**Quantity of SUP waste disposed QDSUPstate (TPA)**	**Qty of Plastic waste processed Qprocess (TPA)**
1	xxx	QT (As per 2.5.1)	QSUP as per 2.5.3	Q_{pack} as per 2.5.2	Q_{other} as per 2.5.4	(QTD) as per 2.5.5	(Q(PACB) D) as per 2.5.6	(Q(SUP$_D$) as per 2.5.7	Column (3)-Column (6)
2									
3									
	l								
TOTAL		∑Column 3	∑Column 4	∑Column 5	∑Column 6	∑Column 7	∑Column 8	∑Column 9	∑Column 10

4.0 Implementation of SOP for characterization and Assessment of PW Generation

a. The SPCBs/PCCs shall impart training to the concerned stakeholders under their jurisdiction for the assessment & characterization of PW as per this SOP.

b. The local bodies shall carry out assessment as per this SOP either directly or through an agency engaged by them. The State Level Authorities can also collectively engage agencies at the state level who can carry out the Assessment at Local body / Village Panchayat level.

c. The SPCBs/PCCs shall monitor the implementation of this SOP by the concerned stakeholders in their jurisdiction.

d. The local bodies/ VPs/SPCBs/PCCs shall submit the information related to assessment & characterization in accordance with provisions 17(4) & 17(6) of PWM Rules, 2016 (as amended).

e. The online portal for assessment & characterization of plastic waste as per the methodology stipulated in this SOP shall be developed by CPCB. The online portal shall have provision for assessment & characterization ay the Local body / Village panchayat level as well as the State level.

ANNEXURE I

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 12th August, 2021

G.S.R. 571(E).—Whereas the draft rules to amend the Plastics Waste Management Rules, 2016, were published in the Gazette of India, Extraordinary, dated the 11th March, 2021 vide notification number GSR 169 (E), inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the date copies of the Gazette containing the said draft rules were made available to the public;

And whereas, copies of the Gazette containing the said draft rules were made available to the public on the 11th March, 2021;

And whereas, objections and suggestions received within the aforesaid period have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by sections 6, 8 and 25 of Environment (Protection) Act 1986, (29 of 1986), the Central Government hereby makes the following rules to amend the Plastic Waste Management Rules, 2016, namely :-

1. (1) These rules may be called Plastic Waste Management (Amendment) Rules, 2021.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Plastic Waste Management Rules,2016 (hereinafter referred to as the said rules), in rule 2, in sub-rule (1), after the word "Importers", the words, "brand-owner, plastic waste processor (recycler, co-processor, etc.)" shall be inserted.

3. In the said rules, in rule 3,

(i) after clause (n), the following clause shall be inserted, namely :-

'(na) "Non-woven plastic bag" means Non-woven plastic bag made up of plastic sheet or web structured fabric of entangled plastic fibers or filaments (and by perforating films) bonded together by mechanical or thermal or chemical means, and the "non-woven fabric" means a flat or tufted porous sheet that is made directly from plastic fibres, molten plastic or plastic films;'

(ii) after clause (q), the following clause shall be inserted, namely: -

'(qa) "Plastic waste processing" means any process by which plastic waste is handled for the purpose of reuse, recycling, co-processing or transformation into new products;'

(iii) after clause (v), the following clauses shall be inserted, namely: -

'(va) "Single-use plastic commodity" mean a plastic item intended to be used once for the same purpose before being disposed of or recycled;'

'(vb) "Thermoset plastic" means a plastic which becomes irreversibly rigid when heated and hence cannot be remoulded into desired shape;'

'(vc) "Thermoplastic" means a plastic which softens on heating and can be moulded into desired shape;'.

4. In the said rules, in rule 4, -

(a) in sub-rule (1),–

(i) for the words "importer stocking", the words "import, stocking" shall be substituted;

(ii) in clause (c), for the words "fifty microns in thickness" , the words, figures, letters and brackets "seventy five microns in thickness with effect from the 30th September, 2021and one hundred and twenty (120) microns in thickness with effect from the 31st December, 2022" shall be substituted;

(iii) in clause (h), after the words, "carry bags", the words "and commodities" shall be inserted;

(iv) in clause (h), after the words, "compostable plastic carry bags", the words "or commodities or both" shall be inserted;

(v) after clause (i), following clause shall be inserted, namely: -

" (j) non-woven plastic carry bag shall not be less than 60 Gram Per Square Meter (GSM) with effect from the 30th September, 2021.";

(b) after sub-rule (1), the following sub-ules shall be inserted, namely:-

"(2) The manufacture, import, stocking, distribution, sale and use of following single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022:-

(a) ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration;

(b) plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.

(3) The provisions of sub-rule (2) (b) shall not apply to commodities made of compostable plastic.

(4) Any notification prohibiting the manufacture, import, stocking, distribution, sale and use of carry bags, plastic sheets or like, or cover made of plastic sheets and multi-layered packaging and single-use plastic, including polystyrene and expanded polystyrene, commodities, issued after this notification, shall come into force after the expiry of ten years, from the date of its publication".

5. In the said rules, in rule 5, in sub-rule (1), in clause (d), for the figures "2000", the figures "2016" shall be substituted.

6. In the said rules, in rule 6, in sub-rule (2), after clause (a), following clause shall be inserted, namely: -

"(aa) ensuring that the provisions of these rules, as amended, are adhered to;".

7. In the said rules, in rule 7, in sub-rule (1), after clause (a), following clause shall be inserted, namely : -

"(aa) ensuring that the provisions of these rules, as amended, are adhered to;".

8. In the said rules, in rule 9, in sub-rule (1), after the words, "local body concerned", the words "as per guidelines issued under these rules from time to time" shall be inserted.

9. In rule 11, sub-rule (1), –

(i) after the words "plastic carry bag", the words, "plastic packaging" shall be inserted;

(ii) in clause (a), after the word "manufacturer", the words "producer or brand-owner" shall be inserted, and after the words "carry bag", the words "and plastic packaging used by the brand owner" shall be inserted;

(iii) in clause (b), after the words "multilayered packaging", the words "excluding multi-layered packaging used for imported goods" shall be inserted;

(iv) in clause (c), after the words "name and certificate number", the words "of producer" shall be inserted.

10. In rule 12, –

(i) in sub-rule (2), after the words "waste generator," ,the words "restriction or prohibition on" shall be inserted;

(ii) in sub-rule (3), after the words "waste generator," ,the words "

restriction or prohibition on" shall be inserted.

11. In rule 13, in sub-rule (1), after the words "Union Territory concerned", the words "or the Central Pollution Control Board" shall be inserted.

[F. No. 17-2-2001 (Pt)-Part I -HSMD]

NARESH PAL GANGAWAR, Jt. Secy.

Note : The principal rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i), *vide* number GSR 320 (E), dated the 18th March, 2016 and subsequently amended vide notification number GSR 285 (E), dated the 27th March, 2018.

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ANNEXURE II

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the16th February, 2022

G.S.R. 133(E).—In exercise of the powers conferred by sections 3, 6, and 25 of the Environment (Protection) Act 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Plastic Waste Management Rules, 2016, namely: -

1. (1) These rules may be called the Plastic Waste Management (Amendment) Rules, 2022.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Plastic Waste Management Rules, 2016 (hereinafter referred to as the said rules), in rule 9, in sub-rule (1), for the words "as per guidelines issued under these rules from time to time", the words "as per guidelines specified in SCHEDULE – II" shall substituted.

3. In the said rules, after SCHEDULE – I, the following Schedule shall be inserted namely:-

'SCHEDULE-II

[See Rule 9 (1)]

Guidelines on Extended Producer Responsibility for Plastic Packaging

1. **Background:**

(1.1) The Ministry of Environment, Forest and Climate Change (MoEFCC), (hereinafter referred to as 'The Ministry'), notified the Plastic Waste Management Rules, 2016 on 18th March, 2016. The Ministry also notified the Solid Waste Management Rules, 2016 on 8th April, 2016. As plastic waste is part of solid waste, therefore, both the rules apply to managing plastic waste in the country.

(1.2) The Plastic Waste Management Rules, 2016, mandate the generators of plastic waste to take steps to minimize generation of plastic waste, not to litter the plastic waste, ensure segregated storage of waste at source and hand over segregated waste in accordance with rules. The rules also mandate the responsibilities of local bodies, gram panchayats, waste generators, retailers and street vendors to manage plastic waste. (1.3) The Plastic Waste Management Rules, 2016 cast Extended Producer Responsibility on Producer, Importer, and Brand Owner. Extended Producer Responsibility shall be applicable to both pre-consumer and post-consumer plastic packaging waste. (1.4) These guidelines provides framework for implementation of Extended Producer Responsibility. The Guidelines provide the roles and responsibilities of Producers, Importers, Brand Owners, Central Pollution Control Board, State Pollution Control Board or Pollution Control Committees, recyclers and waste processors for effective implementation of Extended Producer Responsibility. The definitions given in Plastic Waste Management Rules, 2016, apply until, specifically mentioned in these guidelines;

2. Date of Coming into Effect:

These guidelines shall come into force with immediate effect. The on-going processes related to Extended Producer Responsibility obligations will be aligned with these guidelines.

3. Definitions:

(a) "**Biodegradable plastics**" means that plastics, other than compostable plastics, which undergoes complete degradation by biological processes under ambient environment (terrestrial or in water) conditions, in specified time periods, without leaving any micro plastics, or visible, distinguishable or toxic residue, which have adverse environment impacts, adhering to laid down standards of Bureau of Indian Standards and certified by Central Pollution Control Board.

(b) **"Brand Owner"** means a person or company who sells any commodity under a registered brand label or trade mark;

(c) "**Carry Bags**" (covered under Category II of plastic packaging – Clause (5.1) (II)) means bags made from plastic material or compostable plastic material, used for the purpose of carrying or dispensing commodities which have a self-carrying feature but do not include bags that constitute or form an integral part of the packaging in which goods are sealed prior to use ;

(d) "**End of Life disposal**" means using plastic waste for generation of energy and includes co-processing (e.g. in cement kilns) or waste to oil or for road construction as per Indian Road Congress guidelines, etc;

(e) "**Extended Producer Responsibility**" means the responsibility of a producer for the environmentally sound management of the product until the end of its life;

(f) "**Importer**" means a person who imports plastic packaging product or products with plastic packaging or carry bags or multilayered packaging or plastic sheets or like;

(g) "**Plastic**" means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, polybutylene terephthalate;

(h) "**Plastic Packaging**" means packaging material made by using plastics for protecting, preserving, storing and transporting of products in a variety of ways.

(i) "**Plastic Sheet**" means plastic sheet is the sheet made of plastic;

(j) "**Plastic Waste Processors**" means recyclers and entities engaged in using plastic waste for energy (waste to energy), and converting it to oil (waste to oil), industrial composting.

(k) "**Pre-consumer plastic packaging waste**" means plastic packaging waste generated in the form of reject or discard at the stage of manufacturing of plastic packaging and plastic packaging waste generated during the packaging of product including reject, discard, before the plastic packaging reaches the end-use consumer of the product.

(l) "**Post-consumer plastic packaging waste"** means plastic packaging waste generated by the end-use consumer after the intended use of packaging is completed and is no longer being used for its intended purpose.

(m) "**Producer**" means person engaged in manufacture or import of carry bags or multilayered packaging or plastic sheets or like, and includes industries or individuals using plastic sheets or like or covers made of plastic sheets or multilayered packaging for packaging or wrapping the commodity;

(n) "**Recyclers**" are entities who are engaged in the process of recycling of plastic waste;

(o) "**Recycling**" means the process of transforming segregated plastic waste into a new product or raw material for producing new products;

(p) "**Reuse**" means using an object or resource material again for either the same purpose or another purpose without changing the object's structure;

(q) "**Use of recycled plastic**" means recycled plastic, instead of virgin plastic, is used as raw material in the manufacturing process;

(r) "**Waste Management**" means the collection, storage, transportation reduction, re-use, recovery, recycling, composting or disposal of plastic waste in an environmentally sound manner;

(s) "**Waste to Energy**" means using plastic waste for generation of energy and includes co-processing (e.g. in cement kilns).

4. Obligated Entities:

The following entities shall be covered under the Extended Producer Responsibility obligations and provisions of these guidelines namely: -

(i) Producer (P) of plastic packaging;

(ii) Importer (I) of all imported plastic packaging and / or plastic packaging of imported products;

(iii) Brand Owners (BO) including online platforms/marketplaces and supermarkets/retail chains other than those, which are micro and small enterprises as per the criteria of Ministry of Micro, Small and Medium Enterprises, Government of India.;

(iv) Plastic Waste Processors

5. Coverage of Extended Producer Responsibility:

(5.1) The following plastic packaging categories are covers under Extended Producer Responsibility:

(i) **Category I**

Rigid plastic packaging;

(ii) **Category II**

Flexible plastic packaging of single layer or multilayer (more than one layer with different types of plastic), plastic sheets or like and covers made of plastic sheet, carry bags, plastic sachet or pouches;

(iii) **Category III**

Multilayered plastic packaging (at least one layer of plastic and at least one layer of material other than plastic);

(iv) **Category IV**

Plastic sheet or like used for packaging as well as carry bags made of compostable plastics.

(5.2) The Extended Producer Responsibility Guidelines covers the following with respect to plastic packaging namely: -

(i) Reuse;

(ii) Recycling;

(iii) Use of recycled plastic content;

(iv) End of life disposal.

6. Registration:

(6.1) (a)The following entities shall register on the centralized portal developed by Central Pollution Control Board namely: -

(i) Producer (P);

(ii) Importer (I);

(iii) Brand owner (BO);

(iv) Plastic Waste Processor engaged in (a) recycling, (b) waste to energy, (c) waste to oil, and (iv) industrial composting,

(b) Registration of Producers, Importers & Brand-Owners (operating in one or two states) and Plastic Waste processors shall be done by State Pollution Control Board or Pollution Control Committee through the centralized Extended Producer Responsibility portal developed by Central Pollution Control Board.

(c) After these guidelines have come into effect, with respect to, entities starting their business in a particular year and placing their products in market in that year, they shall have Extended Producer Responsibility target obligations from the next year.

(6.2) The entities covered under clause 6.1 shall not carry any business without registration obtained through on-line centralized portal developed by Central Pollution Control Board.

(6.3) The entities covered under clause (6.1) shall not deal with any entity not registered through on-line centralized portal developed by Central Pollution Control Board.

(6.4) In case, it is found or determined that any entity registered on the on-line portal has provided false information or has willfully concealed information or there is any irregularity or deviation from the conditions stipulated while obtaining registration under Extended Producer Responsibility guidelines, then the registration of such an entity would be revoked for a one -year period after giving an opportunity to be heard. The entities whose registration has been revoked shall not be able to register afresh for the period of revocation.

(6.5) In case any entity falls in more than one sub-category mentioned in the clause (6.1) then the entity shall register under each of those sub-categories separately. Further, in cases, where the entity has units in different states, in a particular sub-category mentioned in clause 6.1, then these units shall also be registered separately. However, only one registration under a sub category in a state would be needed, even if, more than one unit are located in a state. The registration shall be as per Standard Operating Procedure laid down by Central Pollution Control Board for the purpose, as per these Guidelines.

(6.6) While registering, the entities shall have to provide PAN Number, GST Number, CIN Number of the company and Aadhar Number and PAN Number of authorized person or representative and any other necessary information as required.

7. Targets for Extended Producer Responsibility and obligations of Producers, Importers & Brand-Owners:

(7.1) The Extended Producer Responsibility targets for the Producers, Importers & Brand-Owners shall be determined category-wise.

(7.2) Producer (P):

(a) Extended Producer Responsibility target (Refer example 1 to 3 in Annexure):

Eligible Quantity in MT (Q 1) shall be the average weight of plastic packaging material (category-wise) sold in the last two financial years (A) plus average quantity of pre-consumer plastic packaging waste in the last two financial years (B) minus the annual quantity (C) supplied to the entities covered under sub-clause 4 (iii) in the previous financial year as under: -

Q 1 (in MT) = (A + B) -

and the Extended Producer Responsibility target shall be determined category-wise , as given below

Extended Producer Responsibility target

	Year	Extended Producer Responsibility target (as a percentage of Q1 - category-wise)
I	**2021 - 22**	**25 %**
II	**2022 - 23**	**70 %**
III	**2023 - 24**	**100 %**

The Extended Producer Responsibility target in MT category-wise, as applicable, shall be provided by Producer, as part of Action Plan on the centralized portal developed by Central Pollution Control Board.

(b) Obligation for recycling (Refer example 1 to 3 in Annexure):

The Producer shall ensure minimum level of recycling (excluding end of life disposal) of plastic packaging waste collected under Extended Producer Responsibility Target, category-wise, as given below namely: -

Minimum level of recycling (excluding end of life disposal) of plastic packaging waste

(% of Extended Producer Responsibility Target)

Plastic packaging category	2024-25	2025-26	2026-27	2027-28 and onwards
Category I	**50**	**60**	**70**	**80**
Category II	**30**	**40**	**50**	**60**
Category III	**30**	**40**	**50**	**60**
Category IV	**50**	**60**	**70**	**80**

In case of Category IV plastic packaging category (plastic sheet or like used for packaging and carry bags made of compostable plastics), the minimum level of recycling means processing plastic packaging waste for composting through industrial composting facilities.

(c) End of life disposal (refer examples 1 to 3 in Annexure):

(i) Only those plastics, which cannot be recycled will be sent for end of life disposal such as road construction, waste to energy, waste to oil, cement kilns (for co processing) etc. as per relevant guidelines issued by Indian Road Congress or Central Pollution Control Board from time to time.

(ii) The producers shall ensure end of life disposal of the plastic packaging waste only through methodologies specified in Rule 5 (1) (b) of Plastic Waste Management Rules, 2016,

(d) Obligation for use of recycled plastic content (Refer example 6 in Annexure)

The Producer shall ensure use of recycled plastic in plastic packaging category-wise as given below namely: -

Mandatory use of recycled plastic in plastic packaging

(% of plastic manufactured for the year)

Plastic packaging category	2025-26	2026-27	2027-28	2028-29 and onwards
Category I	30	40	50	60
Category II	10	10	20	20
Category III	5	5	10	10

In cases, where it is not possible to meet the obligation in respect of recycled plastic content on account of statutory requirements, the exemption will be granted by Central Pollution Control Board on case-to-case basis. However, in such cases, the Producers, Importers & Brand-Owners will have to fulfil its obligation of use of recycled content (in quantitative terms) through purchase of certificate of equivalent quantity from such Producers, Importers & Brand-Owners who have used recycled content in excess of their obligation. Central Pollution Control Board will develop mechanism for such exchange on the centralized online portal.

7.3 Importer (I):

(a) Extended Producer Responsibility Target (Refer example 1 to 3 in Annexure)

Eligible Quantity in MT (Q 2) shall be the average weight of all plastic packaging material and / or plastic packaging of imported products (category-wise) imported and sold in the last two financial years (A) plus average quantity of pre-consumer plastic packaging in the last two financial years (B) waste minus the annual quantity (C) supplied to the entities covered under sub-clause 4 (iii) in the previous financial years as under: -

Q 2 (in MT) = (A + B) - C
and the Extended Producer Responsibility target shall be determined, category-wise , as given below namely: -

	Year	Extended Producer Responsibility target (as a percentage of Q 2 - category-wise)
I	**2021 - 22**	**25 %**
II	**2022 - 23**	**70 %**
III	**2023 - 24**	**100 %**

The Extended Producer Responsibility target in MT category-wise, as applicable, shall be provided by Importer as part of Action Plan on the centralized portal developed by Central Pollution Control Board.

(b) Obligation for recycling (Refer example 1 to 3 in Annexure)

The Importer shall ensure minimum level of recycling (excluding end of life disposal) of plastic packaging waste collected under extended producer responsibility Target, category-wise, as given below.

Minimum level of recycling (excluding end of life disposal) of plastic packaging waste

(% of extended producer responsibility Target)

Plastic packaging category	**2024-25**	**2025-26**	**2026-27**	**2027-28 and onwards**
Category I	**50**	**60**	**70**	**80**
Category II	**30**	**40**	**50**	**60**
Category III	**30**	**40**	**50**	**60**
Category IV	**50**	**60**	**70**	**80**

In case of Category IV plastic packaging category (plastic sheet or like used for packaging and carry bags made of compostable plastics), the minimum level of recycling means processing plastic packaging waste for composting through industrial composting facilities.

(c) End of life disposal (refer examples 1 to 3 in Annexure)

(i) Only those plastics, which cannot be recycled will be sent for end of life disposal such as road construction, waste to energy, waste to oil as per relevant guidelines issued by Indian Road Congress or Central Pollution Control Board from time to time.

(ii) The importer shall ensure end of life disposal of the plastic packaging waste only through methodologies specified in rule 5 (1) (b) of Plastic Waste Management Rules, 2016, as amended.

(d) Obligation for use of recycled plastic content (Refer example 6 in Annexure)

The Importer shall ensure use of recycled plastic in plastic packaging category-wise as given below.

Mandatory use of recycled plastic in plastic packaging

(% of imported plastic for the year)

Plastic packaging category	2025-26	2026-27	2027-28	2028-29 and onwards
Category I	30	40	50	60
Category II	10	10	20	20
Category III	5	5	10	10

Any recycled plastic used in imported material shall not be counted towards fulfilment of obligation. The importer will have to fulfil its obligation of use of recycled content (in quantitative terms) through purchase of certificate of equivalent quantity from such Producers, Importers & Brand-Owners who have used recycled content in excess of their obligation. Central Pollution Control Board will develop mechanism for such exchange on the centralized online portal.

7.4 Brand Owner (BO):

a) Extended Producer Responsibility target (refer examples 1 to 3 in Annexure)

Eligible Quantity in MT (Q 3) shall be the average weight of virgin plastic packaging material (category-wise) purchased and introduced in market in the last two financial years (A) plus average quantity of (B) of pre-consumer plastic packaging in the last two financial years as under: -

Q 3 (in MT) = A + B

The Extended Producer Responsibility target shall be determined, category-wise , as given below namely: -

	Year	Extended Producer Responsibility Target (as a percentage of Q3 - category-wise)
I	**2021 - 22**	**25 %**
II	**2022 - 23**	**70 %**
III	**2023 - 24**	**100 %**

The Extended Producer Responsibility target in MT category-wise, as applicable, shall be provided by Brand Owner as part of the Action Plan on the centralized portal developed by Central Pollution Control Board.

(b) Obligation for reuse (refer examples 4 and 5 in Annexure):

I. The Brand Owner using Category I (rigid) plastic packaging for their products shall have minimum obligation to reuse such packaging as given below: -

Provided that the reuse of Category I rigid plastic packaging in food contact applications shall be subject to regulation of Food Safety and Standards Authority of India.

(II) Minimum obligation to reuse for Category I (rigid plastic packaging).

	Year	Target (as percentage of Category I rigid plastic packaging in products sold annually)

A	Category I rigid plastic packaging with volume or weight equal or more than 0.9 liter or kg but less than 4.9 litres or kg, as the case may be	
I	2025 – 26	10
II	2026 – 27	15
III	2027-28	20
IV	2028-29 and onwards	25
B	Category I rigid plastic packaging with volume of weight equal or more than 4.9 litres or kg.	
I	2025 – 26	70
II	2026 – 27	75
III	2027-28	80
IV	2028-29 and onwards	85

(III) The quantity of rigid packaging reused by brand Owner shall be calculated by reducing virgin plastic packaging manufactured/imported/purchased in that year from the sales of the Brand Owner. The brand owner shall provide this information on the centralized portal developed by Central Pollution Control Board.

(IV) The quantity of Category I rigid plastic packaging reused shall be reduced from the total plastic packaging used under Category I by the obligated entities (Brand Owners).

III. The quantity of Category I rigid plastic packaging reused during the year 2022 – 2023 and 2023-2024, shall be reduced from the total plastic packaging used under Category I.

(c) Obligation for recycling (refer examples 1 to 3 in Annexure):

The Brand Owner shall ensure minimum level of recycling (excluding end of life disposal) of plastic packaging waste collected under Extended Producer Responsibility target, category-wise, as given below.

Minimum level of recycling (excluding end of life disposal) of plastic packaging waste

(% of Extended Producer Responsibility Target)

Plastic packaging category	2024-25	2025-26	2026-27	2027-28 and onwards
Category I	**50**	**60**	**70**	**80**
Category II	**30**	**40**	**50**	**60**
Category III	**30**	**40**	**50**	**60**
Category IV	**50**	**60**	**70**	**80**

In case of Category IV plastic packaging category (plastic sheet or like used for packaging and carry bags made of compostable plastics), the minimum level of recycling means processing plastic packaging waste for composting through industrial composting facilities.

(d) End of life disposal (refer examples 1 to 3 in Annexure)

(i) Only those plastics, which cannot be recycled will be sent for end of life disposal such as road construction, waste to energy, waste to oil, as per relevant guidelines issued by Indian Road Congress or Central Pollution Control Board from time to time.

(ii) The Brand Owner shall ensure end of life disposal of the plastic packaging waste only through methodologies specified in rule 5 (1) (b) of the Plastic Waste Management Rules, 2016, as amended.

(e) Obligation for use of recycled plastic content (refer examples 6 in Annexure)

(i) The Brand Owner shall ensure use of recycled plastic in plastic packaging, category-wise, as given below namely:

Mandatory use of recycled plastic in plastic packaging

(% of manufactured plastic for the year)

Plastic packaging category	2025-26	2026-27	2027-28	2028-29 and onwards
Category I	30	40	50	60
Category II	10	10	20	20
Category III	5	5	10	10

(ii) In cases, where it is not possible to meet the obligation in respect of recycled plastic content on account of statutory requirements, the exemption will be granted by Central Pollution Control Board on case-to-case basis. However, in such cases, the Producers, Importers & Brand-Owners will have to fulfil its obligation of use of recycled content (in quantitative terms) through purchase of certificate of equivalent quantity from such Producers, Importers & Brand-Owners who have used recycled content in excess of their obligation. Central Pollution Control Board will develop mechanism for such exchange on the centralized online portal.

(iii) In case, where Brand Owner is also Producer and/or Importer of plastic packaging material, the clause 7.2 and 7.3 shall also apply for determining their Extended Producer Responsibility targets and obligations as Producer and /or Importer, respectively.

(7.5) The Extended Producer Responsibility target in MT category-wise, as applicable, shall be provided by all Producers, Importers & Brand-Owners as part of Action Plan on the centralized portal developed by Central Pollution Control Board.

(7.6) The obligations for reuse, recycling of waste and use of recycled plastic content in packaging shall be reviewed every five years based upon available technologies for meeting the Targets specified.

(7.7) Extended Producer Responsibility on plastic packaging will promote sustainable packaging, as per guidelines prepared by Central Pollution Control Board, inter alia based on the following criteria,

(i) package designing promoting reuse;

(ii) package designing amenable for recycling;

(iii) recycled plastic content in plastic packaging material and; (iv) package designing for environment.

(7.8) In case, the obligated entity utilizes plastic packaging which is 100% biodegradable in the ambient environment leaving no traces of micro plastics or chemical residue or any other traces having adverse environmental and health impacts as certified by regulatory entities Central Pollution Control Board, Bureau of Indian Standards, Central Institute of Petrochemicals Engineering & Technology, the Extended Producer Responsibility target will not be applicable for such material.

8. Generation of surplus Extended Producer Responsibility certificates, carry forward and offsetting against previous year Extended Producer Responsibility targets and obligations, and sale and purchase of surplus Extended Producer Responsibility certificates:

(8.1) A Brand Owner who has fulfilled their Extended Producer Responsibility targets, category-wise, can use the surplus for the following namely: -

(i) Off setting previous year shortfall subject to clause 9.5;

(ii) Carry forward for use in succeeding year;

(iii) Sell it to other Producers, Importers & Brand-Owners.

(8.2) Surplus in one category can only be used for off-setting, carry forward and sale in the same category. A surplus under reuse can be used for against reuse, recycling and also end of life disposal. A surplus under recycling can be used for recycling and end of life disposal. A surplus under end of life disposal cannot be used for reuse or recycle.

(8.3) Producers, Importers & Brand-Owners can also meet their Extended Producer Responsibility obligations under a category by purchasing surplus Extended Producer Responsibility certificates from other Producers, Importers & Brand-Owners of the same category.

(8.4) Such transactions shall be recorded and submitted by the Producers, Importers & Brand-Owners on the online portal while filing annual returns under the Extended Producer Responsibility framework. Central Pollution Control Board will develop mechanism for such exchange on the centralized portal.

9. Imposition of Environmental Compensation:

(9.1) Environmental Compensation shall be levied based upon polluter pays principle, with respect to non-fulfilment of Extended Producer Responsibility targets by Producers, Importers &

Brand Owners, for the prupose of protecting and improving the quality of the environment and preventing, controlling and abating environment pollution .

(9.2) Central Pollution Control Board shall lay down guidelines for imposition and collection of environment compensation on Producers, Importers & Brand-Owners, recyclers and end of life processors, in case of non-fulfilment of obligations set out in these guidelines, and the same shall be notified. The Guidelines for Environmental Compensation shall be updated, as required.

(9.3) The Environment Compensation, as applicable, shall be levied by Central Pollution Control Board on the Producers, Importers & Brand-Owners operating in more than two states with respect to non-fulfillment of their Extended Producer Responsibility targets, responsibilities and obligations in these guidelines.

(9.4) The Environment Compensation, as applicable, shall be levied by respective State Pollution Control Board on the Producers, Importers & Brand-Owners operating in their jurisdiction (for Producers, Importers & Brand-Owners not operating in more than two states/Union Territory's), Plastic Waste Processors which includes recyclers and other waste processors – waste to energy, waste to oil, co-processors, with respect to non-fulfillment of their Extended Producer Responsibility targets or responsibilities and obligations set out under these guidelines. In case, the State Pollution Control Board or Pollution Control Committee does not take action in reasonable time, the Central Pollution Control Board shall issue directions to the State Pollution Control Board /Pollution Control Committee.

(9.5) Payment of environmental compensation shall not absolve the Producers, Importers & Brand-Owners of the obligations set out in these guidelines. The unfulfilled Extended Producer Responsibility obligations for a particular year will be carried forward to the next year for a period of three years. In case, the shortfall of Extended Producer Responsibility obligation is addressed within three years. The environmental compensation levied shall be returned to the Producers, Importers & Brand-Owners as given below, namely

(i) Within one year of levying of EC: 75% return;

(ii) Within two years 60% return;

(iii) Within three years 40% return,

After completion of three years on environmental compensation getting due the entire environmental compensation amount shall be forfeited. This arrangement shall allow for collection and recycling of plastic packaging waste by Producers, Importers & Brand-Owners in later years as well.

(9.6) The funds collected under environmental compensation shall be kept in a separate Escrow account by Central Pollution Control Board or State Pollution Control Board or Pollution Control Committee. The funds collected shall be utilized in collection, recycling and end of life disposal of uncollected and non-recycled or non- end of life disposal of plastic packaging waste, on which the environmental compensation is levied. Modalities for utilization of the funds for plastic waste management on an annual basis would be recommended by the Committee for Extended Producer Responsibility implementation and approved by the Competent Authority in the Ministry.

10. Role of Producers, Importers & Brand-Owners:

(10.1) The Producers, Importers & Brand-Owners shall have to register through the online centralized portal developed by Central Pollution Control Board. The certificate of registration shall be issued using the portal.

(10.2) Producers, Importers & Brand-Owners shall provide Action Plan containing information on the Extended Producer Responsibility Target, category-wise, where applicable, through the online centralized portal developed by Central Pollution Control Board, along with application for registration or renewal of registration under Plastic Waste Management Rules, 2016. The Action Plan shall cover tenure of the Registration as per the provisions of Plastic Waste Management Rules, 2016. The standard operating procedure for registration and the action plan pro forma shall be developed by Central Pollution Control Board as per these guidelines.

(10.3) Brand Owner covered under clause 4 (iii) shall provide details of plastic packaging purchased from Producers and/or Importers covered under clause 4 (i) and 4 (ii) separately. The quantities attributed to each Producer and Importer covered under clause 4 (i) and 4 (ii) obligated upon Brand Owner shall be deducted from the obligation of Producers and Importers. The record of such purchase including category-wise quantity purchased, shall be maintained separately by Brand Owner.

(10.4) The Producers and Importers covered under clauses 4 (i) and 4 (ii) will maintain the record of the quantity of plastic packaging material made available to Brand Owner covered under clause 4 (iii). The record of such sale including category-wise quantity sold, will be maintained separately by Producers and Importers. In case such records are not maintained, they will have to fulfil the complete Extended Producer Responsibility obligation. The online platform shall cross-check the declaration of transactions among Producers, Importers & Brand-Owners.

(10.5) In order to develop a separate waste stream for collection of plastic packaging waste for directly fulfilling Extended Producer Responsibility obligations, the Producers, Importers & Brand-Owners may operate schemes such as deposit refund system or buy back or any other model. This will prevent mixing of plastic packaging waste with solid waste.

(10.6) The Producers, Importers & Brand-Owners shall file annual returns on the plastic packaging waste collected and processed towards fulfilling obligations under Extended Producer Responsibility with the Central Pollution Control Board or concerned State Pollution Control Board or Pollution Control Committee as per pro forma prescribed by Central Pollution Control Board by the 30th June of the next financial year. Information on the reuse and/or recycled content used for packaging purposes will also be provided. The details of the registered recyclers from whom the recycled plastic has been procured will also be provided.

11. Role of Plastic Waste Processors (Recyclers or Other Waste Processors including industrial composting facilities)

(11.1) All plastic waste processors shall have to register with concerned State Pollution Control Board or Pollution Control Committee in accordance with provision 13(3) of Plastic Waste Management Rules, 2016 on the centralized portal developed by Central Pollution Control Board. Central Pollution Control Board shall lay down uniform procedure for registration within three months of the publication of these guidelines.

(11.2) The Plastic waste processors shall submit annual returns after end of every financial year by 30th April of the next financial year on the quantity of plastic waste processed category-wise as per prescribed pro forma on the centralized portal developed by Central Pollution Control Board.

(11.3) The total quantity of plastic waste processed by plastic waste processors and attributed to Producers, Importers & Brand-Owners, on an annual basis, will be made available on the centralized portal developed by Central Pollution Control Board as also on the website of Plastic waste processors.

(11.4) In case, at any stage it is found that the information provided by the plastic waste processor is false, the plastic waste processor shall be debarred by State Pollution Control Board, as per procedure laid down by Central Pollution Control Board , from operating under the Extended Producer Responsibility framework for a period of one year.

(11.5) Only plastic waste processors registered under Plastic Waste Management Rules, 2016, as amended**,** shall provide certificates for plastic waste processing, except in case of use of plastic waste in road construction. In case where plastic waste is used in road construction the Producers, Importers & Brand-Owners shall provide a self-declaration certificate in pro forma developed by Central Pollution Control Board. The certificate provided by only registered plastic waste processors shall be considered for fulfilment of Extended Producer Responsibility obligations by Producers, Importers & Brand-Owners.

(11.6) The pro forma for the certificate shall be developed by Central Pollution Control Board. In no case, the amount of plastic packaging waste recycled by the enterprise shall be more than installed capacity of the enterprise. The certificates will be for plastic packaging category-wise and shall include GST data of the enterprise.

(11.7) The certificate for plastic packaging waste provided by registered plastic waste processors shall be in the name of registered Producers, Importers & Brand-Owners or Local authorities, as applicable, based upon agreed modalities. Central Pollution Control Board will develop mechanism for issuance of such certificate on the centralized portal.

(11.8) The Plastic Waste Processors undertaking end-of-life disposal of plastic packaging waste viz. waste to energy, waste to oil, cement kilns (co processing) shall provide information on an annual basis as per prescribed pro forma, on the centralized portal developed by Central Pollution Control Board. These entities shall ensure the disposal of plastic packaging waste as per relevant rules, guidelines framed by regulatory bodies in an environmentally sound manner.

12. Role of Central Pollution Control Board

(12.1) The Central Pollution Control Board shall register Producers, Importers & Brand-Owners who are operating in more than two states and plastic waste processors, through online portal. Central Pollution Control Board shall prescribe the standard operating procedure for registration of Producers, Importers & Brand-Owners under Plastic Waste Management Rules, 2016.

(12.2) The Central Pollution Control Board may charge fee for processing of applications for registration and an annual fee for processing of returns, as per procedure prescribed by CPCB. In case, where Producers, Importers & Brand-Owners, are operating in the jurisdiction of a State Pollution Control Board or Pollution Control Committee, the Central Pollution Control Board as per guidelines so decided, will share the application fee with the concerned State Pollution Control Board or Pollution Control Committee.

(12.3) The registration shall be done within two weeks from the submission of a complete application online by the Producers, Importers & Brand-Owners. The tenure of registration shall be as per Plastic Waste Management Rules, 2016.

(12.4) Central Pollution Control Board by itself or through a designated agency shall verify compliance of Producers, Importers & Brand-Owners through inspection and periodic audit, as deemed appropriate. Central Pollution Control

Board, as required, can also verify compliance of Plastic Waste Processors through inspection and periodic audit. In case of plastic waste processors and Producers, Importers & Brand-Owners operating in a State or Union Territory, Central Pollution Control Board may, if required, direct State Pollution Control Board or Pollution Control Committee to take action.

(12.5) Central Pollution Control Board shall publish the list of Producers, Importers & Brand-Owners who have failed to meet Extended Producer Responsibility targets and obligations in the previous financial year, on an annual basis, by 30th September of the next financial year.

(12.6) The Central Pollution Control Board will establish a mechanism to ensure a regular dialogue between relevant stakeholders involved in the fulfilment of extended producer responsibility obligations for plastics under the Plastic Waste Management Rule, 2016.

(12.7) The Central Pollution Control Board shall carry out a compositional survey of collected mixed municipal waste to determine the share of plastic waste as well as different categories of plastics packaging material on a half-yearly basis.

(12.8) The Central Pollution Control Board shall carry out review of technologies related to plastic packaging and plastic waste management for techno-economic viability and feasibility specifically with respect to clause 7.6.

13. Role of State Pollution Control Board or Pollution Control Committee:

(13.1) The concerned State Pollution Control Board or Pollution Control Committee shall register Producers, Importers & Brand-Owners (operating in one or two states) and plastic waste processors, through the online portal developed by Central Pollution Control Board. Provision for registration shall be made on the Extended Producer Responsibility portal. State Pollution Control Board or Pollution Control Committee by itself or through a designated agency shall verify compliance of Producers, Importers & Brand-Owners through inspection and periodic audit, as deemed appropriate, of Producers, Importers & Brand-Owners as well as plastic waste processors in their jurisdiction as per the Plastic Waste Management Rule, 2016.

(13.2) The State Pollution Control Board or Pollution Control Committee shall bring out a list of entities (Exception Report) who have not fulfilled their Extended Producer Responsibility responsibilities on annual basis and publish the same on their website. The State Pollution Control Board or Pollution Control Committee shall submit the Annual Reports submitted by Producers, Importers & Brand-Owners and plastic waste processors in their jurisdiction to Central Pollution Control Board and upload the same on the online Extended Producer Responsibility portal.

(13.3) State Pollution Control Board or Pollution Control Committee will establish a mechanism to ensure a regular dialogue between relevant stakeholders involved in the fulfilment of extended producer responsibility obligations under the Plastic Waste Management Rule, 2016.

(13.4) State Pollution Control Board or Pollution Control Committee shall carry out a compositional survey of collected mixed municipal waste to determine the share of plastic waste as well as different categories of plastics packaging material on a half-yearly basis.

14. Plastic Packaging Waste Collection System by Producers, Importers & Brand-Owners

(14.1) Producers, Importers & Brand-Owners while fulfilling their Extended Producer Responsibility obligations may develop collection and segregation infrastructure of plastic packaging waste, as required, based on the category of plastics. It may include the following based on implementation modality of Extended Producer Responsibility adopted by Producers, Importers & Brand-Owners: -(a) establish waste plastic collection points and Material Recovery Facilities (MRFs);

(b) ensure the collection of the plastic packaging waste from the collection points, with a frequency that is proportionate to the area covered and the volume;

(c) offer the collection of plastic, from the entities like urban local bodies, gram panchayats, other public authorities or third parties carrying out waste management, and provide for the collection from all entities that have made use of that offer; provide for the necessary practical arrangements for collection and transport;

(d) ensure that the plastic packaging waste collected from the collection points are subsequently subject to recycling in a registered facility by a recycler or its permitted end use in the designated manner.

(14.2) Producers, Importers & Brand-Owners may ensure the network of collection points taking into account population size, expected volume of plastic or packaging waste, accessibility and vicinity to end-users, not being limited to areas where the collection and subsequent management is profitable.

(14.3) The entities involved in waste collection will hand over the waste for treatment and recycling or for identified end uses.

(14.4) Participation of voluntary collection points - voluntary collection points will hand over plastic packaging waste to the Producers, Importers & Brand-Owners or third party agencies acting on their behalf with a view to their treatment and recycling or their identified end use.

15. Fulfilment of Extended Producer Responsibility Obligations

The Producers, Importers & Brand-Owners shall have to provide the details of recycling certificate only from registered recyclers along with the details of quantity sent for end of life disposal, by 30th June of next financial year while filing annual returns on the online portal. The details provided by Producers, Importers & Brand-Owners and registered plastic waste processors will be cross-checked by the online portal. In case of difference, the lower figure would be considered towards fulfilment of Extended Producer Responsibility obligation of Producers, Importers & Brand-Owners. The certificates shall be subject to verification by Central Pollution Control Board or State Pollution Control Board or Pollution Control Committee, as the case may be.

16. Centralized Online Portal

(16.1) Central Pollution Control Board shall establish an online system for the registration as well as for filing of annual returns by Producers, Importers & Brand-Owners, plastic waste processors of plastic packaging waste by 31st March 2022:-

(16.2) The online system developed by Central Pollution Control Board for the registration as well as for filing of returns by Producers, Importers & Brand-Owners shall reflect the plastic packaging material introduced in the market Producers, Importers & Brand-Owners in a financial year. It shall also reflect the details regarding the audit of the Producers, Importers & Brand-Owners as well as recyclers or other waste processors of plastic packaging waste.

(16.3) The State Pollution Control Board or Pollution Control Committee shall also use the centralized portal developed by Central Pollution Control Board for registration of Producers, Importers & Brand-Owners as well as recyclers/waste processors. The centralized portal would act as the single point data repository with respect to orders and guidelines related to implementation of Extended Producer Responsibility for plastic packaging under Plastic Waste Management Rule, 2016 Producers, Importers & Brand-Owners may, if they so desire, facilitate the development of online web portal or platform.

(16.3) Till the online web portal is developed all activities related to implementation of Extended Producer Responsibility under the Plastic Waste Management Rules, 2016 will be done in an offline manner.

17. Monitoring

State Pollution Control Board or Pollution Control Committee shall submit annual report on Extended Producer Responsibility portal with respect to fulfilment of Extended Producer Responsibility by Producers, Importers & Brand-Owners (which include manufacturers of plastic packaging material) and plastic waste processors in the State/Union Territory to Central Pollution Control Board. The report shall also be submitted to the State Level Monitoring Committee constituted under the Plastic Waste Management Rules, 2016. State Pollution Control Board or Pollution Control Committee shall also submit annual report with respect to recyclers or end of life disposal in the State or Union Territory to Central Pollution Control Board by 31st July of the next year.

18. Committee for Extended Producer Responsibility under PWM Rules

(18.1) A committee shall be constituted by the Central Pollution Control Board under chairpersonship of Chairman, Central Pollution Control Board to recommend measures to Ministry of Environment, Forest and Climate Change for effective implementation of Extended Producer Responsibility including amendments to Extended Producer Responsibility guidelines. The committee shall monitor the implementations of Extended Producer Responsibility and also take such measures as required for removal of difficulties. The Committee shall also be tasked with the guiding and supervision of the online portal including approval of requisite forms or pro forma.

(18.2) The committee shall comprise of representative from concerned line Ministries/Departments such as Ministry of Housing and Urban Affairs, Ministry of Micro, Small and Medium Enterprises, Department of Drinking Water and Sanitation, Department of Chemical and Petrochemicals; Bureau of Indian Standards, three State Pollution Control Board or Pollution Control Committee, Central Institute of Plastic Engineering and Technology (CIPET), National Environmental Engineering Research Institute (NEERI), and three industry associations, and any other invitee as decided by the chairperson of the committee.

ANNEXURE

Examples for Clause 7

Extended Producer Responsibility Target and Minimum level of recycling of plastic packaging waste

[Refer Clause 7.2 (a), (b) & (c), Clause 7.3 (a), (b) & (c), and Clause 7.4 (a), (b) & (c)]

Example 1:

Year 2022-23	
Plastic packaging introduced in the market category-wise (Category II Flexible plastic packaging*)*	*100 MT*
Extended Producer Responsibility Target @ 70 %	*70 MT*
Minimum level of recycling of plastic packaging waste collected under Extended Producer Responsibility - no threshold has been prescribed	*Quantity of plastic packaging waste collected under Extended Producer Responsibility and recycled as per actuals* *Quantity of plastic packaging waste collected under Extended Producer Responsibility and used for energy recovery, co-processing, road construction, waste to oil etc. as per actuals*

Example 2:

Year 2024-25	
Plastic packaging introduced in the market category-wise (Category II Flexible plastic packaging*)*	*100 MT*
Extended Producer Responsibility Target @ 100 %	*100 MT*
Minimum level of recycling of plastic packaging waste collected under Extended Producer Responsibility @ 30%	*Minimum 30 MT of plastic packaging waste collected under Extended Producer Responsibility needs to be recycled.* *Remaining plastic packaging waste collected(Maximum 70 MT) may be used for energy recovery, co-processing, road construction, waste to oil etc.*

Example 3:

Year 2028-29	
Plastic packaging introduced in the market category-wise (Category II Flexible plastic packaging*)*	*100 MT*
Extended Producer Responsibility Target @ 100 %	*100 MT*
Minimum level of recycling of plastic packaging waste collected under Extended Producer Responsibility @ 60 %	*Minimum 60 MT of plastic packaging waste collected under Extended Producer Responsibility needs to be recycled.* *Remaining plastic packaging waste collected(Maximum 40 MT) may be used for energy recovery, co-processing, road construction, waste to oil etc.*

Reuse

[Refer Clause 7.4 (b)]

Example 4:

Year 2025 – 26 (Minimum obligation for reuse comes into effect)	
Plastic packaging introduced in the market category-wise (Category I Rigid Plastic Packaging)	*100 MT*
Reuse of Category I rigid plastic packaging with volume or weight equal or more than 0.9 litres or	*15 MT*

kilogrammes bUnion Territory less than 4.9 litres or kilogrammes	*(Reuse @ 15 %; minimum obligation for reuse 10 %)*
Fresh plastic packaging introduced (A)	*85 MT*
Extended Producer Responsibility target for compliance @ 100% of (A)	*85 MT*
Minimum level of recycling of Category I plastic packaging waste collected under Extended Producer Responsibility @ 60%	*Minimum 51 MT of plastic packaging waste collected under Extended Producer Responsibility needs to be recycled.* *A maximum of 34 MT plastic packaging waste collected may be used for energy recovery, co-processing, road construction, waste to oil etc.*

Example 5:

For Year 2022 - 23	
Plastic packaging introduced in the market category-wise (Category I Rigid Plastic Packaging)	*100 MT*
Reuse of Category I rigid plastic packaging with volume or weight equal or more than 0.9 litres or kilogrammes bUnion Territory less than 4.9 litres or kilogrammes	*10 MT*
Fresh plastic packaging introduced (A)	*90 MT*
Extended Producer Responsibility Target @ 35 % of (A)	*31.5 MT*

Use of recycled plastic content

[Refer Clause 7.2 (d), 7.3 (d)]

Example 6:

Year 2025-26	
Plastic packaging introduced in the market category-wise (Category II Flexible plastic packaging*)*	*100 MT*
Extended Producer Responsibility Target as per clause 5.1 @ 100 %	*100 MT*
Minimum content of recycled plastic in packaging @ 10%	*10 MT of plastic content in the packaging should be recycled plastic* *90 MT of virgin plastic content in packaging*

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[F. No. 17/2/2001 – Part I - HSMD]

NARESH PAL GANGWAR, Addl. Secy.

Note : The principal rules were published in the Gazette of India, Extraordinary, Part II Section 3, Sub-Section (i) vide number G.S.R 320 (E) dated the 18th March, 2016 and subsequently amended *vide notification numbers G.S.R 285 (E) dated the 27th March, 2018, G.S.R. 571 (E) dated the 12th August, 2021 and G.S.R. 647 (E) dated the 17th September, 2021.*

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ANNEXURE II A

1. पीईटी
2. एचडीपीई
3. पीवीसी
4. एलडीपीई
5. पीपी
6. पीएस
7. अन्य
8. विनिर्दिष्ट वातावरण में जैव अपघटनीय प्लास्टिक
9. खाद योग्य प्लास्टिक

[फा. सं. 17/6/2023-एचएसएम]

नरेश पाल गंगवार, अपर सचिव

टिप्पण : मूल नियम भारत के राजपत्र में संख्याक 320 (अ), तारीख 18 मार्च, 2016 द्वारा प्रकाशित किए गए थे और तत्पश्चात् अधिसूचना संख्यांक सा.का.नि. 285 (ङ), तारीख 27 मार्च, 2018 अधिसूचना संख्यांक सा.का.नि. 571 (ङ), तारीख 12 अगस्त, 2021 अधिसूचना संख्यांक सा.का.नि. 647 (ङ), तारीख 17 अगस्त, 2021 अधिसूचना संख्यांक सा.का.नि. 133(ङ), तारीख 16 फरवरी 2022 अधिसूचना संख्यांक सा.का.नि. 522(ङ) तारीख 06 जुलाई 2022 अधिसूचना संख्यांक सा.का.नि. 318(ङ), तारीख 27 अप्रैल 2023 द्वारा संशोधित किए गए थे और अधिसूचना संख्यांक सा.का.नि. 807(ङ) तारीख 30 अक्टूबर 2023 द्वारा अंतिम बार संशोधित किए गए थे

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 14th March, 2024

G.S.R.. 201(E).—WHEREAS, the draft rules further to amend the Plastics Waste Management Rules, 2016, were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i), vide notification number G.S.R. 744 (E) dated the 16th October, 2023, for inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the date copies of the Gazette containing the said draft rules were made available to the public;

AND WHEREAS, copies of the Gazette containing the said draft rules were made available to the public on the 16th October, 2023;

AND WHEREAS, objections and suggestions received within the period have been duly considered by the Central Government;

NOW, THEREFORE, in exercise of the powers conferred by sections 3, 6, and 25 of the Environment (Protection) Act 1986, (29 of 1986), the Central Government hereby makes the following rules further to amend the Plastic Waste Management Rules, 2016, namely :-

1. (1) These rules may be called Plastic Waste Management (Amendment) Rules, 2024.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Plastic Waste Management Rules, 2016 (hereinafter referred to as the said rules), in rule 3, -

(i) for clause (ac), the following clause shall be substituted, namely:-

'(ac) "Biodegradable plastics", means plastics, other than compostable plastics, which undergoes degradation by biological processes in specific environment such as soil, landfill, sewage sludge, fresh water, marine, without leaving any micro plastics or visible or distinguishable or toxic residue, which has adverse environment impact;";

(ii) for clause (k), the following clause shall be substituted, namely: -

'(k) "Importer" means a person who imports for commercial use, any plastic packaging or any commodity with plastic packaging or carry bags or plastic sheets or like material, or plastic raw material including in the form of resin or pellets, or intermediate material to be used for manufacturing plastic packaging such as films or preforms;";

(iii) for clause (m), the following clause shall be substituted, namely:-

'(m) "manufacturer" means and includes a person engaged in production of plastic raw material, including compostable plastics and biodegradable plastics;';

(iv) in clause (n), the words "metallised layers or" shall be omitted;

(v) for clause (s), the following clause shall be substituted, namely:-

'(s)"producer" means a person engaged in manufacturing of plastic packaging; and, includes a person engaged in manufacture of intermediate material to be used for manufacturing plastic packaging, and also the person engaged in contract manufacturing of products using plastic packaging or through other similar arrangements for a brand owners;';

(vi) after clause (u), the following clause shall be inserted,-

'(ua) "seller" means a person who sells plastic raw material such as resins or pellets or intermediate material used for producing plastic packaging;'.

3. In the rule 4 of the said rules,-

(A) in sub-rule (1), -

(i) for clause (e), the following clause shall be substituted, namely:-

"(e) the manufacturer shall not sell or provide or arrange plastic to be used as raw material to a producer or to a seller not registered under these rules;";

(ii) for clause (h), the following clause shall be substituted, namely:-

"(h) the provision of thickness under clause (c) shall not apply to carry bags or commodities made from compostable plastic or biodegradable plastics. Carry bags and commodities made from compostable plastics shall conform to the Indian Standard: IS/ISO 17088:2021 titled as Specifications for Compostable Plastics.;",

(iii) after clause (h), the following clause shall be inserted, namely :-

"(ha) the manufacture of carry bags and commodities covered under sub rule (3) shall be permitted to be made from compostable plastics or biodegradable plastics subject to mandatory marking and labelling laid down under these rules and the regulations of the Food Safety and Standards Authority of India for food contact applications. The manufacturers of compostable plastic or biodegradable plastic carry bags or commodities permitted under the rules, shall obtain a certificate from the Central Pollution Control Board before marketing or selling;",

(B) after sub-rule (3), the following sub-rule shall be inserted, namely :-

"(3A) The manufacturer of commodities made from compostable plastics or biodegradable plastics shall report the quantity of such commodities introduced in the market and pre-consumer waste generated to the Central Pollution Control Board.";.

(C) after sub-rule (4), the following sub-rule shall be inserted, namely :-

"(5) Every manufacturer of commodities made from plastic or part thereof shall ensure processing of the pre-consumer plastic waste generated in the form of reject or discard material at the stage of manufacturing and such manufacturer shall report to the State Pollution Control Board or Pollution Control Committee concerned.";

4. In rule 6 of the said rules,-

(i) in sub-rule (1), the words "or producers" shall be omitted;

(ii) after sub-rule (1), the following sub-rule shall be inserted, namely:-

"(1A) Every manufacturer, producer, importer, brand owner, manufacturer of commodities made from compostable plastics or biodegradable plastics may engage with local body on voluntary basis, as per mutually agreed terms and conditions entered into by them and the local body"

(iii) after sub-rule (4), the following sub-rules shall be inserted, namely:-

"(5) The local body shall undertake assessment of plastic waste generated, including plastic waste existing in dump sites, by the 30th June of every year and also estimate the quantity of plastic waste to be generated in following five year period.

(6) The local body shall assess the plastic waste management infrastructure available for collection, segregation and processing and send a report to the State Pollution Control Board or Pollution Control Committee concerned by 30th June of each year.

(7) The local body shall take necessary measures to prevent stocking, distribution, sale and usage of prohibited single use plastic items in their jurisdiction.

(8) The local body shall include in the annual report the following details on plastic waste management, namely:-

(i) plastic waste generated, including plastic waste existing in dump sites, in a year;

(ii) plastic waste management infrastructure available for collection, segregation, processing;

(iii) projection of plastic waste to be generated;

(iv) status on framing and implementation on byelaws;

(v) actions taken action to prevent stocking, distribution, sale and usage of prohibited Single Use Plastic items.".

5. In rule 7 of the said rules,-

(i) in sub-rule (1),-

(A) after the words "gram panchayat" the words "or panchayat at district level" should be inserted;

(B) after clause (c), the following clauses shall be inserted, namely:-

(d) engaging civil societies or groups working with waste pickers;

(e) ensuring that open burning of plastic waste does not take place;

(f) taking necessary measures to prevent stocking, distribution, sale and usage of prohibited Single Use Plastic items in their jurisdiction.";

(ii) after sub-rule (1), the following sub-rule shall be inserted, namely:-

"(2) Every Producer, Importer and Brand owner, manufacturer and manufacturer of commodities made from compostable plastics or biodegradable plastics may engage with Panchayat at District and Village levels, on a voluntary basis, as per mutually agreed, terms and conditions entered into by them and the Panchayat at District and Village levels."

6. After rule 7 of said rules, the following rule shall be inserted, namely:-

"7A. Responsibility of Panchayat at District level.-

(1) The Panchayat at District level shall undertake assessment of plastic waste generated, including plastic waste existing at dump sites, by the 30th June of every year for rural areas of the district and also estimate the quantity of plastic waste to be generated in following five year period.

(2) The Panchayat at District level shall assess the plastic waste management infrastructure available for collection, segregation and processing and report to the State Pollution Control Board or Pollution Control Committee concerned by 30th June each year.

(3) The Panchayat at District Level shall include in the annual report the following details on plastic waste management, namely:-

(i) plastic waste generated, including plastic waste existing at dump sites, in a year;

(ii) plastic waste management infrastructure available for collection, segregation, processing;

(iii) projection of plastic waste to be generated;

(iv) status on framing and implementation on byelaws;

(v) actions taken action to prevent stocking, distribution, sale and usage of banned Single Use Plastic items.".

7. In rule 9 of the said rules,-

(i) for sub-rules (1) and (2), the following sub-rules shall be substituted, namely:-

"(1) The Producers, Importers and Brand Owners who introduce any plastic packaging in the market shall be responsible for collection of such plastic packaging.

(2) Where any Producer, Importer or Brand owner fulfils his extended producer responsibility, he is deemed to have complied with his responsibility under sub-rule (1).

(2A) The Producers, Importers, Brand Owners, manufacturers, and manufacturers of commodities made from compostable plastics or biodegradable plastics, shall fulfil Extended Producer Responsibility as per guidelines specified in Schedule- II.".

8. In rule 10 of the said rule,-

(a) in sub-rule (6), the following proviso shall be inserted, namely: -

" Provided that where testing of biodegradable plastic had commenced prior to the registration of a laboratory, and the report is in conformity with IS 17899 T:2022, the Central Pollution Control Board shall ask the applicant for re-testing and permit the production or usage of such biodegradable plastic, till the period the test report is received from duly recognized laboratory subject to furnishing of bank guarantee equal to the amount of Environment Compensation leviable under rule 18:

Provided further that the bank guarantee shall be forfeited if the result of such test does not conform to IS 17899 T: 2022.

(b) after sub-rule (6), the following sub-rule shall be inserted, namely:-

"(7) BIS shall specify separate colour or marking for plastic packaging and commodities made from compostable plastics or biodegradable plastics.".

9. In rule 11 of the said rule,-

(i) for sub-rule (2), the following sub-rule shall be substituted, namely:-

"(2) Each recycled plastic packaging or commodity shall bear a label "recycled having [-----specify percentage-----] of recycled plastic" and a mark as shown below and shall conform to the Indian Standard: IS 14534: 2023 titled as "Plastics — Recovery and Recycling of Plastics Waste — Guidelines", as amended from time to time."



NOTE: PET-Polyethylene terephthalate, HDPE-High density polyethylene, V-Vinyl (PVC), LDPE- Low density polyethylene, PP-Polypropylene, PS-Polystyrene and Other means all other resins and multi-materials like ABS (Acrylonitrile butadiene styrene), PPO (Polyphenylene oxide), PC (Polycarbonate), PBT (Polybutylene terephalate) etc.

(ii) after sub-rule (2) the following sub-rules shall be inserted, namely: -

"(3) Each plastic packaging or commodity made from compostable plastics shall bear a label "compostable only under industrial composting" and shall conform to the Indian Standard: IS/ISO 17088:2021 titled as Specifications for Compostable Plastics.";

'(4) Each plastic packaging or commodity made from biodegradable plastic shall bear the label "Biodegradable in [--- specify number of days ---] only in the [---specify recipient environment such as soil, landfill, water etc.---]".'.

10. In rule 13 of the said rules,-

(i) for sub-rule (4), the following sub-rule shall be substituted, namely:-

"(4) Every manufacturer and importer of plastic raw material shall make an application to the State Pollution Control Board or the Pollution Control Committee concerned, for registration, in the Form III:

(4A) For the purpose of these rules, the manufacturer and importer of plastic raw material shall,-

(i) sell plastic raw material only to Producer or Seller registered under these rules and the Registration number of such Producer or Seller is mentioned on sale invoice for sale of plastic raw material;

(ii) not sell plastic raw material to any entity or units engaged in manufacturing of prohibited single use plastic items;

(iii) print the following on all packaging bags of plastic raw material:

"Not to be used in the manufacture of single use plastic items prohibited under the Plastic Waste Management Rules, 2016 including plastic sheets < 50 micron thickness, non-woven carry bags < 60 GSM, Carry bags < 120 micron thickness";

(iv) submit Quarterly Report to the Central Pollution Board and State Pollution Control Board or Pollution Control Committee concerned;

"(4B) Every person engaged in sale of plastic raw material or an intermediate material used for manufacture of plastic packaging to producer shall make an application to the State Pollution Control Board or the Pollution Control Committee concerned, for registration.";

(ii) for sub-rule (8), the following sub-rule shall be substituted, namely:-

"(8) Where the registration is not granted within a period of thirty days after the receipt of application complete in all respect, the applicant shall be deemed to be registered under these rules on the expiry of such period."

11. for rule 17, the following rule shall be substituted:

"17. Annual reports.- (1) Every person engaged in recycling or processing of plastic waste shall prepare and submit online an annual report in Form-IV to the local body concerned and also to the State Pollution Control Board or Pollution Control Committee concerned by the 30th April of every year.

(2) Every manufacturer and importer of plastic raw material shall prepare and submit online a quarterly report in Form VII to the State Pollution Control Board or Pollution Control Committee concerned by the last day of month following the quarter and an annual report by 30th June of every year.

(3) Every person engaged in the sale of plastic raw material or an intermediate material used for manufacture of plastic packaging shall prepare and submit online an annual report mentioning therein the detail of transactions to the State Pollution Control Board or Pollution Control Committee concerned by the 30th June of every year.

(4) Every urban local body and Panchayat at District Level shall prepare and submit online an annual report in Form –V to the Urban Development Department and to Rural Development Department, respectively, and also to the State Pollution Control Board or Pollution Control Committee concerned by the 30th June every year.

(5) The State Pollution Control Board or Pollution Control Committee concerned shall cause the report submitted by the urban local body and Panchayat at District level to be audited by itself or through a designated agency and copy of the report of such audit and the annual report shall be made available on website of State Pollution Control Board or Pollution Control Committee concerned.

(6) The State Pollution Control Board or Pollution Control Committee shall prepare and submit online an annual report in Form VI to the Central Pollution Control Board on the implementation of these rules by the 31st July of every year.

(7) The Central Pollution Control Board shall prepare a consolidated annual report on the implementation of these rules and submit to the Central Government along with its recommendations on or before the 31st August of every year.".

12. In schedule II to the said rules,-

(i) in the heading after the words "Guidelines on Extended Producer Responsibility for Plastic Packaging", the words "and commodities made from compostable plastics or biodegradable plastics" shall be inserted.

(ii) for paragraph 4, the following paragraph shall be substituted, -

"4. Obligated Entities:

The following entities shall be covered under the Extended Producer Responsibility obligations, namely: -

(a) Producer of plastic packaging, other than micro and small enterprises as defined under the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006);

(b) Importer of plastic packaging including intermediate material used for manufacturing plastic packaging such as films and preforms and plastic packaging of imported products;

(c) Brand Owners including online platforms/marketplaces and supermarkets/retail chains other than micro and small enterprises as defined under the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006);

(d) Plastic Waste Processors;

(e) Manufacturers and importers of plastic raw material;

(f) Manufacturers of items made from compostable plastics or biodegradable plastics.".

(iii) in paragraph 5, in sub-paragraph (5.1),

(a) in item (iv), after the words "carry bags", the words "and commodities" shall be inserted;

(b) after item (iv), the following item shall be inserted, namely:-

"(v) Category V

Plastic sheet or like used for packaging as well as carry bags and commodities made of biodegradable plastics.".

(iv) in paragraph 6, in sub-paragraph (6.1), for the following items shall be substituted, namely:-

"(a) The following entities shall register on the centralized portal developed by Central Pollution Control Board, namely: -

(i) Producer (P) including micro and small enterprises as defined under the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006)

(ii) Importer (I);

(iii) Brand owner (BO);

(iv) Plastic Waste Processor engaged in (a) recycling, (b) waste to energy, (c) waste to oil, and (iv) industrial composting;

(v) Manufacturers and importers of plastic raw material;

(vi) Manufacturers of items made from compostable plastics or biodegradable plastics.".

(v) in paragraph 7,-

(a) sub-paragraph (7.8) shall be omitted;

(b) after sub-paragraph (7.7), the following new sub-paragraph (7.8) shall be inserted, namely:-

"(7.8) Manufacturer or importer of plastic raw material - Extended Producer Responsibility Target:

(i) The extended producer responsibility of producers, which are micro and small enterprises as defined under the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006), hereinafter referred to as micro and small producers, shall be fulfilled by manufacturer or importer of plastic raw material who has supplied the plastic raw material to such micro and small producers:

Provided that the target for use of recycled plastic content shall be fulfilled by such producers.

(ii) The Extended Producer Responsibility target category-wise for manufacturer or importer of plastic raw material shall be the quantity of plastic raw material sold to micro and small producers where the sale invoice is authenticated by the manufacturer or importer of plastic raw material, on the centralized online portal, excluding the sale made by such micro and small producers to Brand Owners and Producers, which are not categorized as micro and small enterprises as defined under the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006).

(iii) The producer, which is a micro or small enterprise, shall declare category of plastic packaging manufactured by it on the centralized online portal.

(iv) While fulfilling the Extended Producer Responsibility target the manufacturer or importer of plastic raw material shall ensure minimum level of recycling (excluding end of life disposal) of plastic packaging waste collected under the Extended Producer Responsibility Target, category-wise, as given in the Table below, namely: -

TABLE

Minimum level of recycling (excluding end of life disposal) of plastic packaging waste

(% of Extended Producer Responsibility Target)

Plastic packaging category	2024-25	2025-26	2026-27	2027-28 and onwards
(1)	(2)	(3)	(4)	(5)
Category I	50	60	70	80
Category II	30	40	50	60
Category III	30	40	50	60

(vi) in paragraph 8, after sub-paragraph (8.4), the following sub-paragraph shall be inserted, namely :-

"(8.5) The Central Pollution Control Board shall issue guidelines for authorisation of agencies for establishment of electronic platform for trade of Extended Producer Responsibility certificates between obligated entities.

(8.6) The number of electronic platform may be restricted keeping in view volume of trade of Extended Producer Responsibility certificates.

(8.7) The operation of electronic platform shall be as per guidelines issued by Central Pollution Control Board after approval of the Central Government.

(8.8) The Central Pollution Control Board shall fix the highest and the lowest price for extended producer responsibility certificates which shall be equal to 100 % and 30 % ,respectively, of the Environment Compensation leviable on the obligated entities for non-fulfilment of Extended Producer Responsibility obligations, under rule 18 of these rules.

(8.9) The exchange price of Extended Producer Responsibility certificate between registered entities through the portal shall be between the highest and the lowest prices as fixed above.";

(vii). in paragraph 10,-

(a) in the heading, for the words " Role of Producers, Importers & Brand-Owners", the words "Role of Producers, Importers, Brand-Owners and manufacturers, and manufacturers of commodities made from compostable plastic or biodegradable plastic" shall be substituted;

(b) for sub-paragraph (10.1), the following sub-paragraph shall be substituted, namely:-

"(10.1) The Producers, Importers, Brand-Owners and manufacturers, and manufacturers of commodities made from compostable plastic or biodegradable plastic shall have to register through the online centralized portal."

(c) for sub-paragraph (10.5), the following sub-paragraph shall be substituted, namely:-

"(10.5) Producers, Importers, Brand-Owners and manufacturers, and manufacturers of commodities made from compostable plastic or biodegradable plastic may operate schemes such as deposit refund system or buy back or any other model in order to develop a separate waste stream for collection of plastic packaging waste for directly fulfilling Extended Producer Responsibility obligations to prevent mixing of plastic packaging waste with solid waste.";

(d) in sub-paragraph (10.6),

(A) after the words "Producers, Importers & Brand Owners", the following words shall be inserted "manufacturers, and manufacturers of commodities made from compostable or biodegradable plastics".

(B) the following proviso shall be inserted, namely:-

"Provided that the annual return under this sub-paragraph in respect of the financial year 2022-2023 may be filed on or before 31st March 2024.";

(viii) in paragraph 11, in sub-paragraph (11.2), the following proviso shall be inserted, namely:-

"Provided that the annual returns under this sub-paragraph in respect of the financial year 2022-2023 may be filed on or before the 31st March 2024;".

(ix) in paragraph 15, for sub-paragraph(15.1), the following sub-paragraphs shall be substituted, namely:-

"(15.1) The Producers, Importers, Brand-Owners and manufacturers, and manufacturers of commodities made from compostable plastics or biodegradable plastics shall provide the details of certificates for plastic waste recycled and sent for end of life disposal, by 30th June of next financial year while filing annual returns on the online portal.

(15.2) The details of certificates provided by Producers, Importers, Brand-Owners and manufacturers, and manufacturers of commodities made from compostable plastic or biodegradable plastics and registered plastic waste processors shall be verified and in case of difference, the lower figure shall be considered towards fulfilment of Extended Producer Responsibility obligation under these rules.

(15.3) The certificates shall be subject to verification by Central Pollution Control Board or State Pollution Control Board or Pollution Control Committee concerned, as the case may be.

(15.4) The Manufacturer of biodegradable plastics shall fulfil their Extended Producer Responsibility obligations by obtaining Extended Producer Responsibility certificates generated by local authorities, as per agreed modalities.

(15.5) The local authorities shall generate Extended Producer Responsibility certificates equal to the biodegradable plastic collected by them and put to end of life biodegradation in the respective recipient environment as per standard notified by Bureau of Indian Standards, which shall be recorded, and details of such certificates obtained by the manufacturers of commodities of biodegradable plastics shall be submitted on the centralised online portal while filing annual returns under these rules. Central Pollution Control Board will develop mechanism for such exchange on the centralized online portal."

13. for 'Form -I' of the said rules, the following shall be substituted as follows, namely:-

FORM - I

[See rules 13 (2)]

APPLICATION FOR REGISTRATION FOR PRODUCERS or Brand Owners

From: .....

……

…….(Name and full address of the occupier)

To

The Member Secretary,

.....……. Pollution Control Board or Pollution Control Committee

…….

…….

Sir,

I /We hereby apply for registration under rule 9 of the Plastic Waste Management Rules, 2016

1. Producers

(A) other than micro and small enterprises (as per criteria of Ministry of Micro, Small and Medium Enterprises, Government of India)

PART – A **GENERAL**		
1.(a)	Name and location of the unit	
(b)	Address of the unit	
(c)	Registration required for manufacturing of: i. Carry bags; (a) petro- based, (b) Compostable ii. Multilayered plastics	
(d)	Manufacturing capacity	
(e)	In case of renewal, previous registration number and date of registration	
2.	Is the unit registered with the District Industries Centre of the State Government or Union territory? If yes, attach a copy.	
3.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
4.(a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
5.	Furnish a flow diagram of manufacturing process showing input and output in terms of products and waste generated including for captive power generation and water.	
6.	Status of compliance with these rules- Thickness – fifty micron (Yes/No)	
PART – B **PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS**		
7.	a. Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of	

	1974)? If yes, attach a copy	
	b. Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
PART – C **PERTAINING TO WASTE**		
8.	Solid Wastes or rejects: a. Total quantum of waste generated b. Mode of storage within the plant c. Provision made for disposal of wastes	
9.	Attach or Provide list of person supplying plastic to be used as raw material to manufacture carry bags or plastic sheet of like or multilayered packaging	
10.	Attach or provide list of personnel or brand Owners to whom the products will be supplied	
11.	Action plan as per Regulation notified for Extended Producer Responsibility	
Name and Signature Designation Date : Place :		

(B) Producers; Micro and Small Enterprises (as per criteria of Ministry of Micro, Small and Medium Enterprises, Government of India)

PART-A General		
1.	Micro or Small Producer	
2.	Details: (a) Name and location (b) Registered Address (c) Postal Address (d) GST No. (e) PAN No. (f) CIN No (Applicable for companies) (g) Udyam Registration No.	
3.	Authorized Person Details: (a) Name (b) Designation (c) Mobile No. (d) Aadhaar No. (Aadhaar authentication on voluntary basis) (e) PAN No. (f) Email ID	

4.	Plastic packaging manufactured: Category - I /Category - II/ Category - III/ Category - IV/Category – V)	
5.	Year of commencement of business	
6.	Unit Location: S.No. Place of Manufacturing unit Manufacturing capacity (plastic-packaging category wise)	
7.	Total Capital invested in project	
Part B: Details on plastic packaging		
8.	Manufacturing details Year 1 Year 2 Quantity (MT) 1. Raw material procured 2. Plastic packaging produced category-wise 3. Total Plastic packaging sold category-wise (MT) a. Plastic packaging sold to Brand owner b. Plastic packaging sold to Producer (Large and Medium) c. Plastic packaging sold to Producer (Small and micro) c. Plastic packaging sold to seller 4. Pre-consumer plastic packaging waste (MT)	
9.	Status of Compliance with Rule 4 of Plastic Waste Management Rules, 2016 as amended	Yes/No
10.	Cover Letter (with attachment)	
11.	Self-Declaration by Micro and Small Producers	
12.	Authorized Signatory	
13.	Self-Declaration: Name: Digital Signature Date: Place:	

Note:

(i) The registration shall be based upon self-declaration and done through centralized online portal on plastic packaging.

(ii) In case of proprietorship firm not registered under any Act or rules of the Central Government or the State Government, the proprietor may use his or her Permanent Account Number (PAN) issued by Income Tax Department for registration of the enterprise.

2. Brand Owners:

PART – A **GENERAL**		
1.	Name, address and Contact number	
2	In case of renewal, previous registration number and date of registration	
3	Is the unit registered with the District Industries Centre of the State Government or Union territory? If yes, attach a copy.	
4.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
5. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
PART – B **PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS**		
5	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
6	Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
PART – C **PERTAINING TO WASTE**		
7.	Solid Wastes or rejects: (a) Total quantum of waste generated (b) Mode of storage within the plant (c) Provision made for disposal of wastes	
8.	Attach or Provide list of person supplying plastic material	
9	Action plan on collecting back the plastic wastes	
		Name and Signature Designation Date : Place :

3. Importers:

Item 3, 4, 5 of Part A, Part B, and item 7 and 8 of Part C, to be filled as per applicability.

PART – A **GENERAL**		
1.	Name, Address and Contact number	

2	In case of renewal, previous registration number and date of registration	
3	Is the unit registered with the District Industries Centre of the State Government or Union Territory? If yes, attach a copy.	
4.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
5. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
6 (a)	Quantity of plastic sheet or like used for packaging of imported or to be imported products	
(b)	Quantity of imported or to be imported plastic sheet or like used for packaging for further supply or self-use	
(c)	Quantity of imported or to be imported multilayered packaging for further supply or self-use	
PART – B **PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS**		
5	Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
6	Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
PART – C **PERTAINING TO WASTE**		
7.	Solid Wastes or rejects: (a) Total quantum of waste generated (b) Mode of storage within the plant (c) Provision made for disposal of wastes	
8. (a)	Attach or Provide list of person supplying imported (i) plastic sheet or like used for packaging, (ii) multilayered packaging	
(b)	Quantity of imported (i) plastic sheet or like used for packaging, (ii) multilayered packaging used for self use	
9	Action plan as per Regulation notified for Extended Producer Responsibility	
Name and Signature Designation Date :		

Place :

14. For Form V in the said rules, the following Form shall be substituted, namely:-

FORM V

[See rules 17 (4)]

(A) FORMAT FOR ANNUAL REPORT ON PLASTIC WASTE MANAGEMENT TO BE SUBMITTED BY THE URBAN LOCAL BODY

Period of Reporting: (Year)

A	**General Information**	
1	Name of the City or Town and State:	
2	Name & Address of Local body	
3	Contact E-mail:	
4	Contact Phone No.	
5	Population	
6	Area in sq. Kilometers	
7	Whether separate Plastic Waste Management Cell is operational (Y/N)	
8	Staff deployed in Plastic Waste Management Cell	
9	Total numbers of the wards in the area under jurisdiction	
10	Total numbers of households in the area under jurisdiction ward –wise	
11	Number of households covered by door-to-door collection – ward-wise	
12	Total number of commercial establishments and Institutions in the area under jurisdiction and those covered by door to door collection	
a	Commercial establishments	
b	Institutions	
13	(i) Details of human resource including waste pickers in informal sector (concessionaire or own resource) deployed for (a) Collection (b) Street sweeping (c) Transportation (d) Segregation (e) Processing (f) disposal (ii) Details of waste pickers engaged in plastic waste management (ward wise) No. of waste pickers	
B	**Plastic Waste Management**	
1	Quantity of Plastic Waste generated (Tonnes) as per CPCB methodology	
2	Compositional characterization of plastic waste as per CPCB methodology	
	• Plastic packaging (Cat I/Cat II/Cat III/Cat IV/Cat V)	
	• Others type of plastic waste (i) recyclable and (ii) non-recyclable	
3	Door to Door collection of segregated waste (coverage in % or number of households) – ward-wise	

4	Total no. and capacity of MRF	
	(a) No. and capacity of Mechanical MRF Facilities No. Capacity (MT) Waste segregated (MT)	
	b) No. and capacity of Manual MRF Facilities No. Capacity (MT) Waste segregated (MT)	
5	Number of plastic recycling facilities with details of category- wise Name and address with EPR registration number Capacity (MT) Total Plastic Waste recycled (MT) Plastic packaging waste recycled category –wise (MT) Other plastic waste recycled (MT) EPR certificates generated category-wise (MT)	
6	Number and capacity of industrial composting unit for compostable plastics Name and address with EPR registration number Capacity (MT) Waste composted (MT) Compostable plastics processed (MT)	
7	Number and capacity of Operational Waste to energy Plants Name and address with EPR registration number Capacity (MT) Plastic Waste processed (MT) Energy produced	
8	Number and capacity of operational wastes to Oil units Name and address with EPR registration number Capacity (MT) Waste processed (MT) Oil generated	
9	Quantity and capacity of Plastic waste used in road construction along with KM Plastic Waste used (MT) Road Length (Km)	
10	Disposal of thermoset plastic as per guidelines Thermoset plastic Waste sent to secured landfill (MT) Thermoset plastic Waste co-processed (MT)	
11	Cement plants for plastic waste for coprocessing	
a	Name and address with EPR registration number Total unsegregated waste received (MT) Percentage of plastic waste in unsegregated waste Plastic waste co-processed (MT)	
b	Name and address with EPR registration number Total segregated plastic waste received (MT) Plastic waste co-processed category-wise (MT)	
12	Quantity of inert material disposed (MT) from recyclers and other waste processor in sanitary landfill	
13	Scientific Landfill site (number and capacity) No. Capacity (MT) Waste received (MT)	
14	Legacy waste site (number and amount of legacy waste) Waste present (MT) Waste processed to RDF (MT) Plastic waste in RDF (%) Waste remaining (MT)	
15.	EPR Registration No. of ULB in case registered	
16	EPR Guidelines leveraged for PWM (Y/N) Details to be attached	
C.	**Enforcement of Plastic Waste Management Rules**	
1	Please confirm if Bye- laws have been framed (Yes/No)	
2	No. of violations & action taken on non-compliance of provisions of PWM Rules, 2016, except for banned Single Use Plastics and plastic carry bags (Rule 12)	

(i)	Total no of Violations (eg. Burning/ Littering of plastic waste)				
(ii)	Actions Taken (Fines/penalties Imposed Rs.)				
3	**Implementation of ban imposed under Rule 4 including on identified single use plastic items, plastic carry bags having thickness less than 120 microns (ward-wise) (quarterly reporting)**				
(i)	Registration number CPCB SUP compliance App				
(ii)	Total number of commercial establishments/Institutions and Hotspots in the area under jurisdiction				
(a)	-Commercial establishments : Malls, Cinema Halls, Airports, Railway Stations, Metro Stations, others				
(b)	- Institutions- Schools, Colleges, Office Complex etc				
(c)	-Hotspots – Tourist spots, sabzi Mandi, Wholesale market, Fish Market, Flower market, Religious Places etc.				
(iii)	Total No of Inspections carried out				
(iv)	Total Fine imposed (Rs.)				
(v)	Quantity of Banned SUP seized(Tons)				
(vi)	Details of mode of disposal of seized SUP				
	Qty of SUP Seized (T)		Mode of Disposal (Recycling/ WtE/ WtO/ Co-processing/Road making)		Name & Address of the Plastic Waste Processor
(vii)	Details of Entities producing Alternatives				
	S.No.	Name of Entity	SUP Alternative produced	Production Capacity (TPA)	Address
(ix)	Details of Entities producing compostable plastics and biodegradable plastics				
(xi)	Shops for Eco alternatives for banned Single Use Plastic items				
D.	**Data on ingress of littered plastic waste in water bodies**				
1	Ingress points for plastic waste in Drain and Water Body Number of ingress points Measures taken to stop ingress of plastic waste				
2.	Surface water bodies including river stretches Number of surfaces water bodies Quantity of plastic waste collected				
3.	Number of drains cleaned from Plastic waste Total length of drains Total length of drains cleaned from plastic waste Plastic waste collected (MT) Silt collected				

(B) FORMAT FOR ANNUAL REPORT ON PLASTIC WASTE MANAGEMENT TO BE SUBMITTED BY THE PANCHAYAT AT THE DISTRICT LEVEL

Period of Reporting: (Year)

A	**General**	
1	Name of the District and State:	
2	Name & Address of Panchayati Raj Institution At The District Level	
3	Contact E-mail:	
4	Contact Phone No.	
5	Number of Gram Panchayats covered	
6	Number of villages covered	
7	Total Population	
8	Total Area	
9	Total number of households	
B	**Plastic Waste Management**	
1.	Summary of the mechanisms put in place for management of plastic waste in the area under jurisdiction along with the details of agencies involved (Please attach the details)	
2.	Please attach details of infrastructure put in place for management of plastic waste generated in the area under jurisdiction	
3.	Total no. of Plastic Waste Management Units set up with capacity	
4.	Quantity of Plastic Waste generated (Tonnes) as per CPCB methodology	
5	Plastic Waste Characterization as per CPCB methodology (Plastic packaging waste: Cat I/Cat II/ Cat III/Cat IV/Cat V and Others ((i) recyclable and (ii) non-recyclable)	
6.	Quantity of Plastic Waste collected (Tonnes)	
7.	Plastic Waste Segregated (Tonnes)	
8.	Plastic waste channelized for processing and recycling (details quantum of plastic waste, type of processing) (a) Plastic waste to recyclers (b) Plastic waste to co-processing in cement kilns (c) Plastic waste to waste to energy/waste to oil plants (d) Plastic waste for road construction	
9	(i) Details of human resource including waste pickers in informal sector (concessionaire or own resource) deployed for (a) Collection (b) Street sweeping (c) Transportation (d) Segregation (e) Processing (f) disposal (ii) Details of waste pickers engaged in plastic waste management (ward wise) No. of waste pickers	
10	EPR Guidelines leveraged for PWM (Y/N)	
	Details to be attached	
C	**Enforcement of Plastic Waste Management Rules**	
1	Please confirm if Bye- laws have been framed (Yes/No)	
2	No. of violations & action taken on non-compliance of provisions of PWM Rules, 2016, except for banned Single Use Plastics and plastic carry bags (Rule 12)	

I	Total no of Violations (eg. Burning/ Littering of plastic waste)	
Ii	Actions Taken (Fines/penalties Imposed Rs.)	
3	**Implementation of ban imposed under Rule 4 including on identified single use plastic items, plastic carry bags having thickness less than 120 microns (ward-wise) (quarterly reporting)**	
I	Total number of Institutions & Hotspots in the area under jurisdiction	
(a)	- Institutions- Schools, Colleges, etc	
(b)	Hotspots – Subzi Mandi, Wholesale market, Fish Market, Flower market, Religious Places etc.	
II	Total No of Inspections carried out	
III	Total Fine imposed (Rs.)	
IV	Quantity of Banned SUP seized(Tons)	
D.	**Data on ingress of littered plastic waste in water bodies**	
1	Ingress points for plastic waste in Drain and Water Body Number of ingress points Measures taken to stop ingress of plastic waste	
2.	Surface water bodies including river stretches Number of surfaces water bodies cleaned Quantity of plastic waste collected	
3.	Number of drains cleaned from Plastic waste Total length of drains Total length of drains cleaned from plastic waste Plastic waste collected (MT) Silt collected	

15. for Form VI in the said rules, the following shall be substituted, namely:-

FORM VI

[See rule 17(6)]

FORMAT FOR ANNUAL REPORT ON PLASTIC WASTE MANAGEMENT TO BE SUBMITTED BY SPCB/PCC

Period of Reporting:

A	**General**	
1	Name of the State/UT:	
2	Name & Address of SPCB/PCC:	
3	Contact E-mail:	
4	Contact Phone No.	
5	Details of Plastic Waste Management (State Level)	
	• Collection (MT)	
	• Segregation (MT)	
	• Processing including recycling (MT)	
	• Disposal (MT)	
B	**Mechanism of Plastic Waste Management**	
1	Summary of the mechanisms put in place for management of plastic waste in your State/UT along with the details of agencies involved (Please attach the details)	
2	Please attach details of infrastructure put in place for management of	

	plastic waste generated in your State/UT	
3	Total no. of MRF Facilities	
(a)	No. of Mechanical MRF Facilities with capacity	
(b)	No. of Manual MRF Facilities with capacity	
C	**Plastic Waste Generation, Collection, Segregation & Characterization**	
1	Total Numbers of the Urban Local Bodies (ULBs) in the area under jurisdiction	
2	No. of ULBs who have submitted Annual Report	
3	Total Numbers of the Gram Panchayat (GPs) in the area under jurisdiction	
4a	Total number of Panchayati Raj institution at District Level	
4b	No. of Panchayati Raj institution at District Level who have submitted annual report	
5	Please confirm that all GPs/ULBs have provided complete information in stipulated time as per format prescribed by CPCB (Yes/No)	
6.	Please provide no. of ULBs/GPs which have not submitted complete information within the stipulated time frame	
7.	Please provide total amount of EC levied on PRI at District Level / ULBs who have not submitted annual report as per prescribed timelines under the rules	
8.	Quantity of Plastic Waste generated (Tonnes) as per CPCB methodology (Cat I/Cat II/ Cat III/Cat IV/Cat V/ Others)	
9.	Quantity of Plastic Waste collected (Tonnes)	
10.	Plastic Waste Segregated (Tonnes)	
11.	Please confirm that all Local Bodies/ GPs have carried out Assessment of Plastic Waste Generation & Characterization as per methodology specified by CPCB (Yes/No)	
12.	Please upload Plastic Waste Characterization Report as per methodology specified by CPCB	
13.	Please confirm that data validation and reconciliation for ULB and PRI at District Level has been done as per methodology specified by CPCB (Yes /No)	
D	**Extended Producer Responsibility Implementation**	
1.	Total Number of ULBs registered on EPR (To be auto fetched from EPR portal)	
2.	Details of Plastic Waste Processors (To be auto fetched from EPR Portal)	

	Name	Type (Recycler/Coprocessors/Waste to Energy/Waste to Oil/Road Making)	Registration No	Processing Capacity (TPA)					
				PW (Cat-I)	PW (Cat-II)	PW (Cat-III)	PW (Cat-IV)	PW-(Cat-V)	Other

3.	**Plastic Waste Processed through PWPs (TPA)**						
	Type (Recycler/Coprocessors/Waste to Energy/Waste to Oil/Road Making)	PW (Cat-I)	PW (Cat- II)	PW (Cat-III)	PW (Cat-IV)	PW (Cat-V)	Others

4.	**Audit & Levying of Environmental Compensation (EC) (To be auto fetched from the EPR Portal)**	
(a)	No. of Entities (PIBOs/PWPs) audited	
(b)	No. of Entities (PIBOs/PWPs) found in violation	
(c)	EC levied on violating Entities (PIBOs/PWPs)	
E.	**Implementation of ban imposed under Rule 4 including on identified single use plastic items, plastic carry bags having thickness less than 120 microns**	
1	Total number of commercial establishments/ Institutions &	

	Hotspots in the area under jurisdiction				
(a)	-Commercial establishments :Malls, Cinema Halls, Airports, Railway Stations, Metro Stations				
(b)	- Institutions: Schools, Colleges, Office Complex etc				
c	-Hotspots :Tourist spots, sabzi Mandi, Wholesale market, Fish Market, Flower market, Religious Places etc.				
2	Total No of Inspections (Data Auto fetched from SUP Compliance Monitoring Portal)				
3	Total No of Commercial Establishment and hotspots closed for SUP Ban Violation				
4	Total No. of Industries inspected(Data Auto fetched from SUP Compliance Monitoring Portal)				
5	Total no. of industries closed for manufacturing banned SUP items				
6	Total Fine imposed (Rs.) (Data Auto-fetched from SUP Compliance Monitoring Portal)				
7	Quantity of Banned SUP seized(Tons) (Data Auto-fetched from SUP Compliance Monitoring Portal)				
8	Total No of Commercial establishment and hotspot made SUP free				
9	Details of mode of disposal of seized SUP				
	Qty of SUP Seized (T)			Mode of Disposal (Recycling/ WtE/WtO/ Co-processing/ roadmaking)	Name & Address of the Plastic Waste Processor
10.	Details of Entities producing Alternatives including compostable plastics				
	Sl.No.	Name of Entity	SUP Alternative	Processing Capacity (TPA)	Address
11.	No of Complaints received on SUP grievance App (Data Autofetched from SUP Grievance redressal app)				
12.	No of Complaints resolved (Data Autofetched from SUP Grievance redressal app)				
F	**Enforcement of Plastic Waste Management Rules**				
1.	**Details of Registered Plastic Raw Material Manufacturing Units**				
	Total No:		Capacity:		Product Manufactured
2.	**Details of Registered PWP (Non- packaging) Processing Facilities**				
	Total No:		Capacity:		Product Manufactured
3.	**Details of Unregistered Manufacturing or Recycling Units (in residential or unapproved areas).**				
	Total No:		Capacity:		Product Manufactured
4.	No. of ULBs which have framed bye-laws				
5.	No. of violations & action taken on non-compliance of provisions of PWM				

	Rules, 2016, as amended, 2018 (Rule 12)	
6.	Total no. of violations (Burning/ Littering/non-registration and other non-compliance)	
7.	Action Taken (Fine Imposed / Closures issued)	

16. After Form VI in the said rules, the following Form shall be inserted, namely:-

FORM VII

[See rule 17(2)]

Format for Quarterly report of Plastic Raw Material

Manufacturer/Importer of plastic raw material

Year : Quarter : Q1/Q2/Q3/Q4

S. No.	Name of Buyer	Address of Buyer	Email ID	Phone No.	Buyer Category	GST no. of Buyer	Category of plastic packaging	Qty of plastic raw material supplied (T)	Type of plastic raw material supplied

Note:

(i) Quarterly report shall be submitted as per pro forma in electronic format prescribed by CPCB.

(ii) Individual invoices for transactions are not required for the purposes of quarterly report.

Buyer Category

1. Large and Medium Producers (as per criteria of Ministry of Micro, Small and Medium Enterprises, Government of India
2. Micro and Small Producers (as per criteria of Ministry of Micro, Small and Medium Enterprises, Government of India)
3. Brand Owners
4. Seller
5. Others (Non-plastic packaging applications)

Type of plastic raw material supplied

1. PET
2. HDPE
3. PVC
4. LDPE
5. PP
6. PS
7. Others
8. Biodegradable plastic in specified environment
9. Compostable plastic

[F. No- 17/6/2023 HSM]

NARESH PAL GANGWAR, Addl. Secy.

Note- The principal rules were published in the Gazette of India, vide number G.S.R. 320(E), dated the 18th March, 2016 and subsequently amended vide notification number G.S.R. 285(E), dated the 27th March, 2018, vide notification number G.S.R. 571(E), dated the 12th August, 2021, vide notification number G.S.R. 647(E), dated the 17th August, 2021, vide notification number G.S.R. 133(E) , dated the 16th February 2022, vide notification number G.S.R. 522(E) dated the 6th July 2022, vide notification number G.S.R. 318(E) , dated the 27th April 2023 and last amended vide notification number G.S.R. 807(E) dated the 30th October 2023.

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ANNEXURE III

SINGLE-USE PLASTICS

NATIONAL LEVEL COMPLIANCE ASSESSMENT METHODOLOGY OF SINGLE-USE PLASTIC BAN

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

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List of Abbreviations

ASTM	American Society for Testing and Materials
CIPET	Central Institute of Petrochemicals Engineering and Technology
CPCB	Central Pollution Control Board
CSIR	Council of Scientific and Industrial Research
HDPE	High-density polyethylene
LDPE	Low-density polyethylene
MoEF&CC	Ministry of Environment, Forest and Climate Change
MLPs	Multi- Layer Plastics
MRF	Material Recovery Facility
NEERI	National Environmental Engineering Research Institute
NGT	National Green Tribunal
PCCs	Pollution Control Committees
PET	Polyethylene Terephthalate
PP	Polypropylene
PPE	Personal Protective Equipment
PS	Poly-Styrene
PVC	Poly-Vinyl Chloride
SDMC	South Delhi Municipal Corporation
SPCBs	State Pollution Control Boards
SUPs	Single-Use Plastics
ULBs	Urban Local Bodies
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UTs	Union Territories

Executive Summary

The mismanagement of plastic waste, especially that of Single-use Plastics products (SUPs), has emerged as a major environmental challenge for the country. Globally, countries are enforcing rules and legislations at the policy level for sustainable management of plastic waste and SUPs. The Government of India is also placing significant emphasis on curbing the adverse impacts of littered plastic waste on both terrestrial and aquatic ecosystems, and has banned manufacture, import, stocking, distribution, sale and use of identified SUP items, having low utility and high littering potential, all across the country from 1 July 2022.

A national level task force is in place and a comprehensive action plan is developed by the Ministry of Environment, Forest and Climate Change (MoEF&CC) for effective implementation of the SUP ban. The Ministry of Environment, Forest and Climate Change (MoEF&CC), Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), Pollution Control Committees (PCCs), Urban Local Bodies (ULBs) and other state government agencies are collecting working together for effective implementation of the ban in India. The Government departments at state, district levels are ensuring action plans in place through by-laws, awareness generation, municipal solid waste surveys on banned SUP items to implement the ban in India. However, there is no standard methodology to estimate the quantum of SUP being used and sold to access the compliance status of the ban. In this backdrop, this study introduces a standardized methodology that can be employed to evaluate the compliance status of the ban on Single-Use Plastics (SUPs) in India. This methodology can be adopted by relevant stakeholders, including regulatory bodies and local authorities.

The suggested methodology was pilot tested for its robustness in 20 cities during the months of March to September 2022 and presents a baseline of SUPs in the selected cities, enabling a comparison of the compliance status of the ban on SUPs in the future.

Key Observations

- With increased dependence on use-and-throw plastics, the proportion of plastics in municipal solid waste has almost doubled in India, from 6.9% in 2015 to 12.2% in the present study (2022).
- Banned SUPs accounted for about 20% of the total plastic waste. In other words, on an average, banned SUPs account for about 2.4% of the total municipal waste (by weight). The proportion of banned SUPs in cities ranged from 5% to about 45% of the total plastic waste.
- The use and availability of banned SUPs were still prevalent in the market, during the surveys (March - September 2022). On an average, 57% of the samples surveyed in 137 markets across 20 cities includes the banned SUP items (use/sale).
- Alternatives for all banned SUPs are available in the market.
- The cost of the alternatives to the SUPs are on higher side. Depending upon the product category, it varies from 3 to 5 times the cost of SUP items.
- Most of the alternatives to the banned SUP are again of single-use nature. Multi-use alternatives should be promoted and made available, which will ultimately help in reducing plastic pollution.
- It is challenging to directly implement the ban in most of the cities, therefore a grace period was in place in few cities.
- The proposed methodology in this study is robust and has the capability to effectively capture the on-ground situation in different cities. It is designed to be simple, less time-consuming, and resource-efficient, allowing for its implementation by Urban Local Bodies (ULBs).

Way Forward

- Similar SUP inventory studies should be undertaken across the country to assess the status of the ban and gaps in implementation.
- The study should be repeated at an interval of every 6 months to assess the progress, regular inventorisation at MRFs to track the SUP in all cities. Training to all MRF operator on inventorisation.
- Research studies focused on providing multi-use alternatives to SUPs should be developed in association with industries.
- Continuous effort is required to bring down the cost of the alternatives.
- Improvement in infrastructure to support collection and treatment of the SUPs as well as alternatives, and the recycling potential of alternative to SUP items should be enhanced.

1. Introduction

1.1. About the Project

Under the Indo-German Bilateral Cooperation, the Federal Ministry of Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), the Federal Republic of Germany, is supporting the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India to implement a Technical Cooperation (TC) project on "Circular Economy Solutions (CES) Preventing Marine Litter in Ecosystems". The project is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in collaboration with MoEFCC. The project focus ranges from tracking and monitoring of marine litter and to demonstrate technological solutions in river, marine and coastal ecosystems to close material cycles of marine litter using resource efficient and circular economy approaches in the selected states of India.

The Government of India is also placing significant emphasis on curbing the adverse impacts of littered plastic waste on both terrestrial and aquatic ecosystems. In this direction, MoEFCC has banned identified Single-Use Plastics products (SUPs) from 1 July 2022. Under the CES project, GIZ India is supporting the Central Pollution Control Board (CPCB) for developing a compliance assurance methodology to assess the compliance with the notified ban. GIZ India has collaborated with Sustainability Innovations and Advisories (SIA) Pvt. Ltd. to develop and test the National Level Compliance Assessment Methodology of Single-Use Plastic Ban in 20 cities of India.

1.2. Background

In July 2022, The Plastic Waste Management (PWM) Rules, 2016, as amended, provide the statutory framework and prescribed authorities for enforcing the rules, including the ban on identified single-use plastic items. The Plastic Waste Management Amendment Rules, 2021, which came into effect on 1st July, 2022, have prohibited the following single-use plastic items having low utility and high littering potential:

- Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, and polystyrene [Thermocol] for decoration;
- Plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, cigarette packets, plastic or PVC banners less than 100 microns, and stirrers.

The following banned items are shown below.



Plastic carry bags (<75 µ or <75 microns)



Plastic flags



PVC banners (<100 µ)



Plastic films on cigarette packets



Plastic films on invitation cards



Plastic films on sweet boxes



Plastic balloon sticks



Plastic spoons



Plastic cups



Plastic candy sticks



Plastic straws



Ice cream sticks



Plastic glasses



Plastic forks


Earbuds with plastic sticks



Plastic plates



Plastic trays



Thermocol - based decorative items



Stirrers



Plastic knives

Post the official notification of the ban, a National Task Force was constituted by the Ministry for taking coordinated efforts to eliminate identified single-use plastic items and effective implementation of Plastic Waste Management Rules, 2016. As per provision 9.2 of Schedule-II notified through amendments to PWM Rules dated February 16, 2022, CPCB has to finalise the compensation and penal action regime in case of violation. CPCB was also given the responsibility to establish a National Control Room to monitor effective implementation of SUP Ban, and develop a comprehensive action plan to ensure that the ban is implemented successfully throughout the country. The action plan encompasses measures to reduce the SUPs from the supply, demand and the usage side. This includes measures to restrict the supply of raw materials, demand-side measures to reduce plastic demand, enabling measures to promote alternatives to SUP, digital interventions for efficient monitoring and creating awareness and guidance to SPCB/PCCs for effective implementation of directions.

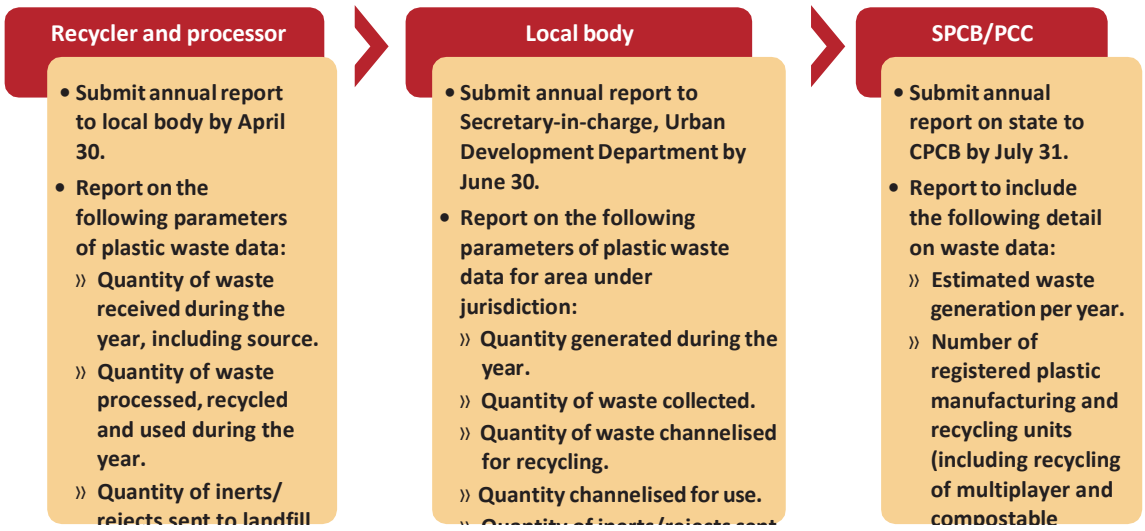
The directions issued by CPCB specifies the role of different stakeholders, as well as the need for coordinated activities, timely action and awareness programmes among different stakeholders. Further, the SPCBs/PCCs have been directed to execute the same at the state district levels in coordination with local authorities. The action points for the SPCBs/PCCs also includes identifying major stockiest/retailers/sellers and survey of municipal solid waste for presence of banned SUP items. This necessitates a standard compliance assessment methodology which will help in quantifying the presence of banned SUP in municipal solid waste and analyse the quantum and types of banned SUPs sold in the markets. The specified role of SPCBs/PCCs and local authorities among others are as provided in Annexure 1.

Presently, there is also no established methodology to estimate the quantum of SUPs in the municipal waste or the quantum of SUPs being sold and used, The only framework for plastic waste is a reporting framework developed by CPCB to publish its annual report on the state of plastic waste management in the country. The report contains only data on the quantity of plastic waste produced by different states and UTs with no specific data on SUPs.[1]

The data published by CPCB is based on the data submitted every year by SPCBs and PCCs. The data collection and reporting format is specified in Rule 17 of the Plastic Waste Management Rules, 2016. As per Rule 17, an annual report is to be submitted by waste processors and ULBs on waste generation, treatment and disposal to SPCBs/PCCs, and the collated report is further submitted to CPCB by SPCBs/PCCs. The mechanism for this is outlined in the diagram below *(see Figure 1)*.[2] The biggest challenge with the data collection mechanism, as specified under Rule 17, is that there is no standard methodology to quantify and characterise total plastic wastes. Due to a lack of suitable methodologies, there is currently a gap in both the assessment of compliance with SUP (Single-Use Plastic) bans and the quantification and characterisation of plastic waste.

In this context, the present report "National Level Compliance Assessment Methodology of Single-Use Plastic Ban" aims to support CPCB and other regulatory agencies in developing a robust methodology for estimating plastic waste and to assess compliance with the notified ban on SUPs.

Figure 1: Data collection and reporting on plastic waste



[1] Central Pollution Control Board (CPCB). 2021. Annual Report 2019-20, Implementation of Plastic Waste Management Rules, 2016. Retrieved 2 December 2022, from https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2019-20_PWM.pdf

[2] Ministry of Environment, Forest and Climate Change, 2016. Plastic Waste Management Rules,2016. Retrieved 2 December 2022, from https://cpcb.nic.in/displaypdf.php?id=cGxhc3RpY3dhc3RlL1BXTV9HYXpldHRlLnBkZg==

1.3. Objectives and Scope

The key objective of this study is to:

1. Assess the compliance of SUPs ban –
   a. Through characterisation of SUPs in MSW samples, and
   b. By conducting market survey of SUPs/alternatives to ascertain their availability within the developed methodological framework,
2. Test the methodology in 20 selected cities and develop the baseline for SUPs in the selected cities.

Based upon the objective of the study and desired outcome, the study framework is as depicted below in Figure 2.

Figure 2: Study Framework



As the methodology for National Level Compliance Assessment Methodology of Single-Use Plastic Ban also includes quantification and characterisation of waste (see Section 2.2), the scope of the methodology, under the study includes:

1. Estimation of plastic waste in the city under composition and quantification.
2. Compliance assessment with the notified SUP ban.

To ensure that the methodology is easily implemented by cities of different sizes (and in turn the capacity of the ULBs), the following guiding principles were used to develop the methodology.

- It should be a rapid method to assess the on-ground situation and be less intensive in terms of resource requirements.
- It should be easy to replicate at a fixed time interval (once or twice a year) to check on-ground level effectiveness of the ban.
- It should assist in ensuring compliance, identify gaps and help in strengthening strategy for effective implementation.

1.4Studies Carried Out Previously

For finalising the suitable framework for the assessment of SUP ban, we looked into some of the previous studies carried out. The reference was made to some of the existing studies on waste inventorisation, as no specific study on SUP quantification was available. Therefore, to arrive at the methodology for SUPs, it is necessary to review the assessment methodologies for the plastic waste.

The available studies, includes the following;

1. Assessment and Characterisation of Plastic Waste Generation in 60 Major Cities, 2015.
2. Assessment of the Status of Municipal Solid Waste Management in Metro Cities, State Capitals, Class I Cities, and Class II Towns in India: An insight, 2008.
3. Baseline Assessment Report, Rishikesh and Haridwar, 2020.

All three studies have used one of the following two methodologies:

- Guidelines for solid waste management assessment (baseline survey) in secondary cities and small towns in Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 2010.
- Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, American Society for Testing and Materials (ASTM) standard test method (D5231- 92).

The Baseline assessment study in Rishikesh and Haridwar was carried out on the methodology derived from UNESCAP, and was customised to suit the Indian context, which is largely to quantify the waste generation from different contributing sectors.

The NEERI study has used the ASTM method which involve sampling of waste from vehicles employed for collection and transportation of waste. The assessment and characterisation of plastic waste generation in 60 major cities, done by CIPET, has referred the ASTM Method (D5231-92) as guiding principle for assessment and quantification of plastics waste at Dump sites.

The UNESCAP method is based on the household survey and is used for detailed municipal waste quantification and characterisation for the development of waste management infrastructure. These studies are resource intensive and should be done once in 5-10 years to assess the status of waste management and infrastructure in cities. The ASTM method is for municipal waste characterisation and is a rapid method to assess the composition of waste. This is less resource intensive and can be done annually to assess the changing composition of municipal waste.

Based on the above, it is advisable to use ASTM Method (D5231-92) as the guiding principle for developing the methodology for analysing SUP in the waste stream.

2. Methodology

The primary objective of this study is to develop a methodology for assessing the compliance with the SUP ban notification. In India, so far, there is no documented study to assess the quantity of SUPs being sold/used in cities. A global framework or methodology also does not exist that is used worldwide or internationally. As SUPs are a sub-set of the plastic waste, any methodology that attempts to quantify and characterise SUPs, must necessarily also quantify and characterise the total plastic waste.

2.1 Literature Review

This literature review focuses on the selection of an appropriate methodology for compliance assessment of Single Use Plastics (SUPs) in India and verify its suitability for this study. It acknowledges the limited number of studies conducted at the city-level to quantify and characterize plastic waste. Three key studies on plastic waste inventorisation have been identified, along with their respective methodologies (as discussed in section 1.4). The ASTM method emerges as a suitable choice, in the context of waste characterisation and quantification for SUPs.

Suitability of the ASTM Method (D5231-92) for Compliance Assessment of SUPs:

1. Simplicity and Resource Efficiency: The ASTM method offers a simplified and less resource-intensive approach to waste characterization. This makes it practical for conducting regular assessments to track the changing composition of municipal waste, including SUPs.
2. Standardization and International Recognition: The ASTM method (D5231-92) is an internationally recognized standard for waste characterization. Its use ensures consistency and comparability of results across different studies and regions.
3. Focus on Plastic Waste: The ASTM method provides specific guidelines for the characterization and quantification of different waste materials, including plastics. It allows for the identification and separation of SUPs from other waste streams, enabling a targeted analysis of their quantity and composition.
4. Supplementary Approach: To obtain a comprehensive picture of SUP ban compliance, it is advisable to supplement waste inventorisation studies with an assessment of the supply-side, including the sale and use of SUPs. This approach would provide a more accurate understanding of the overall SUP landscape and inform effective compliance measures.

The ASTM method is widely recognized and accepted for its comprehensive guidelines and established procedures. It ensures standardization, comparability, and reliability of results across studies and locations.

However, relying only on waste inventorisation to assess the compliance is fraught with uncertainties. The Indian waste sectors is based to a significant extend on informal activities, which poses a notable challenge for arriving at a reliable data based on inventory studies. For a compliance assessment study on SUP, it would be prudent to also assess the supply-side to get an accurate picture on the sale and use of SUPs.

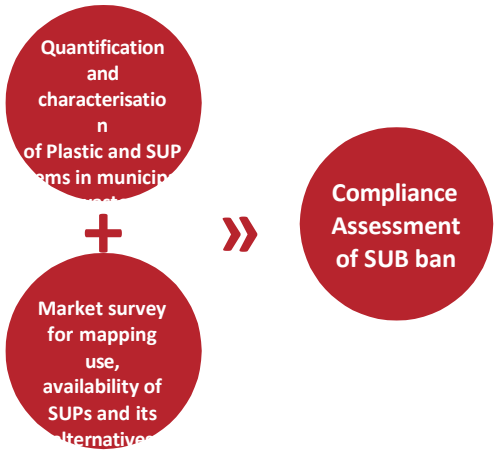
2.2 Methodology for Compliance Assessment

The objective of the methodology is to assess and quantify the availability of the SUP products in the market and its use in the city. A two-pronged methodology is being proposed to ensure a robust compliance assessment:

1. Compliance assessment through quantification and characterisation of Plastic and SUP items in municipal waste.
2. Compliance assessment through a market survey for mapping use, availability of SUPs and its alternatives.

The methodology targets both the supply as well as the demand side, to get a comprehensive picture of the compliance status. The objective of the market survey is to assess the availability of banned SUPs and its alternatives in the market. On the other hand, the waste inventory study has been designed to determine the prevailing use and disposal practices.

Figure 3 (a): Two-pronged methodology for assessment of compliance of SUP ban



The indicators used for assessing compliance with the ban are:

1. Percentage of banned SUPs in the municipal waste.
2. Proportion of surveyed entities selling SUP products in major markets of the city.



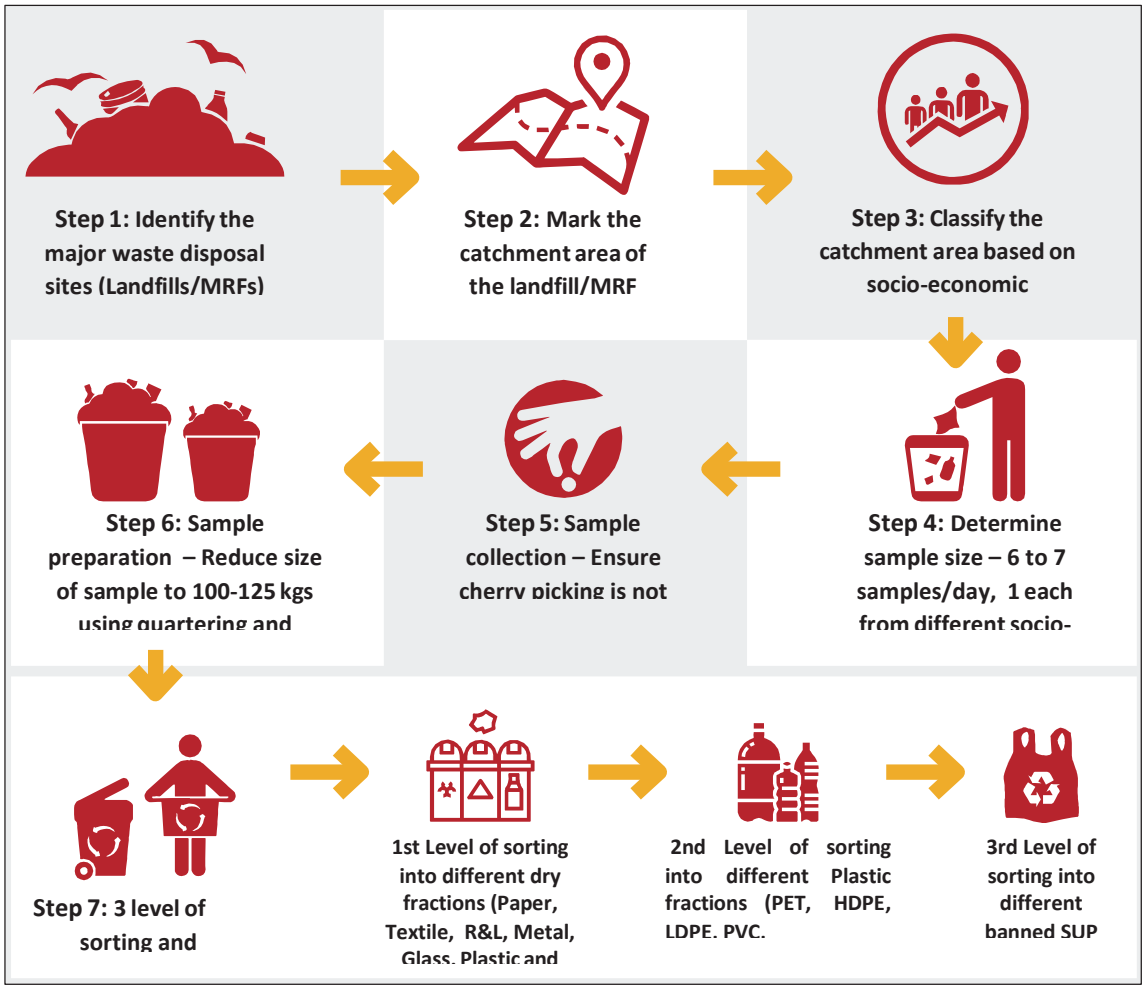
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2.2.1 Plastic and SUP Quantification and Characterisation in Municipal Waste

The Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, American Society for Testing and Materials (ASTM) standard test method (D5231- 92) is taken as the basis for developing the methodology for conducting inventorisation of Single-Use Plastics (SUPs).

The detailed procedure for conducting the SUP inventorisation study is as follows:

Figure 3: Methodology for quantification and characterisation of SUP in municipal waste



Step 1: Identify the major waste disposal sites

The major waste disposal sites in a city, which could either be landfills collecting unsegregated waste or Material Resource Facilities (MRF) with a good rate of source segregation, should be identified.

All major landfills/MRFs needs to be identified, this will help in deciding the number of samples. Landfills are selected in cities with direct waste collection at landfills, and MRFs are selected in cities with operational MRFs. The waste from the catchment area, catered by the facility is mapped and categorised, accordingly. In cities where no landfill is present (as in Thiruvananthapuram), the MRF or the resource recovery centre will be identified, and in cities where both landfill and MRFs are present (as in Surat), the first entry point is selected where the waste is collected without any recovery or cherry picking.

Step 2: Mark the catchment area

Divide the city based on the area catered by the landfill/MRF. All wards catered by the landfill/MRF should be mapped and classified under the following 5 major categories based on its socio-economic characteristics/ land use:

- High-income residential wards
- Middle-income residential wards
- Economically Weaker Section (EWS) residential wards/slums
- Commercial wards
- Mixed commercial and residential wards

See Table 1 on guidance on classification of wards.

Table 1: Classification of different wards

Wards	Example of housing type/land use
EWS/Low-income group/ Slums	Single room residents, areas with low rentals/slum areas. Lowest property tax or tax exempted or unauthorized settlement.
Middle income	Apartments, single detached houses without garden. Median tax rate.
High income	Single detached houses with parking and garden, Luxury condominiums, and high-rise buildings. Highest tax rate.
Mixed commercial and residential	Areas where both commercial and residential complexes are present in an equal ratio or areas where waste from both commercial establishments as well as residential houses are collected in equal ratio.

The socio-economic characteristics of the city should be analysed to understand the population characteristics and determine the proportion of the population residing in each economic strata/ land use. The number of samples to be sorted from each category should be fixed based on the population proportions observed in the city, to eliminate any biases in the selection of samples and ensure representativeness.

Step 3: Determine sample size

The sample size should be determined based on ASTM (D5231- 92). The methodology for determining the sample size is given in Box 1. In the Indian context, for determining the composition of plastic waste, 30-35 samples should be collected over a period of five days (6-7 samples per day) from the catchment areas of each landfill/MRF facility. If a city has only one landfill site, then 30-35 samples should be collected. If the city has two landfills, then 60-70 samples are to be collected. One sample is equal to one vehicle load of waste.

BOX 1: METHODOLOGY FOR DETERMINING SAMPLING SIZE

Vehicles for sampling shall be selected at random during each day of the sampling period, so as to be representative of the waste stream. With respect to the random selection of vehicles, any method is acceptable that does not introduce a bias into the selection. For a weekly sampling period of k days, the number of vehicles sampled each day shall be approximately n/k, where n is the total number of samples (1 sample is equivalent to 1 vehicle load from 1 ward) to be selected for the determination of waste composition.

$n=(t*s/(e*x))2$

Where,
t = student t statistic corresponding to the desired level of confidence[1] s = estimated standard deviation
e = desired level of precision x = estimated mean.

The required number of samples will vary among the components for a given set of conditions, a compromise will be required in terms of selecting a sample size, that is, the number of samples that will be sorted. The component that is chosen to govern the precision of the composition measurement is termed the "governing component" for the purposes of this method, which is plastic in our case.

Box 1 continued

The mean value and standard deviation for plastic waste is estimated based on field test data from our previous ground study on MSW in Rishikesh and Haridwar (also cross checked with some other national studies) reported for MSW sampled for a week, the values of standard deviation is 0.03 and mean value is 0.09 for plastic.

The desired level of precision is taken at 10% for calculating the sample size.

The sample size has been calculated for confidence level 90%, and is as provided below;

› 90% confidence level and 10% precision

s = 0.03 (as explained above from different ground studies)

e = 0.10 (10% desired level of precision)

x = 0.09 (as explained above from different ground studies)

Using formula for n at (n = ∞), with value of t from table at (n = ∞);

n = ((1.645*0.03)/(0.1*0.09))2 = 30, referring to t table again for t value at n = 30

n = ((1.699*0.03)/(0.1*0.09)) 2 = 32

The value 32 is within 10 % of 30 (for n = z), 32 sample should be selected for analysis within the desired spread of 5 to 7 days.

That is, 32/5 = 6 samples/day if analysis is done for 5 days, and 32/7 = 5 samples/day if analysis is done for 7 days.

At least one sample should be collected from each socio-economic strata/land use, i.e., one sample each from High income, Middle-income, and Low-income residential wards, Commercial wards, and Mixed residential and commercial wards. However, based on the proportion of population, the number of samples from certain socio-economic strata/land use can be increased. For example, if the catchment area is predominantly mixed residential, then the number of samples can be increased to two from the mixed residential wards. Similarly, if the catchment area is predominantly commercial, and mixed commercial and residential, then two samples each from commercial, and mixed commercial and residential wards can be collected. The number of samples from each economic stratum should remain constant on all days throughout the Inventory study.

The basic idea of collecting waste from different socio-economic strata/land use is to make sure that the waste sample is representative of the city/town waste profile, and there is no bias while selecting the sample size. In case of cities/towns where such predefined bifurcation is not available, the bifurcation of wards is based upon the predominant nature. For example, wards with more than 50% high income residences is classified as High income wards, and so on.

APPENDIX 1: CALCULATION OF SAMPLES FOR SORTING

a. Number of samples for sorting

The number of sorting samples (that is, vehicle loads) (n) required to achieve a desired level of measurement precision is a function of the component(s) under consideration and the confidence level. The governing equation for n is as follows:

n=(t*s/(e*x))2 ..... (Eq 1)

Where,
t = student t statistic corresponding to the desired level of
confidence s = estimated standard deviation
e = desired level of
precision x = estimated
mean

b. One sorting sample is chosen per vehicle load.

c. Suggested values of s and of x for waste components are listed in Table A.

Table A: Values of mean (x) and standard deviation (s) for determining waste composition

Component	Standard Deviation (s)	Mean (x)
Paper	0.05	0.10
Textile	0.01	0.03
Glass	0.02	0.03
Rubber & Leather	0.01	0.02
Metal	0.007	0.01
Plastic	0.03	0.09

The tabulated mean values and standard deviations are estimates based on field test data reported for MSW sampled during weekly sampling periods at different locations.

d. Values of t are given in Table B for 90 and 95 % levels of confidence, respectively.

Table B: Values of t Statistics (t) as a Function of Number of Samples and Confidence Interval

Number of Samples, n	90 %	95 %	Number of Samples, n	90 %	95 %
2	6.314	12.706	25	1.711	2.064
3	2.920	4.303	26	1.708	2.060
4	2.353	3.182	27	1.706	2.056
5	2.132	2.776	28	1.703	2.052
6	2.015	2.571	29	1.701	2.048
7	1.943	2.447	30	1.699	2.045
8	1.895	2.365	31	1.697	2.042
9	1.860	2.306	36	1.690	2.030
10	1.833	2.262	41	1.684	2.021
11	1.812	2.228	46	1.679	2.014
12	1.796	2.201	51	1.676	2.009
13	1.782	2.179	61	1.671	2.000
14	1.771	2.160	71	1.667	1.994
15	1.761	2.145	81	1.664	1.990
16	1.753	2.131	91	1.662	1.987
17	1.746	2.120	101	1.660	1.984
18	1.740	2.110	121	1.658	1.980
19	1.734	2.101	141	1.656	1.977
20	1.729	2.093	161	1.654	1.975
21	1.725	2.086	189	1.653	1.973
22	1.721	2.080			

e. Estimate the number of samples (n) for the selected conditions (that is, precision and level of confidence) and components using (Eq 1). For the purposes of estimation, select from Table B the t value for $n = \infty$ for the selected level of confidence. Since the required number of samples will vary among the components for a given set of conditions, a compromise will be required in terms of selecting a sample size, that is,

the number of samples that will be sorted. The component that is chosen to govern the precision of the composition measurement (and therefore the number of samples required for sorting) is termed the "governing component" for the purposes of this method.

f. After determining the governing component and its corresponding number of samples (n), return to Table B and select the student t statistic (t) corresponding to n. Recalculate the number of samples, that is, n.

g. Compare n at t=1.645 with the new estimate of n, which was calculated for the governing component. If the values differ by more than 10 %, repeat the calculations given in (e) and (f).

h. If the values are within 10 %, select the larger value as the number of samples to be sorted. Refer to Box 1 for a sample calculation of n.

Step 4: Sample collection

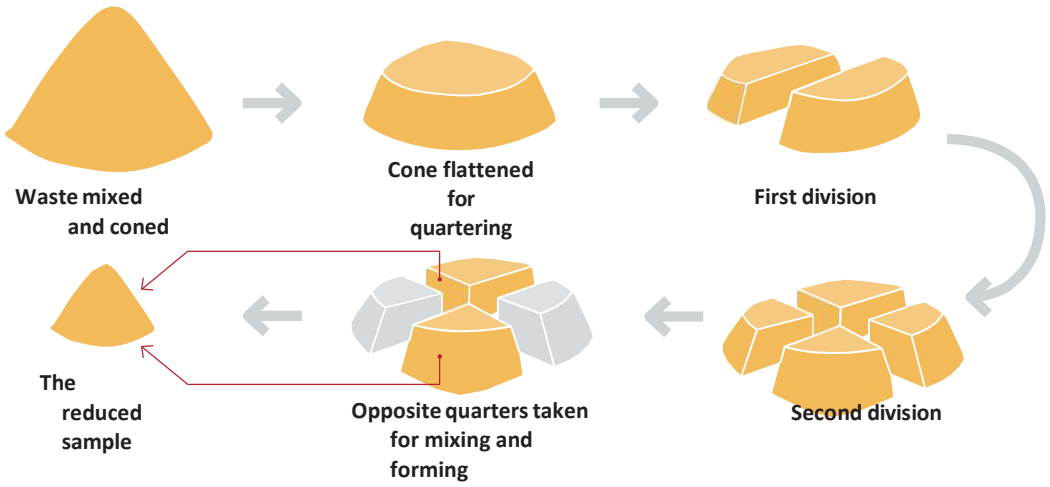
Identify the vehicles collecting waste from each socio-economic strata/land use. Every day, select vehicles randomly from each socio-economic strata/land use. Make sure that the waste collectors are not removing valuable plastics/ dry wastes beforehand.

Step 5: Sample preparation

The entire truckload of waste (approximately 400-500 kg) should be discharged in a designated area. Use the Quartering and coning method to reduce the size of the sample to the range of 100-125 kg.

Method: Unload an entire truckload of waste on the ground or on a sheet, divide the waste into four parts. Select two samples positioned diagonally opposite to each other for the next step, and discard the other two as shown in the figure. Repeat this process once again, to reduce the size of the sample from 400-500 kg to 100-125 kg.

Figure 4: Quartering and coning process



Step 6: Sorting and quantifying

A temporary platform with High-density polyethylene (HDPE) liner should be made for waste quantification at the sorting station (either at the landfill site or at the MRF). Two helpers and five sorters should be engaged in carrying out the quantification exercise. The helpers and sorters should be provided with appropriate personal protection equipment (PPE) for their safety. Before the sorting, the helpers and sorters should be trained on different types of plastics and various kinds of SUPs banned.

The resource requirement human and logistics for sorting and quantifying is as provided in Box 2.

BOX 2: RESOURCE REQUIREMENT (EQUIPMENT/APPARATUS AND HUMAN RESOURCE)

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i). Select a location for the discharge of waste load, manual sorting activity, and weighing operations that is flat, level, and away from the normal waste handling and processing area.

ii). HDPE liner to make a platform for sorting and quantification which will help in eliminating possibility of leachate contaminating the soil and the surroundings.

iii). Containers for storing and weighing each waste component, labelled accordingly for storing different fractions (like paper, textile, glass, metals, etc.). or subsequently sacks can be used except for the storing and quantifying wet waste. The weight of containers and sacks should be noted at the beginning and the same should be subtracted from the measurements while noting the data.

iv). Electronic weighing scale, 2 weighing scale (1 scale of 250 kg capacity and accuracy of ±10 g, and second smaller with accuracy of ±1 g or less). All weighing scale shall be calibrated according to the manufacturer's instructions. Take appropriate corrective action if the readings are different from those of the calibration weights.

v). Shovels, Rakes, Brooms (push and hand), First Aid kit, and other PPEs (such as safety boots, gloves, apron/ jacket, etc.)

vi). For the sorting and quantification exercise, at least two helpers and five sorters will be required along with one coordinator to monitor and oversee the whole process.

vii). The helpers and sorters should be trained to identify the different types of plastics and SUPs, pictorial banner is used to train them on this. (*refer Annexure 3*)

Sorting and quantification level 1: Dry waste fraction

Firstly, the total waste, sampled from coning and quartering method, should be weighed. It should then be separated into dry and wet waste and weighed separately. The dry waste should be further sorted into seven primary sorting categories:

- Paper
- Rubber and Leather
- Metal
- Glass
- Plastics, and
- Others (including medical waste, Sanitary waste, Hazardous substances, etc).

The weight fraction of each seven components should be measured.

Sorting and quantification level 2: Plastic waste fraction

The total plastic waste, sorted and weighed from above, should further be sorted into seven secondary categories, as per the IS 14534:1998 guidelines. Each sub-category category was weighed and registered in the datasheet.

Table 2: Categories of plastic

Category Type	Short Name	Scientific Name	Uses	Quantification (Kg/Kg of municipal waste)
1	PET	Polyethylene terephthalate	Water bottles, soft drink bottles, Juice bottles/ Rigid cosmetic jars/microwavable containers	
2	HDPE	High-density polyethylene	Shampoo bottles/Toys/Chemical containers/Pipe system/Recycling bins/Flower pots	
3	PVC	Polyvinyl chloride	Water pipes/Insulation wiring and cables/Bio-medical drips and tubings	
4	LDPE	Low-density polyethylene	Carry bags (grocery, dry cleaning, bread and bin liners)/Plastic wraps/Milk pouches/Squeezable bottles	
5	PP	Polypropylene	Bottle lids/Straws/Lunch boxes/Take away food containers/Ice cream containers/Syrup bottles	
6	PS	Polystyrene	Form packaging/Tea cups, plates and disposable cutlery/Containers/Yogurt containers	
7	Others	-	Multilayer packaging of chips, biscuits, etc.	

Notes: 1. Compostable plastic should be collected as a separate category or in Others category, but while quantifying MLPs it should be separated.

2. While quantifying banned SUP items, products made from compostable plastic should not be included.

BOX 2(A): IDENTIFY DIFFERENT PLASTIC CATEGORY

To identify different plastics, markings are made on the products. For example refer picture below,

©wikipedia.org



The number mentioned in the triangle on bottles show the recycling codes of the specific products. The one

Sorting and quantification level 3: Banned SUPs

All the 19 banned SUP along with carry bags above 75 micron, obtained from waste samples should be separated from the plastic wastes and weighed as shown in Table 3 below.

Table 3: Different categories of SUPs

Sr. No.	SUP items (banned)		Quantification (kg/kg of plastic waste)	Percentage
1	Plastic sticks	Ear buds		
2		Balloon		
3		Candy		
4		Ice-cream		
5		Straw		
6	Carry bags	< 75 µ		
7	Plastic sheets	< 50 µ		
8	Cutlery items	Plates		
9		Cups		
10		Glasses		
11		Spoons		
12		Forks		
13		Stirrers		
14		Knives		
15		Trays		
16	Plastic wrapping and packaging films	Sweet Box		
17		Invitation cards		
18		Cigarette packets		
19	Others	Plastic flags		
20		PVC banners <100 µm		
21		Polystyrene for decorations		
	Total			

BOX3: SAMPLING IN CITIES WITH SEGREGATED WASTE COLLECTION

In cities where waste collection is being done separately i.e. dry and wet fraction is being collected separately, the following sampling procedure should be used:

- If mixed dry waste is being collected, then in that case select the vehicle of dry waste from each economic stratum. Reduce it to 100-125 kg by quartering and coning method.
- If all the dry waste is collected separately. That is, glass, cloth, rubber and leather, domestic hazardous, sanitary, plastic, E-waste etc. are collected separately, then in that case take 30-50 kg of plastic waste from each economic strata for quantification and characterisation.

(Note: If the agency is collecting dry waste from different localities each day, collect waste each day depending upon the economic strata of the locality. Ensure that each day waste from all different categories is collected for quantification and characterisation)

2.2.2 Market Survey for Use, Availability and Alternatives of Banned SUPs

The major objective of the Market survey is to understand the availability of banned SUP items and its alternatives within the municipal boundaries.

To capture the entire municipal area with diversity in location as well as the economic activity associated with the usage of SUP, it is important to have an indicative sample from different market areas within the municipal boundary. The stratified random sampling method provides flexibility to divide population into smaller groups with respect to the characteristic under the study, which helps in providing a representative sample and makes it less resource intensive and time consuming. A two-stage stratified random sampling here would help in dividing the market area within the municipal area into smaller groups and help in capturing the diversity in terms of location, so that the results are not bias by a survey at a particular market location in the city.

As a next step, the commercial areas in each zone is further divided into more specific categories such as restaurants, offices, shops and stores, and cinemas etc. A reference here is taken from UNESCAP suggested sampling method for commercial establishments, which suggests to select approximately 10 to 20 samples for each category. A predefined number for each category was finalised to have a comparable analysis from different locations and cities.

A check for total number of sample to be surveyed was also done based upon the statistical method to provide precision. The sample size was estimated based on a 90% confidence level and 10% error. This reflects a reasonable balance between resources and statistical integrity. This essentially means that the results will be accurate to within 10% percentages points, 90% of the time.

©SIA



Formula for calculating Sample Size

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where:
N = population size
e = Margin of error (percentage in decimal form)
z = z-score
z-score is calculated based on the confidence level. For 90% confidence level, z-score is 1.645

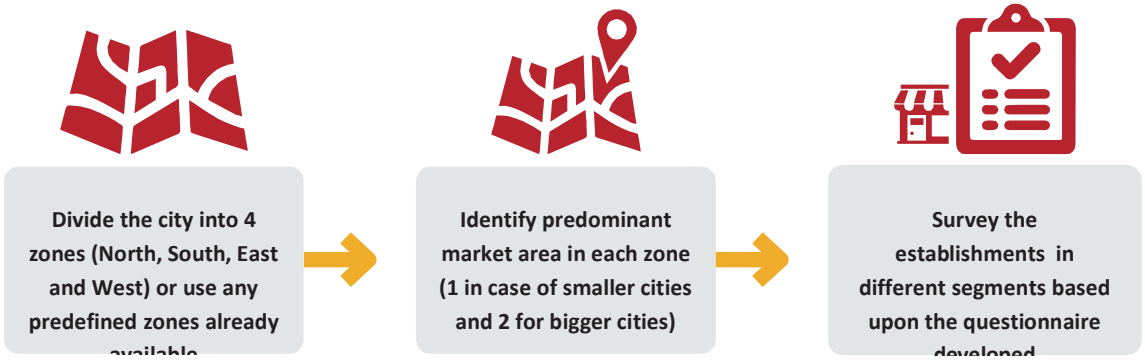
Through this formula the number of commercial establishments to be surveyed comes out to be 69 (sixty-nine). To meet the theoretical requirement, the actual sample size is kept on higher side to ensure that maximum category of economic activity involved in usage of banned SUP is included.

Therefore, it was decided to survey 125-150 commercial establishments in smaller cities and 250-300 commercial establishments in big cities.

(a). Sampling

A two-stage stratified random sampling method is used to capture the diversity in location and type of commercial establishment (economic activity) in the city.

Figure 5: Methodology for market survey



Step 1: Divide the city area into four zones, and identify the predominant commercial areas in each zone. In small cities (cities with up to 5 lakhs population), take one market area in each zone. For big cities (cities with population above 5 lakhs), take two market areas in each zone.

Step 2: In each commercial area, nine major types of commercial establishments where the maximum amount of SUP is likely to be sold should be identified. These establishments are: medical stores, restaurants and roadside eateries, paan shops, Ice-cream parlors/carts, vegetable, fish, chicken, and meat shops, printing shops, sweet shops, general stores and stationaries, toy shops, and decorative item stores.

Step 3: In each market area, 30-35 commercial establishments under these nine different segments should be selected randomly for conducting the survey. In smaller cities, about 120-150 commercial establishments are to be surveyed. In big cities, the number of establishments to be surveyed should be 250-300.

Table 4: Sample size

Sl. No.	Types of shops	Sample size
1	Medical stores	3
2	Restaurants and roadside eateries	7
3	Paan shops	2
4	Ice-cream vendors	3
5	Vegetable, fish, chicken and meat shops	5
6	Printing stores	2
7	Sweet shops	3
8	General stores and stationeries shops	5
9	Toy sellers and decorative item stores	5

Step 4: A structured questionnaire (*as given in Annexure 2*) should be used for quantifying the availability, sale, and use of each banned SUP product and its alternatives in these commercial establishments.

Step 5: Results

The results should be compiled as shown in Table 5 below.

Table 5: Availability of SUPs and its alternatives in the market

Sr. No.	SUP items (banned)		Number of samples surveyed	Number of samples selling SUPs	Number of samples selling alternatives	Number of samples selling both	Percentage of samples selling SUPs
1	Plastic sticks	Ear buds					
2		Balloon					
3		Candy					
4		Ice-cream					
5		Straw					
6	Carry bags	< 75 µ					
7	Plastic sheets	< 50 µ					
8	Cutlery items	Plates					
9		Cups					
10		Glasses					
11		Spoons					
12		Forks					
13		Knives					
14		Trays					
15	Plastic wrapping and packaging films	Sweet Box					
16		Invitation cards					
17		Cigarette packets					
18	Others	Plastic flags					
19		PVC banners <100 µm					
20		Polystyrene for decorations					
	Total for the city						

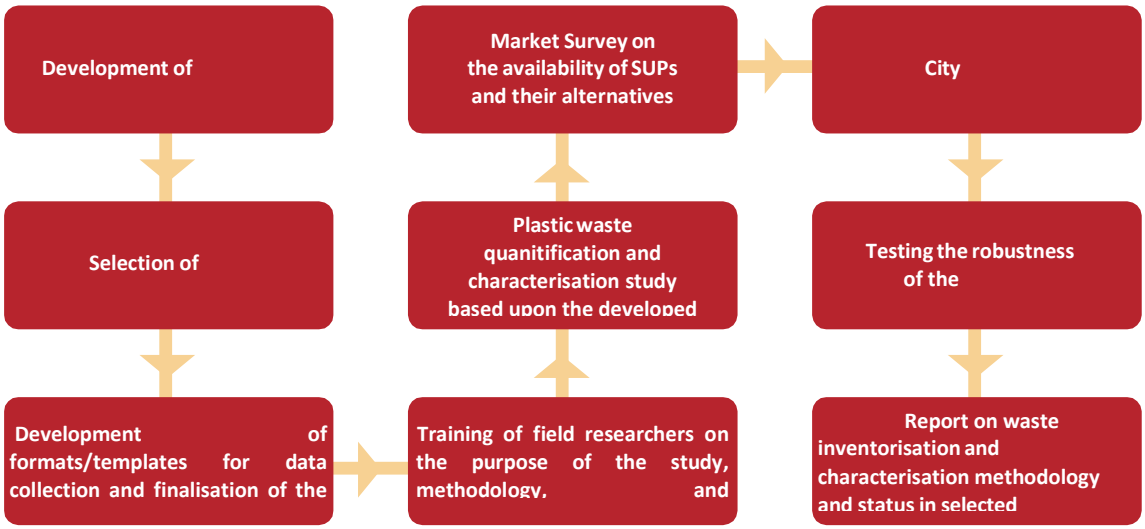
Note: Carry bags above 75 µ is allowed till 31 December, 2022 post this date carry bags thickness will be revised to 100 µ.

3. Study of 20 cities

3.1 Approach

A comprehensive study was conducted to test the methodology, and to find out its robustness and applicability on the ground. The approach used in the cities is shown in Figure 6.

Figure 6: Approach



The process followed for the study was as follows:

- Selection of cities
- Development of questionnaire and information collection forms
- Identification of city partners (organisations who are already working in the field of waste management in the cities) in each city to undertake the survey.
- Development of training toolkit: An online training and mock survey was done for each city partner to train them on data form, market survey and waste inventory.
- The sampling size, location and procedure was finalised in coordination with city partners.
- The SIA team travelled to cities for hand holding the city partners in waste inventory, and market surveys.
- Random data check (approximately 1/4th of the sample size) done by SIA team to authenticate the survey results.

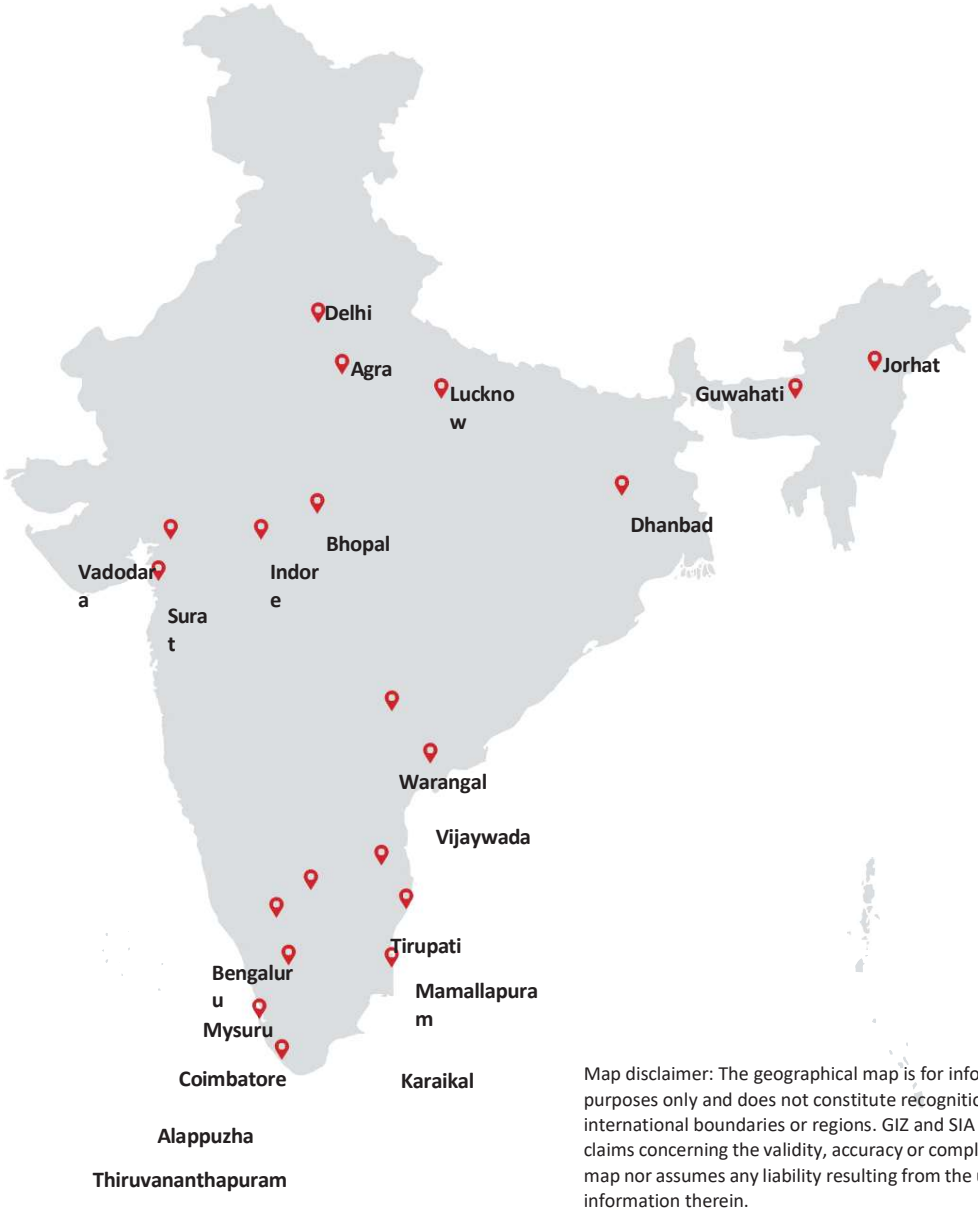
3.1.1 Selection of Cities

The study was done in 20 cities across 11 states, with diversity in location, population, waste generation quantity and current waste management practices. The selected cities are given in Table 6 and shown in MAP 1 below.

The selection of the 20 cities was done at three levels:

1. Stratification of the cities to ensure best representation of the country, and to best capture the diversity (hill, plain, tourist, capitals, etc.).
2. Stratification in terms of population, waste management practice, Swachh Sarvekshan ranking, and quantum of waste generation.
3. Lastly, cities with better waste data collection were selected to cross-check the inventory results and thus establish the robustness of the methodology.

Map 1: Cities selected for the survey



Map disclaimer: The geographical map is for informational purposes only and does not constitute recognition of international boundaries or regions. GIZ and SIA makes no claims concerning the validity, accuracy or completeness of the map nor assumes any liability resulting from the use of the information therein.

Table 6: Selected cities

North	South	East	West	Central	North East

1. Delhi • South Delhi Municipal Corporation 2. Uttar Pradesh • Agra • Lucknow	1. Karnataka • Mysuru • Bengaluru 2. Kerala • Alappuzha • Thiruvananthapuram 3. Andhra Pradesh • Tirupati • Vijayawada 4. Telangana • Warangal 5. Tamil Nadu • Coimbatore • Mamallapuram 6. Puducherry • Karaikal	1. Jharkhand • Dhanbad	1. Gujarat • Surat • Vadodara	1. Madhya Pradesh • Bhopal • Indore	1. Assam • Guwahati • Jorhat

(a). Diversity in location

The selected cities are from across the country. The cities are selected such that at least one state from each zone is represented. The maximum representation is from the Southern states due to several factors factors including availability of past inventory data, cooperation from ULBs and wider diversity in the classification of cities.

The cities represent the geographical diversity cities from coastal areas, plains, and hills. The cities also represent diversity in terms of religious, tourist, commercial and historical places.

(b). Diversity in population

The sample includes small cities such as Mamallapuram and large corporations with populations above five million like Bengaluru. The largest number of cities in the sample are in the population range of 1-5 million.

Table 6 (a): Diversity of cities based upon population range

City based on population				
0-100,000	100,000-500,000	500,000-1,000,000	1,000,000-5,000,000	5,000,000 above
Mamallapuram	Alappuzha	Thiruvananthapuram	Vijayawada	SDMC
Jorhat	Tirupati	Mysuru	Agra	Bengaluru
Karaikal		Guwahati	Bhopal	
			Indore	
			Lucknow	
			Dhanbad	
			Surat	
			Coimbatore	
			Warangal	
			Vadodara	

(c). Diversity in waste management practices

The list includes cities with both centralised and decentralised waste management systems. Some cities like Alappuzha perform well with excellent source segregation and home composting mechanisms, whereas other cities like Dhanbad and Jorhat do not practice source segregation. The list includes cities without landfill, and also cities which use information technology to effectively manage its waste such as Bengaluru. The list includes cities where the waste management is done by the municipality itself, and also cities where private companies and NGOs have been given the responsibility.

(d). Diversity in terms of Swachh Sarvekshan rankings

Cities from both above 10 lakh population and 1 to 10 lakh population are selected. Indore with rank number 1 and Guwahati with rank 310 shows a diversity of selection. There are also few municipal towns, namely Mamallapuram, which are not part of the Swachh Survekshan ranking.

Table 6 (b): Diversity of cities in terms of Swachh Sarvekshan ranking

Swachh Survekshan Ranking for cities with more than 10L population		Swachh Survekshan Ranking for cities with 1L-10L population			
1-10	11-50	1-100	101-200	201-300	301-400
Indore	Lucknow				Guwahati
Surat	Agra	Mysuru		Alappuzha	
Vijayawada	Dhanbad				Thiruvananthapuram
Bhopal	Bengaluru				
Vadodara	SDMC				
	Coimbatore				

(e). Diversity in quantum of waste generation

In terms of waste generation, cities represent a huge variation, Mamallapuram generates only about 6 tonnes/day, Bengaluru generates more than 6,000 tonnes/day.

Table 6 (c): Diversity of cities based upon quantum of waste generation

Cities based on waste generation (Metric tonnes per day)			
0-500	501-1,000	1,001-1,500	1,501 and above
Mamallapuram	Guwahati	Indore	SDMC
Jorhat	Bhopal	Lucknow	Bengaluru
Karaikal	Agra	Coimbatore	Surat
Alappuzha	Vijayawada		
Tirupati	Vadodara		
Mysuru	Dhanbad		
Warangal			
Thiruvananthapuram			

3.1.2 Development of Information Collection Form

A detailed information collection form was developed to collect all the basic information of current waste management scenarios in the city. The form included information on waste generation, collection, transportation and available infrastructure to manage the same. The information collection form was discussed and validated through discussions with the experts working in the waste management sector at national level. The information collection forms were put online, and for the market survey an online survey software was used.

3.1.3 Training Toolkit

A training toolkit was developed to facilitate and train the partners, their volunteers and sorters in different cities. This included a pictorial representation of the sorting facility, material requirements, a guide to identify different types of banned SUPs, and different plastic categories (*refer Annexure 3*).

An online training session was organised for every partner to familiarise them with the data collection form, daily entry sheet, and market survey form. This training included mock sessions and training videos.

3.1.4 Project Implementation

The implementation of the project in all 20 pilot cities across 11 states, took place from March to September, 2022. The city wise detail of inventory and market survey is as provided in the table 6 (d) below. The results and findings of the study are presented in the subsequent sections. The city wise details of inventory is presented in Annexure 5: Cities Case Files.

Table 6 (d): Diversity of cities in terms of Swachh Sarvekshan ranking

Sr No	City Name	Inventory Dates	Market survey month
1	Jorhat	7 to 11 April, 2022	April and May
2	Guwahati	7 to 10 May, 2022	April and May
3	Agra	13 to 17 May, 2022	April and May
4	Delhi	26 to 29 May, 2022	March and May
5	Dhanbad	26 to 30 June, 2022	April and May
6	Mamalapuram	1 to 5 July, 2022	June and July
7	Karaikal	4 to 8 July, 2022	June and July

Table 6 (d) continued

Sr No	City Name	Inventory Dates	Market survey month
8	Indore	7 to 12 May, 2022	April and May
9	Coimbatore	25 to 29 July, 2022	July
10	Bengaluru	30 May to 3 June, 2022	May and June
11	Mysuru	02 to 06 July, 2022	May and June
12	Vijayawada	03 to 07 July, 2022	June and July
13	Tirupati	30 June to 4 July, 2022	June and July
14	Warangal	30 June to 4 July, 2022	June and July
15	Lucknow	15 to 19 September, 2022	August and September
16	Bhopal	24 to 28 July, 2022	July and August
17	Trivandrum	21 to 25 June, 2022	April and May
18	Allappuzha	24 to 26 July, 2022	April and May
19	Surat	02 to 06 August, 2022	August and September
20	Vadodara	08 to 13 August, 2022	August and September

3.2 Results and Findings: Waste Inventory

3.2.1 Composition of Municipal Solid Waste (MSW)

The composition of the municipal waste in the pilot cities is presented below in Table 7 and Figure 7.

Table 7: Composition of Municipal solid waste of selected cities

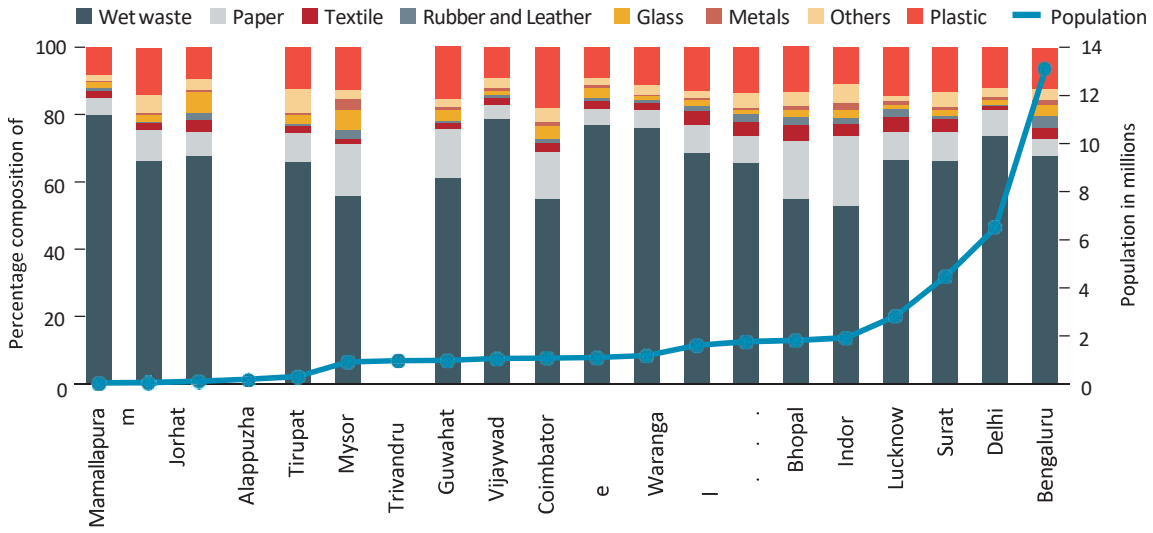
State	City	Wet Waste (%)	Dry Waste (%)							
			Paper	Textile and Leather	Rubber	Glass	Metals	Plastic	Others	Total
Assam	Guwahati	61.4	14.5	1.6	0.7	3.3	1	15.3	2.2	38.6
	Jorhat	66.3	9.3	2.1	0.1	2.1	0.8	13.7	5.3	33.7
Delhi (SDMC)	South Delhi Municipal Corporation	73.8	7.6	1.1	0.4	1.7	0.9	12	2.4	26.6
Uttar Pradesh	Agra	68.9	8.2	4	1.7	1.6	0.8	12.7	2.1	31.1
	Lucknow	66.6	8.4	4.3	2.4	1.4	0.9	14.4	1.6	33.4
Madhya Pradesh	Indore	53	20.7	3.6	1.8	2.25	2.25	10.8	5.6	47
	Bhopal	55	17.4	4.7	2.4	2.1	1	13.3	4.1	45
Jharkhand	Dhanbad	76	5.5	2	1	1	0.5	11	3	24
Tamil Nadu	Mamallapuram	80	5	2	1	1.7	0.3	8	2	20
	Coimbatore	55	14.1	2.7	1.1	3.8	1.3	17.9	4	45
Puducherry	Karaikal	67.7	7.3	3.7	1.9	6.3	0.6	9.1	3.3	32.3
Andhra Pradesh	Vijayawada	79	4	2	1	1	1	9	3	21
	Tirupati	66	8.6	2	0.7	2.8	0.6	12.3	7.1	34
Kerala	Thiruvananthapuram	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Alappuzha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Telangana	Warangal	77	5	2	1	3	1	9	2	23
Karnataka	Bengaluru	68	4.8	3.5	3.5	3.2	1.6	11.8	3.2	32
	Mysuru	56	15.4	1.4	2.8	5.8	3.3	12.6	2.5	44
Gujarat	Vadodara	65.6	8.2	3.9	2.6	1.3	0.6	13.4	4.4	35.4
	Surat	66.3	8.6	3.9	1.1	1.7	0.7	13.2	4.5	33.7

Notes: 1. All the values in the table are in percentage of the total MSW.

2. The composition could not be ascertained in Kerala because wet waste is not collected and different fractions of dry waste are

collected separately. The inventory study in Kerala was only done on plastic waste.

Figure 7: Municipal waste composition in selected cities

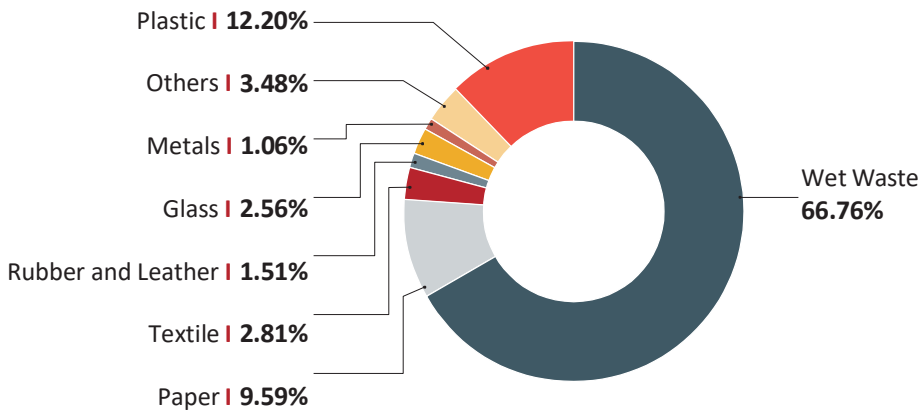


The range and average composition of municipal waste in the pilot cities is represented in Table 8.

Table 8: Average municipal waste composition in 20 cities

Component	Range (%)	Average (%)
Wet Waste	53-80	66.76
Dry Waste	20-47	33.36
Paper	4.8-20.7	9.59
Textile	1.1-4.7	2.81
Rubber and Leather	0.2-3.5	1.51
Glass	1-6.3	2.56
Metals	0.3-3.3	1.06
Others	2-5.6	3.48
Plastic	8-17	12.20

Figure 8: Average Municipal waste composition



(a). Wet Waste

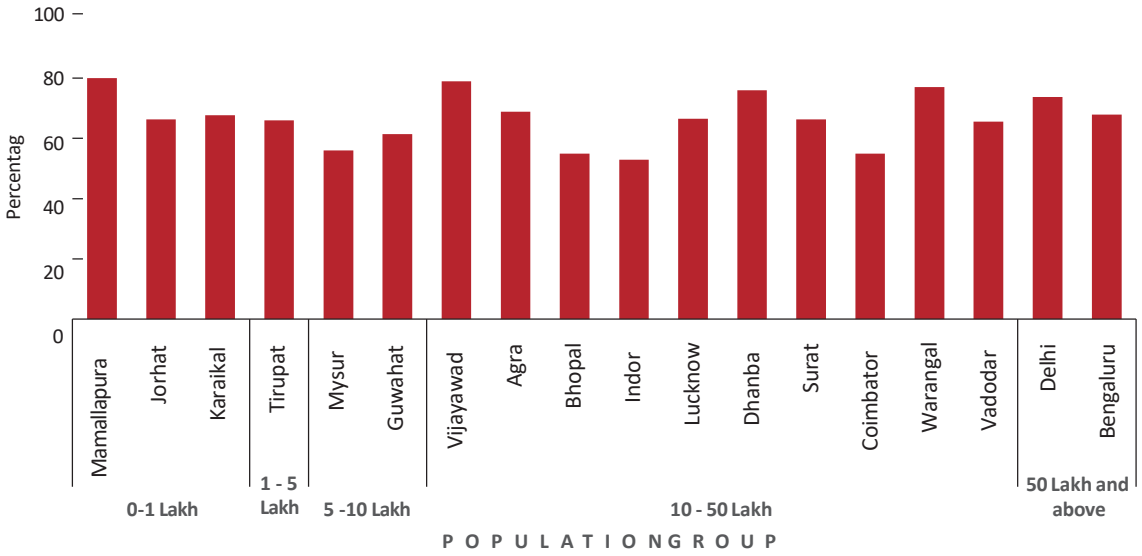
The percentage of wet waste in the total municipal waste in the cities lies between the range of 53% to 80%. Out of the cities surveyed, in 9 cities, namely, Guwahati, Tirupati, Jorhat, Karaikal, Bengaluru, Vadodara, Surat, Lucknow and Agra, the wet waste percentage lies in the range of 60% to 70%. In Five cities, namely, Delhi

(SDMC), Dhanbad, Warangal, Vijayawada, and Mamallapuram the wet waste are in the range of 70% to 80% of the total municipal waste. The wet waste component is less than 60% in four cities, namely, Bhopal, Coimbatore, Indore and Mysuru.

The highest percentage of wet waste was observed in Mamallapuram and Vijayawada at 80% and 79%, respectively. It can be observed that in these two cities, the contribution of paper to the waste stream is much lower than in other cities. It lies in the range of 4-5%, whereas in other cities, the average contribution of paper waste is around 9%. This is due to the the increase in usage of banana leaves as a packaging alternative to plastic. The contribution of plastic waste is also the least in these two cities, at 8% and 9%, respectively.

The cities with lowest wet waste content are Indore and Coimbatore, at 53% and 55%, respectively. The wet waste content in the municipal solid waste in various cities is depicted below in Figure 9.

Figure 9: Percentage of wet waste in municipal solid waste in different cities



(b). Dry Waste

The total dry waste content in the Municipal Solid Waste in the selected cities is given in Figure 10.

The percentage of dry waste in the total municipal waste in the cities lies in the range of 20% to 47%. Out of the cities surveyed, in four cities, namely Mamallapuram, Vijayawada, Warangal, and Dhanbad, the dry waste percentage was found to be below 25% . In ten cities, the dry waste percentage is in the range of 25% to 40%. The dry waste component is above 40% in four cities, namely, Bhopal, Coimbatore, Indore and Mysuru.

The highest percentage of dry waste content was observed in Indore at 47%, and in Bhopal and Coimbatore at 45%. In these three cities, the contribution of paper to the waste stream is much higher than in other cities, in the range of 14.1% to 20.7%, whereas in other cities the average contribution of paper waste is around 9%. In these three cities, it was observed that the percentage of samples selling alternatives was the highest; increase in usage of paper as an alternative (such as paper bags, envelops, cups, glasses, plates, straws, etc.) to SUPs could be one of the reasons for this trend.

An opposite trend can be observed in cities where dry waste percentage is low. In these cities, the paper content in the waste stream is found to be low. In the four cities with lowest dry waste percentage, the contribution of paper waste to the total waste was in the range 4 to 5.5 percent.

The dry waste content in the municipal solid waste in pilot cities is depicted below in Figure 10.

Figure 10: Percentage of dry waste in municipal solid waste in different cities



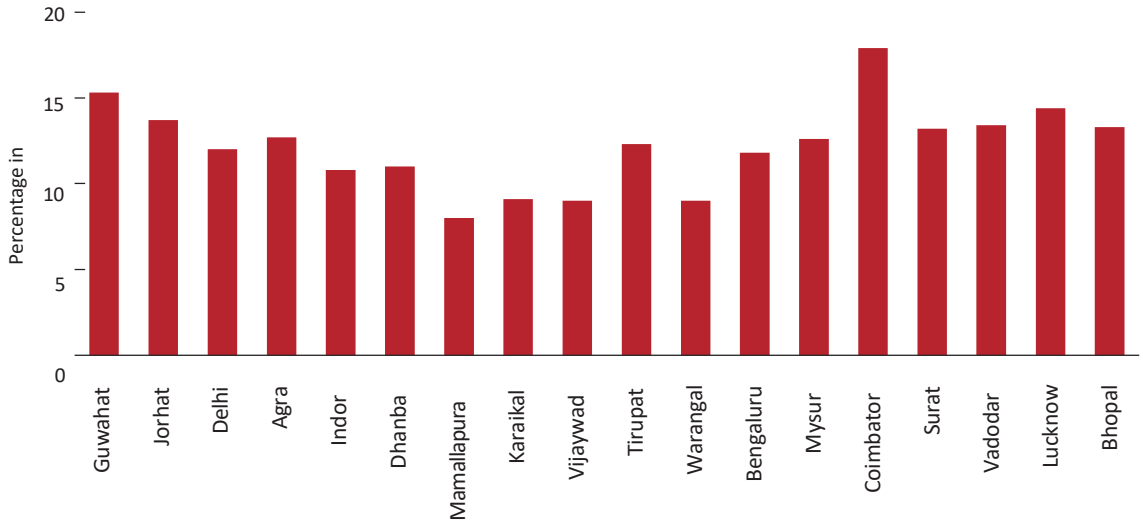
(c). Plastic waste

The average percentage of plastic waste in the total stream was observed to be around 12.2%. The plastic waste percentages in cities ranged from 8% to 17%. The percentage of plastic waste (including banned SUP products) was observed to be as follows in pilot cities:

- The highest percentage of plastics was observed in Coimbatore at 17.9%, followed by Guwahati and Jorhat at 15.3% and 13.7%, respectively.
- The lowest percentage of plastic waste was observed in Mamallapuram at 8% and Vijayawada and Warangal at 9%; Karaikal follows with a plastic component of 9.1%.

The percentage of plastics in the municipal solid waste of different cities are illustrated in Figure 11.

Figure 11: Plastic percentage in MSW of pilot cities.



3.2.2 Plastic Inventory

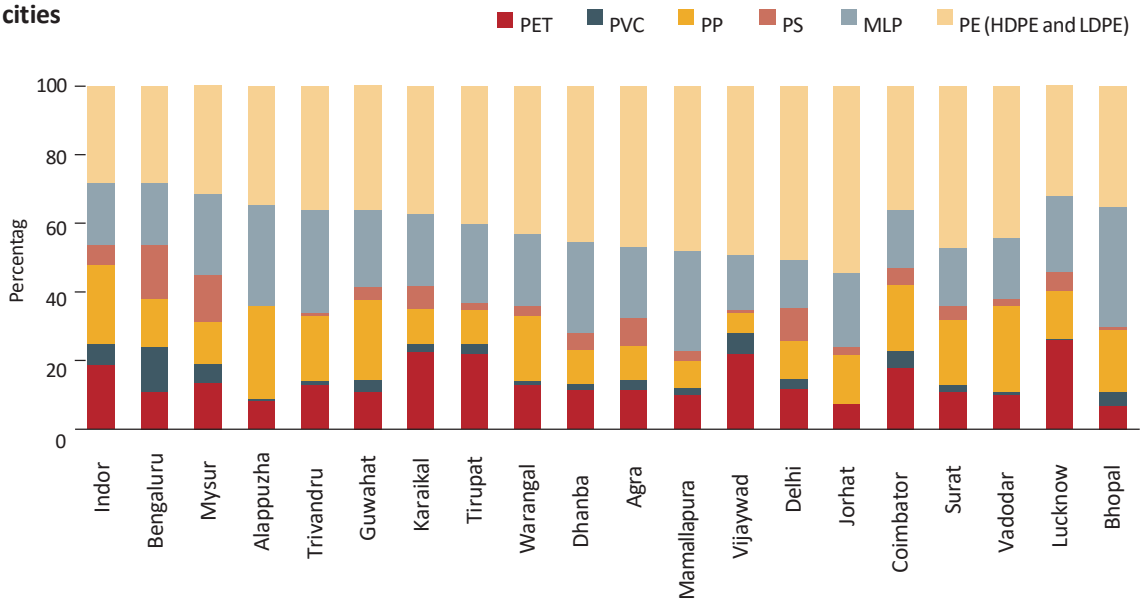
Plastics were inventoried into seven types as per the IS 14534:1998 guidelines. All the plastics items obtained in the samples were weighed to determine the composition of plastic waste. Plastic categorisation becomes extremely important because of the varying uses and recyclability of these materials. It also helps in developing plastic waste management systems, setting up infrastructure for recycling etc. The composition of different types of plastics in the pilot cities is given in Table 9 and Figure 12, and the average composition in Figure 13.

Table 9: Composition of plastic waste in pilot cities

City	PET	HDPE	LDPE	PVC	PP	PS	MLP
Guwahati	11	6.3	30	3.4	23.3	3.9	22.2
Jorhat	7.5	6.36	47.9	0	14.09	2.5	21.53
Delhi (SDMC)	11.9	7.2	43.3	2.8	11.2	9.5	14.1
Indore	19	16	11	6	23	6	18
Bhopal	7	12	22	4	18	1	35
Dhanbad	11.6	10.5	34.7	1.7	9.9	4.9	26.7
Agra	11.5	9.5	37.3	2.9	10.1	7.9	20.8
Lucknow	26	10	22	0.5	14	5.5	22
Mamallapuram	10	7	40	2	8	3	29
Coimbatore	18	19	17	5	19	5	17
Karaikal	22.4	8.2	29	2.5	10.3	6.6	21
Vijayawada	22	15	35	6	6	1	16
Tirupati	22	19	21	3	10	2	23
Trivandrum	13	12	24	1	19	1	30
Alappuzha	8.3	15.6	18.9	0.6	27.1	0	29.5
Warangal	13	9	35	1	19	3	21
Bengaluru	11	15	13	13	14	16	18
Mysore	13.5	16.8	14.6	5.6	12.4	13.7	23.4
Surat	11	10	37	2	19	4	17
Vadodara	10	10	34	1	25	2	18
AVERAGE	14.0	11.7	28.3	3.2	15.6	4.9	22.2

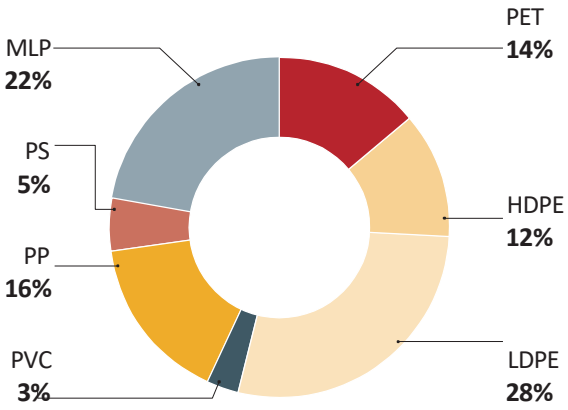
(Note: All the values in the table are in percentage of the total plastic waste in the cities)

Figure 12: Plastic composition in pilot cities



The average composition of plastic waste in pilot cities are depicted below.

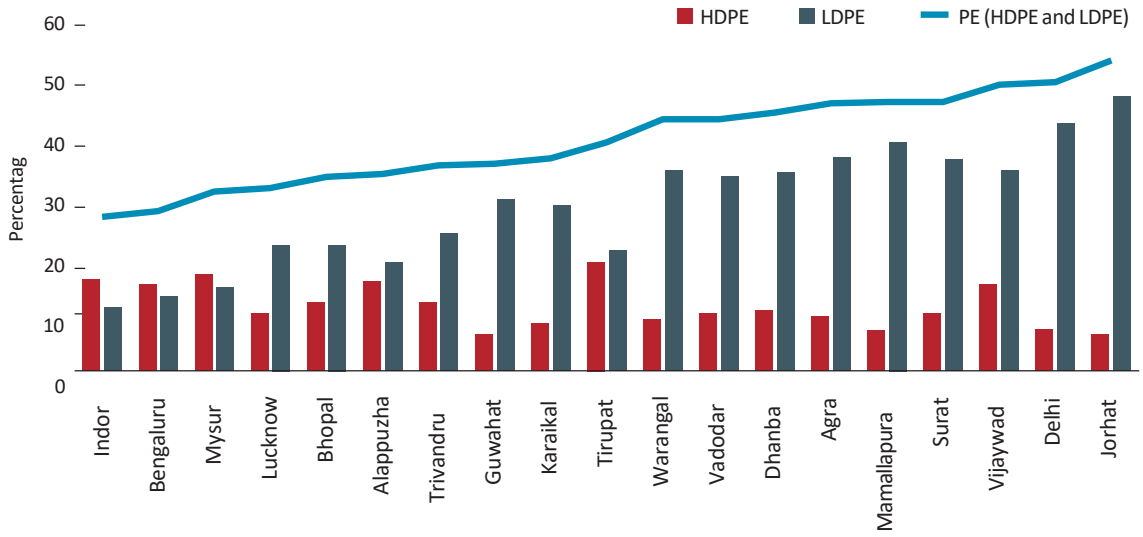
Figure 13: Average Plastic composition



(a). LDPE and HDPE

In all cities, PE (both HDPE and LDPE together) formed the largest component of plastic waste. On an average, PE accounted for about 40% of the total plastic waste, ranging from 27% (the least observed) in Indore to about 54.3% in Jorhat. In all cities, except in Indore (27%) and Bengaluru (28%), the proportion of PE in total plastic waste was higher than 30%. Of the 40% PE, LDPE makes up for the bigger share (approximately 28%), while HDPE accounts for about 12%. This high consumption of LDPE can be attributed to the daily usage of disposable milk packets, LDPE carry bags, and the increased use of LDPE in packaging materials especially by e-commerce companies. HDPE waste mostly consisted of hard packaging of FMCG goods like Shampoo bottles, Detergent and Laundry packaging and chocolate boxes, etc.

Figure 14: Percentage composition of PE in cities



(b). MLPs

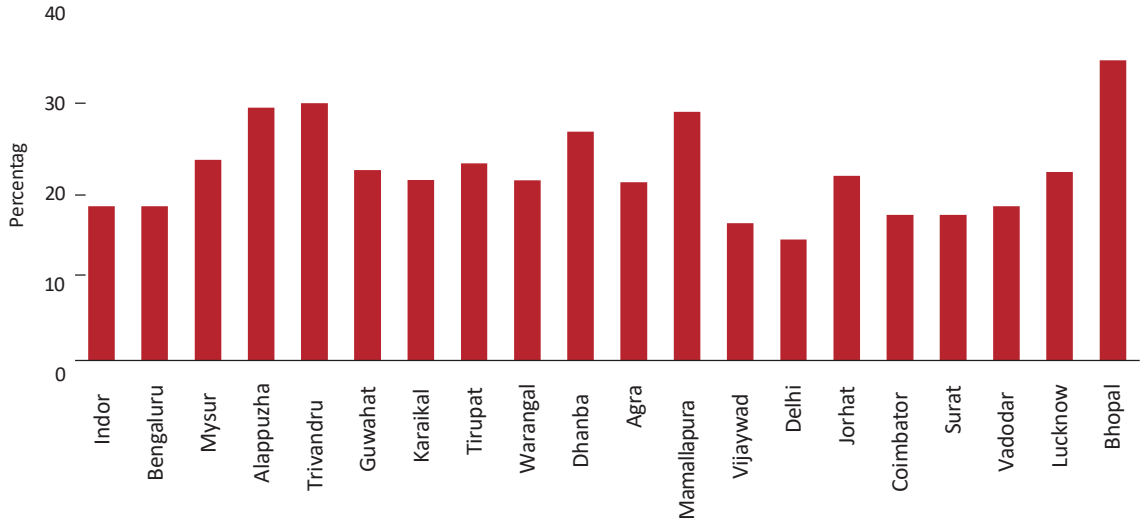
After PE, Multi-Layer Plastics (MLPs) are the largest contributors to plastic waste. It accounts for 22% of the total plastic waste. MLPs are the most widely used material in the packaging of almost all kinds of FMCG products. Almost all packaged goods ranging from chocolate wrappers, biscuits, snacks, shampoos, chips, groceries, etc. are packed using MLPs. MLPs are made by laminating several thin sheets of various materials like Aluminium, paper, plastic, etc. together to form a single wrapper. The separation of these materials for recycling is very difficult and requires advanced technologies, making MLPs one of the hardest materials to recycle. MLPs are the least recycled plastics across the world.

The proportion of MLPs in the waste stream in cities ranges from 14.1% in Delhi (SDMC) to 35% in Bhopal.

Out of the cities studied, the MLP percentage mostly ranged between 14% to 24%. About 15 cities lie in this range. In five cities, namely, Coimbatore, Dhanbad, Trivandrum, Alappuzha and Mamallapuram, the MLP

composition was between 25% to 35%.

Figure 15: Percentage of MLP in cities

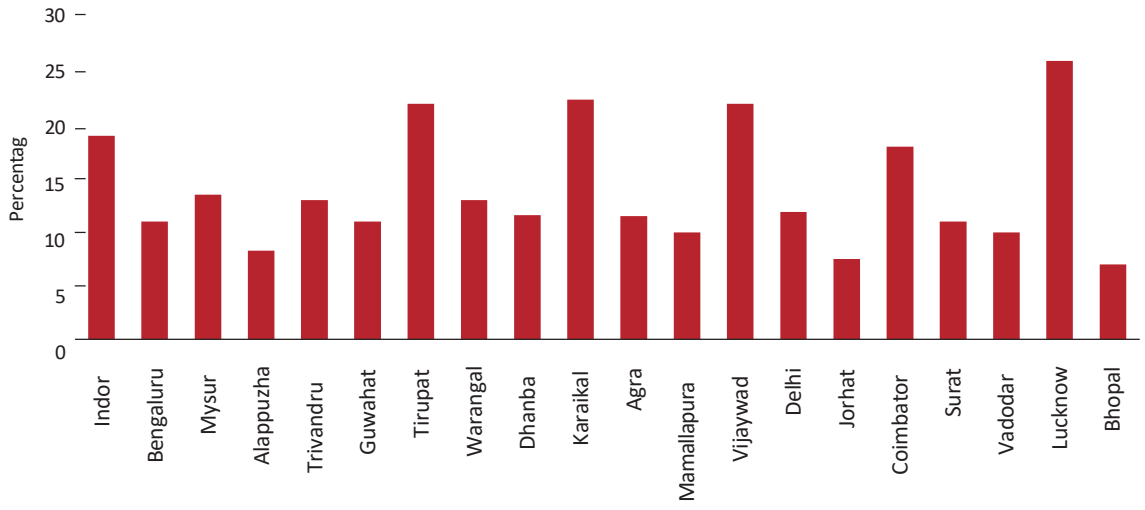


(c). Polyethylene Terephthalate (PET)

On an average, PET contributes about 14% of the total plastic waste in cities. The PET percentage varies from about 7% (observed in Bhopal) to 26% (in Lucknow). In Karaikal, the PET percentage was 22.4% of the total plastic waste. It should be noted that, due to an extraordinary circumstance, the PET percentage in Karaikal was higher than usual due to the spread of Cholera epidemic. This led to a sudden surge in the sale and use of PET bottles due to high consumption of packaged drinking water, coconut water, etc. A 22% contribution by PET to the total waste stream was also observed in Vijayawada and Tirupati. Even in Indore and Coimbatore, the proportion of PET in total plastic waste was about 19% and 18%, respectively.

In all other cities, the PET percentage was in the range of 7% to 14%. The percentage of PET in different cities is presented below in Figure 16.

Figure 16: Percentage of PET in selected cities

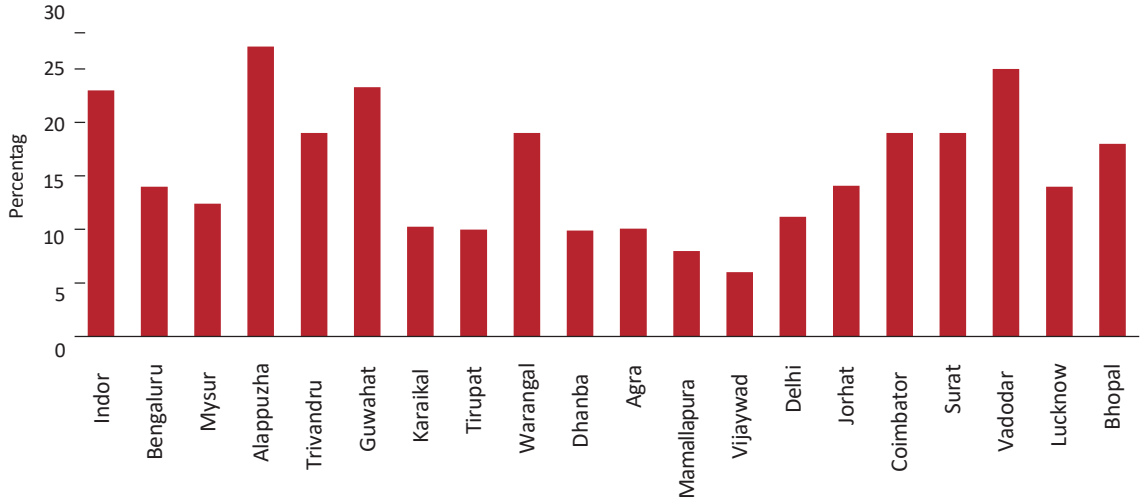


(d). Polypropylene (PP)

On an average, Polypropylene (PP) made up about 15.6% of the total plastic waste. The contribution of PP to the total plastic waste stream lies between 6% to 27.1%. The lowest proportion of PP in the plastic waste stream was observed in Vijayawada, whereas the highest was observed in Alappuzha (27.1%). Due to its high strength, resilience to wear and tear, sun, water, and bacteria, PP is used widely in the manufacturing of plastic goods as well as in packaging. It is used for manufacturing items like utensils, houseware like boxes, buckets, toys, rigid packaging, and also in certain kinds of flexible packaging. Most items made of PP are designed for long-term

use. The recyclability of PP is also high. In 11 cities out of 20, the percentage of PP in the total plastic waste was between 14% to 27.1%.

Figure 17: PP percentage in different cities

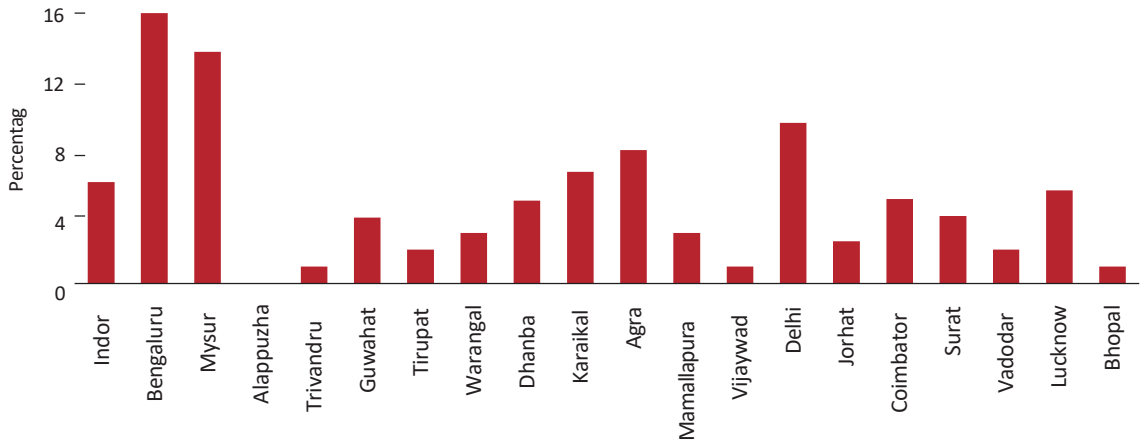


(e). Poly-Styrene (PS)

Polystyrene is a versatile form of plastic used for making hard plastic products as well as lightweight plastic products. Expanded Polystyrene (EPS) is a lightweight foam type material, used for manufacturing packaging materials for appliance insulation, food service, and packaging crockery and cutlery, automobile parts, etc. On average, PS was 5% of the total plastic waste in the pilot cities. The proportion of PS varied widely. It ranges from less than 1% in Alappuzha to about 16% in Bengaluru. In Mysuru also, the percentage of PS in the total plastic waste was 13.7%. The next highest proportion of PS in plastic waste was observed in Delhi (SDMC), with 9.5%. In most cities, PS in the waste stream was observed in the form of disposable plates, cups, and insulation packaging. The PS content was observed to be high in samples of waste collected from commercial areas.

Certain cities like Alappuzha, Vijayawada, Thiruvananthapuram, Tirupati, Warangal, and Mamallapuram has very little proportion of PS, i.e., less than 3%, in the plastic waste stream. The city-wise percentage of PS in the total plastic waste is presented in Figure 18 below.

Figure 18: PS percentage in MSW



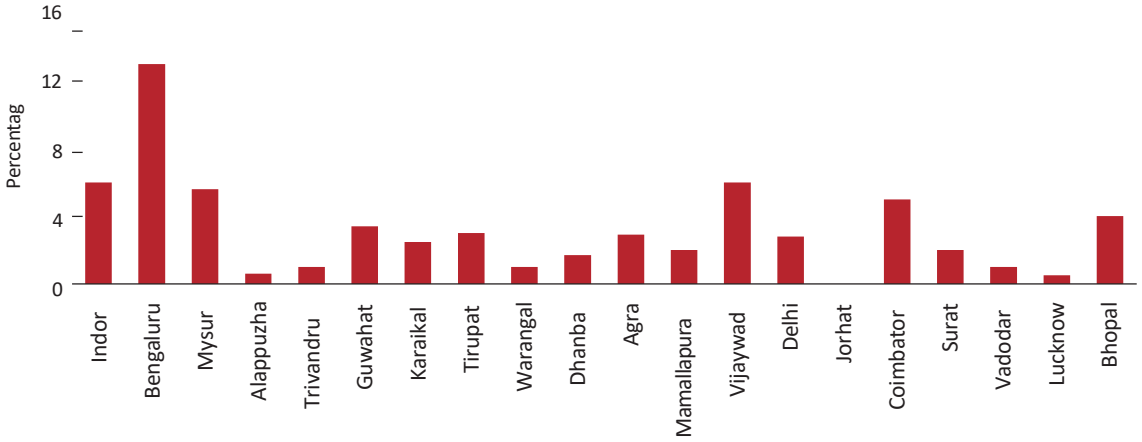
Note: In Alappuzha the negligible per cent is also because most of the PS item is handed over with paper, which is collected separately.

(f). Poly-Vinyl Chloride (PVC)

PVC is mostly used in construction and building materials like pipes, plumbing materials, windows, etc., and also in the packaging of certain edible items like dairy products, beverages, etc. The percentage of PVC in the waste stream was around 3.2%. The proportion of PVC in the total plastic waste during the inventory study, ranged

from negligible in Jorhat (less than 1%), to about 13% in Bengaluru. In most cities, it was less than 6% of the total plastic waste.

Figure 19: PVC percentage in MSW



3.2.3 Banned SUP Products

The banned Single-Use Plastic Products (SUPs) by MoEFCC is categorised into six major types for the purpose of the inventory study. They are Plastic sticks, Carry bags, Plastic sheets, Cutlery, Wrappings and Films, and Others.

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers.
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

As explained above, the average percentage plastic in the total municipal solid waste is about 12.2%. Of the total plastic waste, banned SUPs accounted for about 20%. In other words, on an average, banned SUPs account for about 2.4% of the total municipal waste (by weight).

The proportion of banned SUPs in pilot cities ranges from 5% to about 45% of the total plastic waste. In Coimbatore, the percentage of banned SUPs in total plastics was found to be least (only 5.1%), indicating very less usage of banned SUPs in the city. However, in three cities, Delhi (SDMC), Jorhat and Guwahati, the banned SUPs account for more than 30% of total plastic waste. In Jorhat, the proportion of banned SUPs to the total plastics is exceptionally high, accounting for 45.6% of the total plastic waste generated in the city. The percentage of banned SUPs in total plastic waste are depicted in Table 10 and Figure 20 below.

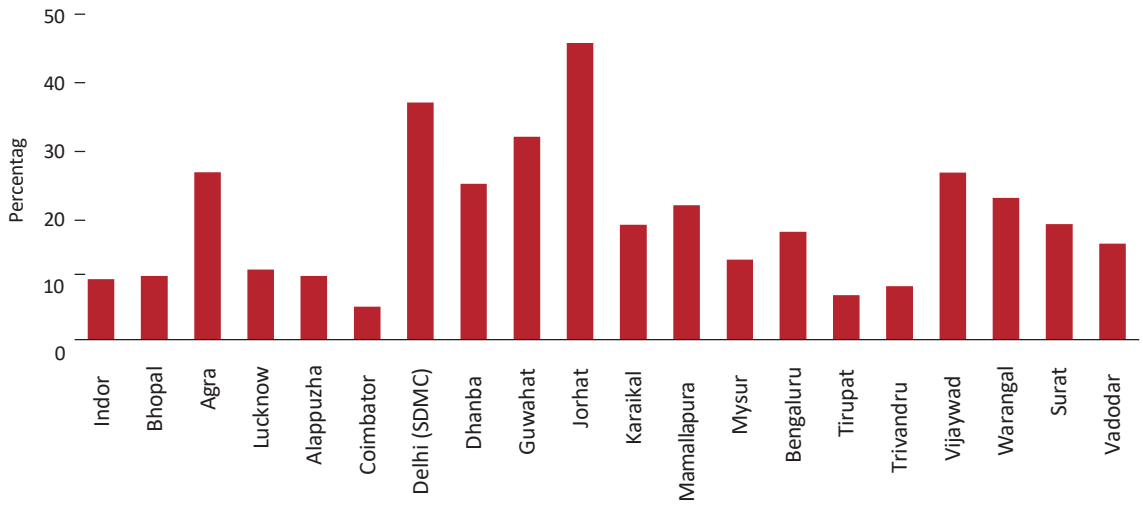
Table 10: Percentage of Banned SUPs in Total Plastic waste

Population group	City	Percentage of Banned Sups in total Plastic waste (%)	Average (population group wise)
0-100,000	Mamallapuram	20.66	27.96
	Jorhat	45.56	
	Karaikal	17.65	
100,000-500,000	Alappuzha	9.78	8.33
	Tirupati	6.88	
500,000-1,000,000	Thiruvananthapuram	8.23	17.24
	Mysuru	12.32	
	Guwahati	31.18	

Table 10 continued

Population group	City	Percentage of Banned Sups in total Plastic waste (%)	Average (population group wise)
1,000,000-5,000,000	Vijayawada	25.65	15.45
	Agra	25.73	
	Indore	9.31	
	Bhopal	9.79	
	Dhanbad	23.92	
	Lucknow	10.76	
	Warangal	21.78	
	Surat	7.75	
	Vadodara	14.77	
	Coimbatore	5.08	
5,000,000 above	Delhi (SDMC)	36.39	26.47
	Bengaluru	16.54	

Figure 20: Proportion of Banned SUPs in total plastic waste



(a). Composition of Banned SUPs

Plastic carry bags formed the largest portion of banned SUPs in almost all cities. It accounts for about 80% (by weight) of the total banned SUPs.

- The percentage of carry bags in total banned SUPs ranged from 14% in Bengaluru to 98% in Alappuzha. In Bengaluru the percentage of cutlery was much higher.
- Cutlery items, i.e., Spoons, Forks, Plates, Trays and Knives, formed the next largest proportion of banned SUPs in almost all cities. The average percentage of cutlery items in total banned SUPs is around 12%. The proportion of cutlery items varies in the range of 2% to 38%, depending on the usage in different cities. In Alappuzha, the usage of cutlery items was observed to be very minimal. Here, cutlery items contribute only 1.8% of the total banned items. The highest contribution of cutlery items to banned SUPs was observed in Indore and Bengaluru, with 37.8% and 30.5%, respectively.
- On average, Plastic sheets below 50 microns, contribute to about 3% of the total banned SUPs in different cities. The highest use of plastic sheets was noted in Vijayawada with a percentage of almost 38%, almost equal to the percentage of carry bags. It was observed that in Vijayawada, plastic sheets were being used in the packaging of food for takeaway in small eating joints, packaging of sweets, and baked goods, in sweet shops, bakeries, etc. In Bengaluru, the proportion of plastic sheets was observed to be 5.7%. In thirteen cities, the proportion

of

Table 10 continued

plastic sheets to the total waste was less than 1%, and no significant amount of plastic sheets with a thickness of less than 50 microns could be obtained during the inventory. These cities include Guwahati, Jorhat, Delhi (SDMC), Agra, Lucknow, Dhanbad, Mamallapuram, Karaikal, Thiruvananthapuram, Alappuzha, Warangal, Surat and Vadodara.

- On an average, plastic sticks contributed about 2% of the total waste generated by banned SUPs. Plastic sticks included earbuds, balloon sticks, candy sticks, ice-cream sticks, straws, and stirrers, however, straws, contributed the most under this category. Especially in samples from commercial areas which housed roadside juice shops, a significant amount of straws could be obtained. In most cities, earbuds, candy sticks, and balloon sticks were found in very small quantities. Plastic Ice cream stick was not observed in most cities. The highest proportion of plastic sticks was found in Bengaluru, about 16% of the total banned SUPs. Here, straws and balloon sticks formed the largest proportion. In Bhopal, Mysuru and Vijayawada, the proportion of plastic sticks was around 4% of the total weight of banned SUPs. In the rest of the cities, the proportion of plastic sheets was less than 2% of the total SUPs.
- Wrappings/films on sweet boxes, invitation cards, and cigarette packets contributed to about 1.1% of the total waste generated by banned SUPs. It is to be noted that small quantities of wrappings/films were obtained in all the cities. It was observed that the wrapping on sweet boxes and on cigarette films mainly contributed to this portion of the waste. Wrappings/films on invitation cards were observed in very small quantities. In almost all the cities, except in Mysuru and Bengaluru, where the percentages were 3.4% and 13.4%, respectively, the proportions of plastic films in the total waste was between 1%-2%. In Bengaluru, wrapping films on sweet boxes and invitation cards were obtained in slightly larger quantities.
- Plastic flags, PVC banners, and Thermocol decorations were categorised into the "others" category. They contributed to about 2.1% of the weight of total banned SUP products. The highest proportion was observed in Bengaluru and Mysuru, with a percentage of 19.6% and 8.6%, respectively. In Bengaluru, PVC banners and plastic flags used in political rallies mainly contributed to this weight. In Mysuru, certain amounts of thermocol decorations, and PVC banners with a thickness of less than 100 microns was observed in the sample during inventory. It must also be noted here that the weight of PVC banners is significantly higher than the weight of most banned SUPs. In all other cities, the proportion of 'others' category was between 0 to 3%. In cities, where the study was conducted in the months of April, May, and June, the percentage of flags and flag sticks in the waste stream was almost nil because of the seasonal nature of these products. However, in cities where the Inventory was conducted during the end of July and in early August, a small proportion of flags and flag sticks could be observed.
- The percentages of all banned SUPs are given below in Table 11 and Figure 21.

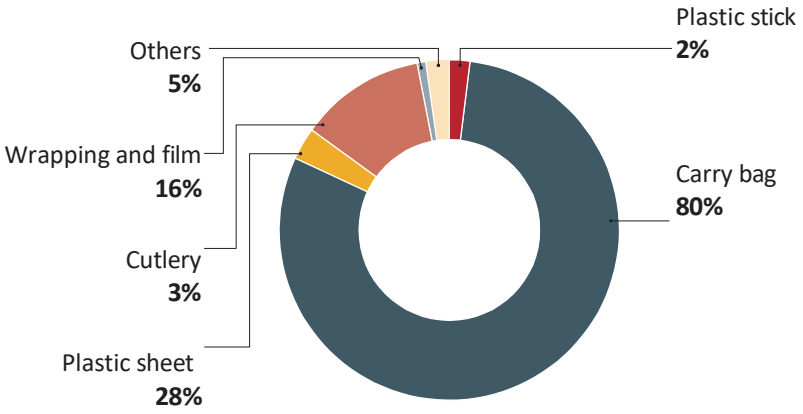
Table 11: Composition of banned SUPs in cities

Banned SUP	Plastic stick	Carry bag	Plastic sheet	Cutlery	Wrapping and film	Others
Guwahati	0.32	76.18	0	23.45	0.05	0
Jorhat	1.6	92.9	0	5.3	0.1	0
Delhi (SDMC)	0.29	92.53	0	7.09	0.09	0
Agra	0.46	85.68	0	13.67	0.18	0
Lucknow	0.35	93.42	0.05	5.11	0.5	0.56
Indore	0.6	56.1	1.5	37.8	1.6	2.3
Bhopal	3.43	84.28	1.2	9.23	0.26	1.6
Dhanbad	0.24	92.35	0.06	7.09	0.1	0.16
Mamallapuram	1.96	85.02	0.02	12.9	0.1	0
Coimbatore	0.435	93.358	2.121	3.852	0.125	0.109
Karaikal	1.48	89.43	0.08	7.58	0.12	1.32
Vijayawada	4.21	37.54	37.93	16.04	0.79	3.48

Banned SUP	Plastic stick	Carry bag	Plastic sheet	Cutlery	Wrapping and film	Others
Tirupati	0.22	95.27	1.44	2.62	0.18	0.27
Trivandrum	0.86	92.28	0	3.55	0.49	2.82
Allapuzha	0.12	98.11	0	1.77	0	0
Warangal	1.13	88.16	0	10.01	0.17	0.54
Bengaluru	16.34	14.43	5.74	30.45	13.44	19.59
Mysore	3.39	57.93	3.04	23.62	3.42	8.6
Surat	1.57	85.91	0.4	10.78	0.12	1.22
Vadodara	1.46	87.86	0.27	9.9	0.11	0.4
Average	2.02	79.94	2.69	12.09	1.1	2.15

(Note: All the values in the table are in percentage of the total banned SUPs in the cities)

Figure 21: Average composition of banned SUPs



Overall, carry bags and cutlery items accounted for 90% of the banned SUPs in the waste stream. The other banned items were less than 10% (by weight).

3.3 Results and Findings: SUPs in the Market

In 20 surveyed cities, 137 markets were surveyed to assess the sales of SUPs and availability of alternatives.

(a). City-wise status

The city-wise result of the market survey is given in Table 12 below.

Table 12: City-wise sales of SUP products

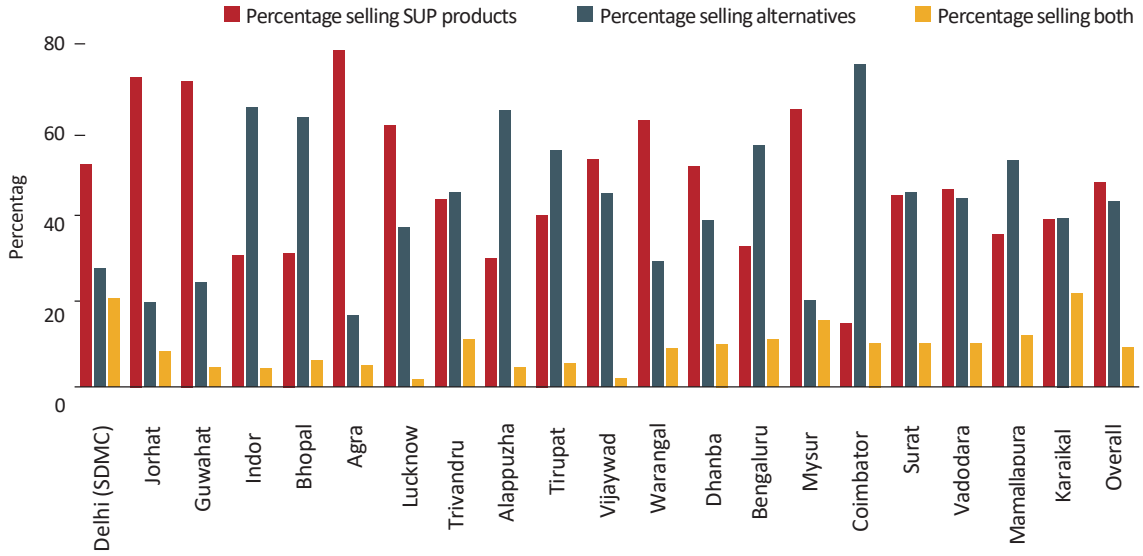
City selling	Percentage of sample selling only SUPs	Percentage of sample only alternatives	Percentage selling both	Overall percentage of sample selling SUP
Delhi (SDMC)	52%	28%	21%	72%
Jorhat	72%	20%	8%	80%
Guwahati	71%	24%	4%	76%
Indore	31%	65%	4%	35%
Bhopal	31%	63%	6%	37%
Agra	78%	17%	5%	83%
Lucknow	61%	37%	2%	63%
Thiruvananthapuram	44%	45%	11%	55%
Alappuzha	30%	65%	5%	35%
Tirupathi	40%	55%	5%	45%
Vijayawada	53%	45%	2%	55%
Warangal	62%	29%	9%	71%
Dhanbad	51%	39%	10%	61%
Bangalore	33%	56%	11%	44%
Mysuru	65%	20%	15%	80%
Coimbatore	15%	75%	10%	25%
Surat	45%	45%	10%	55%
Vadodara	46%	44%	10%	56%
Mamallapuram	35%	53%	12%	47%
Karaikal	39%	39%	22%	61%
Overall (Average)	48%	43%	9%	57%

Note: One sample means one shop and one product category matrix. For example, one medical shop selling five types of SUPs will be equal to five samples.

On an average, 57% samples surveyed in 20 cities were still selling or using the banned SUPs. Out of this, only 48% sold SUP products, while 9% sold both SUP and alternatives. It was also found that 43% of the samples sold only alternatives to SUPs.

- The percentage of samples selling only SUP products in the pilot cities ranged from 15% to 78%. The highest percentage of samples selling/using banned SUPs was observed in Agra, Uttar Pradesh. Here, 78% of the samples still sold/used only SUP products. The lowest percentage was observed in Coimbatore (15%). After Coimbatore, Alappuzha had the lowest percentage, with only 30% of samples selling SUPs. In Indore, Bhopal, Bengaluru, Mamallapuram, and Karaikal, the percentage of samples selling SUPs was in the range of 31-39%. In Tirupati, Surat, Vadodara and Thiruvananthapuram the percentage of samples selling SUPs was in the range 40% to 46%. In Delhi (SDMC), Dhanbad, and Vijayawada, the percentage of samples selling SUPs ranged between 50% to 55%. In Lucknow, Warangal and Mysuru, more than 60% samples sold SUPs. More than 70% of samples sold SUP products in Jorhat, Guwahati, and Agra.
- The percentage of samples selling only alternatives to SUPs varied between 17% and 75%. The highest percentage of alternatives to SUPs was observed in Coimbatore and Alappuzha, while the lowest percentage was in Agra. Overall, in 7 cities Indore, Tirupati, Bhopal, Bengaluru, Mamallapuram, Coimbatore and Alappuzha the proportion of samples selling only alternative products was higher than 50%. In Agra, Jorhat and Mysuru the percentage of samples selling alternatives was 20% or below.

Figure 22: City wise scenario of sales/availability of banned SUPs



Overall, just before and after the bans were enforced, SUPs were being sold/used widely in the market. Close to 60% of all the samples were selling SUPs. Here, the highlight is that 43% of the samples were also selling/using the alternatives.

(b). Product-wise status

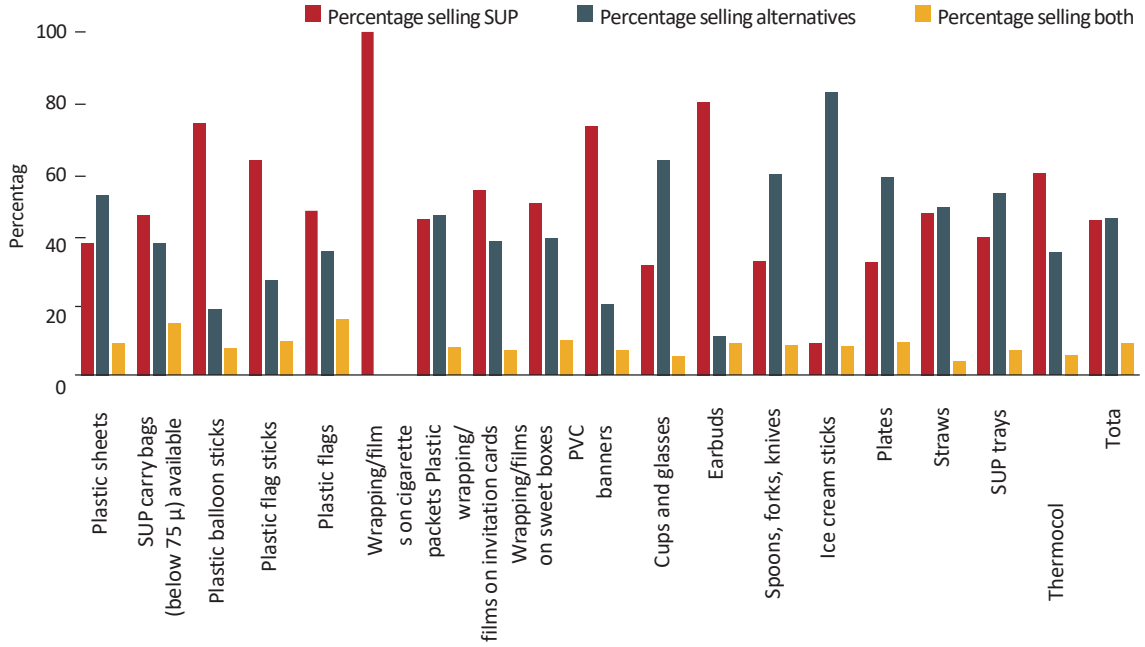
From the survey, it is noted that alternatives are available for almost all banned SUPs. Other than films on cigarette packets, alternatives are also sold in the market in varying degree. Table 13 and Figure 23 provide the product-wise sales on SUPs and the availability of its alternatives in 20 selected cities.

Table 13: Product-wise sales of SUPs and alternatives in pilot cities

Banned SUP items	Percentage selling only SUPs	Percentage selling only alternatives	Percentage selling both	Total percentage selling SUPs
Ice cream sticks	9%	82%	8%	17%
Cups and glasses	32%	63%	5%	37%
Spoons, forks, knives	33%	59%	9%	42%
Plates	33%	58%	10%	43%
SUP trays	40%	53%	7%	47%
Plastic sheets	39%	52%	9%	48%
Straws	47%	49%	4%	51%
Plastic wrapping/films on invitation cards	45%	47%	8%	53%
PVC banners below 100 µ	50%	40%	10%	60%
Wrapping/films on sweet boxes	54%	39%	7%	61%
SUP carry bags (below 75 µ) available	47%	38%	15%	62%
Plastic flags	48%	36%	16%	64%
Thermocol decorative	59%	36%	6%	65%
Plastic flag sticks	63%	28%	10%	73%
SUP candy sticks	73%	21%	7%	80%
Plastic balloon sticks	73%	19%	8%	81%
Earbuds	80%	11%	9%	89%
Wrapping/films on cigarette packets	100%	0%	0%	100%

Total	45%	46%	9%	54%

Figure 23: Banned SUPs in the markets of 20 selected cities



The results clearly highlights that for SUP products such as Ice cream sticks and cutlery (cups, glasses, Spoons, forks, knives, plates and trays), alternatives are being widely sold/used. For SUP items like plastic balloon sticks, flag sticks, candy sticks and earbuds though alternatives are available, the usage is still on the lower side.

The market survey indicates that alternatives are slowly emerging to replace banned SUPs. The product wise list of alternatives being widely sold is given in Table 14 below.

Table 14: Alternatives available for banned SUP items

Banned SUP items	Alternatives
Plastic sheets	Paper sheets, Aluminium sheets, Aluminium foils, Banana leaves
Plastic carry bags (<75 µ)	Paper bags, Cloth bags, Reusable plastic bags, Non-woven carry bags, Handy-craft bags.
Plastic balloon sticks	Rubber balloon sticks, Wooden sticks, Yarn and Thread
Plastic flag sticks	Wooden sticks, Rubber sticks, Paper sticks
Plastic flags	Metal flags, Paper flags, cloth flags
Plastic films on cigarette packets	Nil
Plastic films on invitation cards	Paper cards without films, Paper envelopes
Plastic films on sweet boxes	Cardboard boxes, Hard plastic containers
PVC banners (<100 µ)	Above 230 GSM, Cloth banners
Plastic candy sticks	Wooden sticks
Plastic cups and glasses	Steel crockery, Glass crockery. Paper crockery, ceramicware, Earthen clay cups and glasses, Sugar bagasse crockery, Areca-nut disposable crockery, Sal leaf cups
Plastic earbuds	Wooden earbuds, Bamboo earbuds, Reusable steel earbuds
Plastic spoons, forks and knives	Steel cutlery, Wooden disposable cutlery, Aluminium cutlery
Plastic ice-cream sticks	Wooden sticks
Plastic plates	Paper plates, Steel plates, Hard ceramic plates, Hard plastic plates, Wooden plates, Banana Leaves, Earthen clay plates, pattal
Plastic straws	Paper straws, edible wafer straw
Plastic trays	Aluminum trays, Cardboard box trays

Thermocol decorative items	Paper décor, Inflatable balloon décor, tissue paper décor

3.4 Robustness of Methodology

One of the major objective of this study was to develop a statistically robust methodology. To test the robustness, a two-step check was used:

1. Selection of cities with a wide diversity in population and waste distribution.
2. Standard deviation was used to check the outliers within the city data from each day, and compared separately for residential, commercial and dumpsites.

The methodology was tested in different cities with wide diversity and was able to adopt and accommodate the variations to provide consistent and efficient results. The results obtained from this methodology was compared with the visible analysis of the waste received on ground and was found to represent the actual scenario. Further, the methodology was able to capture the data set in all condition without any replicability issues in various conditions.

The Standard Deviation (SD) is a single number that summarises the variability in a data set, thus simplifying the interpretation. It is useful in capturing both the variability and the uniformity at the same time from a given data set, and thus a good and easy indicator for analysing the data set. A smaller value of SD indicates that the values in the data set are relatively consistent and a higher value signifies higher variability and spread.

In the cities:

- The SD of the composition of waste during elaborate five days of the sampling period in all cities was less than 10%. As the composition of the waste did not show a huge variation on a daily basis, this means the sampling procedure is robust.
- The waste composition variability was also low, which means the data capturing template and procedure is robust.
- The variability in samples from residential, commercial and mixed use was less than 10%.

Overall, the on ground usability of the methodology was tested in 20 cities and was ascertained by its ability to capture consistent and reliable data set, which was also tested by the SD values indicates that the methodology is robust. (The low SD values for city-wise, product-wise and economic activity-wise for cities of varying population and waste composition indicates the ability of the methodology to be replicated in various condition and also capture consistent and reliable data set).

BOX4: GOOD PRACTICES IN PLASTIC WASTE AND SUP MANAGEMENT

During the course of implementation of the study, efforts were made to understand how some of the Indian cities fared better than other cities in implementing the SUP ban. This box highlights some of the practices observed during the study, which can be replicated in other cities.

1. Indore

Importance of awareness and communication and availability of alternatives

Indore is ranked as the cleanest city of the country for the past five times in a row as per the Swachh Survekshan survey, conducted by the Ministry of Housing and Urban Affairs (MoHUA). The city was able to bring in behavioral change at the mass level for source segregation by an intensive awareness and communication strategy. To ensure that the SUP ban is effectively implemented in the city, the city administration has followed the same process of involving citizens through effective awareness and communication drives on SUP availability in the market followed by a robust monitoring system.

The major problem of generation of plastic waste is being tackled at the initial stage by reducing the availability of plastic products and increasing access to sustainable alternatives. The Indore Municipal Corporation has successfully launched vigorous campaigns to make the city plastic-free.

Some of the campaigns which has helped the city are as follows:

i). Setting up of the Jhola (cloth bag) banks at different market places in the city, where people get reusable cloth bags and paper bags at a minimal price. One can use the cloth bags a number of times and then exchange the same with a new one at the Jhola bank.

Box 4 continued

ii). Identified city markets were targeted and a large number of alternatives were introduced in the market with the help of school children and residents. The school students were engaged in making paper envelopes and residents were engaged in making cloth bags from old clothes which were distributed among the shopkeepers for use.

iii). The campaign has been extended to a few selected religious institutions, where shopkeepers at these establishments have been involved in eliminating the usage of SUPs from the premises. The same will be extended to all religious institutions in the city.

2. Thiruvananthapuram

Source segregation and focus on plastic recycling

The city of Thiruvananthapuram has a unique decentralised approach to manage the municipal waste. The city currently does not have any centralised solid waste management facility, like landfills or dumpsites. At present, more than 40% of the households are managing the biodegradable waste by themselves. For non- biodegradable waste, the Thiruvananthapuram Municipal Corporation (TMC) has developed a calendar for collecting different types of non-biodegradable waste. For example, weekly collection is organised for plastic waste, and monthly collection for glass, rubber, leather and textile waste.

TMC has set-up MRFs for collection of non-biodegradable waste with the help of SHGs and private agencies, and has also introduced an app 'Smart Thiruvananthapuram'. This app enables users to find out the nearest recycling facility. Recyclables are extracted from MRFs and sold to authorised recyclers whereas non-recyclables are disposed off by the state government-owned Clean Kerala Company. The Clean Kerala Company ensures that all plastic including sanitary waste is properly discarded.

The mechanism has helped the city to collect plastic waste in an organised manner and has increased the recycling rate of collected plastics, be it carry bags or even MLPs.

3. Tamil Nadu

Fines and penalties have worked in Tamil Nadu

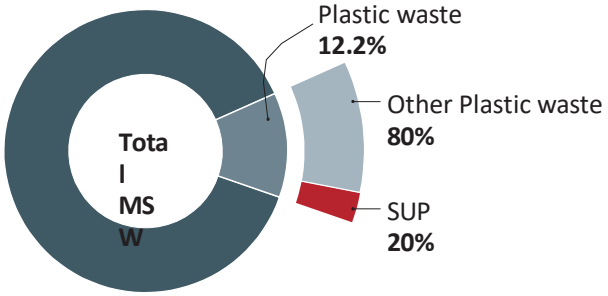
In 2018, Tamil Nadu was one of the few states to have implemented the plastic ban through a state Gazette notification. This notification provided time and had banned most of the listed SUP items at the time. Since then, relentless policing, fines, penalties and seizure have shown results in the state, both in rural as well as urban areas.

The fines and penalties have been imposed at all levels, be it the supplier, small and large vendors or the manufacturers, and thus targets the entire supply chain, from the production to the use of disposable plastics. The effectiveness of the ban depends upon how strictly it is being implemented by the local authorities. In the state, the public is encouraged to report violators and their locations through the means of an app. Thus, the public pressure on the authorities and the agencies has also worked in favour of the relative success of the ban in the state.

4. Conclusion and Way Forward

The key findings of the study are:

- Plastic waste accounts for 12.2% of the total municipal waste in the selected 20 cities. This is almost double the national average (6.9%) as per the Central Pollution Control Board, 2015. The plastic waste composition in selected cities varied from 8% to 17%. In most of the cities, it was between 10 to 14%.
- The composition of plastic waste in selected cities shows that PE (HDPE + LDPE) is the major contributor which constitutes around 40% of the total plastic waste, followed by MLPs which is around 20%. In PE, LDPE has the bigger share, which can be attributed to the daily usage of disposable milk packets, carry bags, and the increased use of LDPE in packaging materials especially by e-commerce companies. In totality, LDPE and MPLs accounted for about 50% of the total plastic waste.
- Banned SUPs accounted for about 20% of the plastic waste. In other words, on an average, banned SUPs account for about 2.4% of the total municipal waste (by weight). The proportion of banned SUPs in selected cities ranged from 5% to about 45% of the total plastic waste.



- Carry bags constituted the major proportion of the banned SUPs, accounting for 80% of the banned SUPs. Cutlery items were the other prominent banned SUPs, and accounted for around 12%. The other banned SUPs were around 8% (by weight).
- The use and availability of banned SUPs are still prevalent in the markets across the country. On an average, 57% of the samples surveyed in 137 markets across 20 cities were found to be using/selling banned SUP items. Out of this, 48% of samples only sold SUP products, while 9% sold both SUP and alternatives. The percentage of shops selling only SUP products in the cities ranged from 15% in Coimbatore to 78% in Agra.
- 43% of the samples were found to be using/selling alternatives to the banned SUPs. Alappuzha, Coimbatore and Indore are the cities where more than 65% of the surveyed samples were found to be using/selling alternatives only.
- Except for wrapping/films on cigarette packets, alternatives for all banned SUPs are available in the market.
- SUP items like plastic balloon sticks, flag sticks, candy sticks and earbuds are still being widely used whereas the use of most cultery items like spoons, forks, knives, cups and glasses, plates and trays, availability/usage of alternatives is higher. Ice-cream sticks seems to be completely replaced with alternatives.

In general, it was found that though alternatives are available, most establishments are hesitant to use or want to delay its usage as much as possible due to the cost factor. The cost of the available alternatives to the SUPs are on higher side. For example, a packet of plastic spoons which has 100 units costs around ₹30 per packet, whereas the available alternatives like wooden spoons same quantity (100 units) would cost anywhere around ₹100 to ₹140, which is 3 to 5 times the cost of plastic. The sudden increase in the demand of the alternatives and decline in the demand of SUPs has further escalated the gap. This has resulted in high-end brand owned establishments switching to alternatives whereas smaller vendors like roadside eateries and juice centres are finding it difficult to replace.

Most of the alternatives are again of single-use nature, like paper cups, kullads, wooden spoons, paper straws, etc. The recycling capacity of most of the alternatives to SUP products is the same and a challenge in recycling these alternatives can be foreseen. Therefore, alternatives with multi-use should be promoted and made available, which will ultimately help in reducing the pollution burden.

Overall, except for few cities, most of the cities (both big and small) are finding it challenging to implement the ban. Few cities have already started giving some grace period. For accelerating the progress towards a successful SUP ban, all possible efforts should be done by involving citizens, creating awareness, providing alternatives and better infrastructure, and imposing fines and penalties, wherever necessary. There are examples of good practices documented in country (*refer BOX 4: Good practices in plastic waste and SUP management*) which can be replicated for better results.

4.1 The Way Forward

The methodology developed for the compliance assurance is robust and can be used by the regulatory authorities to plan the next steps in improving the compliance with SUP ban. The following are few key suggestions emerging from the study:

- Similar SUP inventory studies should be undertaken in all major cities of all states to assess the status of the ban and gaps in implementation.
- The study can be taken up further for studying the implications for SPCBs/PCCs/ULBs towards understanding the impact of SUP ban.
- The study should be repeated at an interval of every six months to assess the progress.
- Research studies focused on providing multi-use alternatives to SUPs should be developed in association with industries.
- Continuous effort is required to bring down the cost of the alternatives.
- Improvement in infrastructure to support collection and treatment of the SUPs as well as alternatives, and the recycling potential of alternative to SUP items should be enhanced.

Annexure 1

Specified role of SPCBs/PCCS and Local authorities as per directions issued by CPCB under Section 5 of Environmental (Protection) Act, 1986

1. Role of SPCBs/PCCs

- Random inspection of Plastic waste raw material suppliers to check that plastic raw material is not supplied to banned SUP producers
- Meeting of SPCBs/PCCs with DMs for issuing of Public Notice
- District-wise identification of major Stockists/ retailers/ sellers of banned SUP items
- Directions to identified Stockists / retailers/ sellers to take necessary action to ensure zero inventory by June 30, 2022. Commercial licenses issued shall be cancelled if found to be selling banned SUP items.
- Fresh commercial licenses to be issued to the Stockists/ retailers/sellers with the condition that they shall not be selling banned SUP items
- Structured Market Survey to be conducted by third party identified by SPCBs/PCCs
- Identification of banned SUP producers through backward integration and taking action against them
- Organisation of Workshops for MSMEs jointly with CIPET to facilitate shifting to production of Plastic Alternatives
- Plan for Awareness Campaign. To organise meeting workshops/webinars for all key stakeholders and key ministries directly or indirectly involved or associated with the production, storage, distribution, stocking and sale of banned SUP items.
- To take penal action levy EC on violators of stipulated conditions
- Meeting with local authorities to appraise them about their roles and responsibilities.

2. Role of Local authorities

- Random inspection of market areas to check the usage of banned SUP item, and survey of municipal solid waste for presence of banned SUP items.
- District-wise identification of major Stockists/ retailers/ sellers of banned SUP items
- Identification of banned SUP producers through backward integration and taking action against them
- Monitoring through SUP App
- Conduction of Structured field inspection, as per format provided by CPCB.

Annexure 2

Questionnaire for Market Survey

A. Generic Information

City Name:

Market Name:

Date of Survey:

Name of Surveyor:

- The questions will be capture the responses on usage of SUP.
- Like, Are plastic earbuds available? If YES, tick the corresponding box. If Alternative is available, tick NO or if BOTH (SUP and alternative) is available tick the corresponding box.
- Wherever alternative is available note down the type of alternatives for each product.

1. Medical shop (3 Nos.)

Shop (Name)	Ear buds			Carry bags		
	Yes	No	Both	Yes	No	Both
1:						
2:						
3:						

Alternatives available:

- Ear Buds:
- Carry bags:

2. Restaurant and roadside eateries (7 Nos.)

Shop Name	Carry bags			Straw			Plastic sheet			Plate			Cups			Glass			Spoon			Fork			Knives			Tray		
	Y	N	B	Y	N	B	Y	N	B	Y	N	B	Y	N	B	Y	N	B	Y	N	B	Y	N	B	Y	N	B	Y	N	B

Alternatives available:

- Carry bags
- Straw
- Plastic sheet
- Plate
- Cups
- Glass
- Spoon
- Fork
- Knives
- Tray

3. Vegetable, fish and meat shops (5 nos.)

Shop (Name)	Carry bags		
	Yes	No	Both
1.			
2.			
3.			
4.			
5.			

Alternatives:

- Carry bags

4. General Store, Stationary shop and Decoration shop (5 Nos.)

Shop (Name)	Candy stick			Invitation card film			Thermocol decorations		
	Yes	No	Both	Yes	No	Both	Yes	No	Both
1.									
2.									
3.									
4.									
5.									

Alternatives

- Candy sticks
- Invitation cards
- Thermocol decorations

5. Printer (2 Nos.)

Shop (Name)	PVC Banner < 100 micron			Invitation card film		
	Yes	No	Both	Yes	No	Both
1:						
2:						

Alternatives

- PVC Banner
- Invitation card film

6. Sweet shop (3)

Shop (Name)	Film on Sweet Box			Tray			Carry bags		
	Yes	No	Both	Yes	No	Both	Yes	No	Both
1:									
2:									
3:									

Alternatives

- Film on sweet box
- Tray
- Carry bags

7. Paan Shop (2 Nos)

Shop (Name)	Film on Cigarette pack		
	Yes	No	Both
1:			
2:			

Alternative

- Film on Cigarette pack

8. Roadside toy seller (Balloon + Flags) – 5 Nos.

Shop/Vendor (Name)	Balloon stick			Flags			Flag stick		
	Yes	No	Both	Yes	No	Both	Yes	No	Both
1:									
2:									
3:									
4:									
5:									

Alternative

- Balloon stick
- Flags
- Flag stick

9. Ice cream cart (3 Nos.)

Shop/Vendor (Name)	Ice Cream Stick		
	Yes	No	Both
1:			
2:			
3:			

Alternative

- Ice Cream Stick

B. A brief note on observation made at religious/tourist place and market areas.

- **Religious place**
  - Usage
  - Disposal
- **Tourist Place**
  - Usage
  - Disposal
- **Market Areas**
  - Usage
  - Disposal

NOTE: Take pictures of alternatives available and different types of SUPs being used as decorative.

Annexure 3

Training Toolkit

This toolkit intends to train the city administration and their staff on using the methodology for compliance assessment through quantification and characterisation of Plastic and SUP items in municipal waste. Before starting the process, the logistic arrangements and resources required for it, and the hazards and risk associated should be understood.

A. Equipment/Apparatus and Human Resource

1. HDPE liner to make a platform for sorting and quantification which will help in eliminating possibility of leachate contaminating the soil and the surroundings.
2. Fibre, Plastic or Metal Containers for storing and weighing each waste component, labelled accordingly for storing different fractions (like paper, textile, glass, metals, etc.). or subsequently sacks can be used except for the storing and quantifying wet waste.
3. Electronic weighing scale, 2 weighing scale (1 scale of 250 kg capacity and accuracy of ±10 g, and second smaller with accuracy of ±1 g or less)
4. Shovels, Rakes, Brooms (push and hand), First Aid kit, and other PPEs (such as safety boots, gloves, apron/ jacket, etc.)
5. For the sorting and quantification exercise, at least two helpers and five sorters will be required along with one coordinator to monitor and oversee the whole process.

B. Hazards and Risks

1. Review the hazards and procedures with the operating and sorting personnel prior to conducting the field activities.
2. Sharp objects, such as nails, razor blades, hypodermic needles and pieces of glass, are present in solid waste. Personnel should be instructed of this danger, and they should brush waste particles aside while sorting rather than projecting their hands with force into the mixture. Personnel handling and sorting solid waste should wear appropriate protection, such as heavy leather gloves, dust masks and safety boots.
3. During the processes of unloading waste from collection vehicles and handling waste with heavy equipment, projectiles may issue from the mass of waste. The projectiles can include flying glass particles from breaking glass containers and metallids from plastic and metal containers that burst under pressure when run over by heavy equipment. The problem is particularly severe when the waste handling surface is of high compressive strength, for example, concrete. Personnel should be informed of this danger and wear eye and head protection if in the vicinity of either the collection vehicle unloading point or heavy equipment, or both.
4. Select a location for the discharge of designated loads, manual sorting activities, and weighing operations that is flat, level, and away from the normal waste handling and processing areas.
5. Weigh storage containers each day, or more frequently, if necessary, in order to maintain an accounting of the tare weight.
6. Containers of liquids or other potentially dangerous wastes (domestic hazardous waste and biomedical waste like used masks, etc.) shall be put aside and handled by the crew chief.

C. Calibration

1. All weighing scale shall be calibrated according to the manufacturer's instructions. Take appropriate corrective action if the readings are different from those of the calibration weights.
2. The weight of containers and sacks should be noted at the beginning and the same should be subtracted from the measurements while noting the data.

D. The process

The entire process is divided into 7 steps as detailed below;

Step 1: Identify the major waste disposal sites

The major waste disposal sites of a city, which could either be landfills in the case of cities collecting unsegregated waste or Material Resource Facilities (MRF) in case of cities with a good rate of source segregation, should be identified.

Step 2: Mark the catchment area

Divide the city based on the area catered by the landfill/MRF. All wards catered by the landfill/MRF should be mapped and classified into the following 5 major categories based on their socio-economic characteristics/ land use:

- High-income residential wards;
- Middle-income residential wards;
- Economically Weaker Section (EWS) residential wards/ slums;
- Commercial wards; and
- Mixed commercial and residential wards.

See Table 1 on guidance on classification of wards.

Table 1: Classification of different wards

Wards	Example of housing type/land use
EWS/Low-income group/Slums	Single room residents, areas with low rentals/ slum areas. Lowest property tax or tax exempted or unauthorised settlement.
Middle income	Apartments, single detached houses without garden. Median tax rate.
High income	Single detached houses with parking and garden, Luxury condominiums, and high- rise buildings. Highest tax rate.
Mixed commercial and residential	Areas where both commercial and residential complexes are present in an equal ratio or areas where waste from both commercial establishments as well as residential houses are collected in equal ratio

The socio-economic characteristics of the city should be analysed to understand the population characteristics and determine the proportion of the population residing in each economic strata/ land use. The number of samples to be sorted from each category should be fixed based on the population proportions observed in the city, to eliminate any biases in the selection of samples and ensure representativeness.

Socio-economic characteristic of the catchment area

The basic idea of collecting waste from different socio-economic strata/land use is to make sure that the waste sample is representative of the catchment area waste profile, and there is no biasness while selecting the sample size. In case of catchment areas where such predefined bifurcation is not available, the bifurcation of wards is based upon the predominant nature. For example, wards with more than 50% high income residences is classified as High income wards, wards with more than 50% low income residents is classified as low income wards and so on. In case where even such bifurcation is not possible in that case areas (pockets) with such socio- economic characteristic needs to be identified and vehicles from these pockets is selected.

Step 3: Determine sample size

The sample size should be determined based on ASTM (D5231- 92). For Indian conditions, for determining the composition of plastic waste, 30 to 35 samples should be collected over a period of five days (6-7 samples per day) from the catchment areas of each landfill/MRF facility. If a city has only one landfill site, then 30-35 samples should be collected. If the city has two landfills, then 60-70 samples are to be collected. One sample is equal to one vehicle load of waste.

At least one sample should be collected from each socio-economic strata/land use, i.e., one sample each from High income, Mixed-income, and Low-income residential wards, Commercial wards, and Mixed residential

and commercial wards. However, based on the proportion of population, the number of samples from certain socio-economic strata/land use can be increased. For example, if the catchment area is predominantly mixed residential, then the number of samples from the mixed residential wards can be increased to 2. Similarly, if the catchment area is predominantly commercial, and mixed commercial and residential, then two samples each from commercial, and mixed commercial and residential wards can be collected. The number of samples from each economic stratum should remain constant on all days throughout the Inventory study.

What does step 1 to 3 mean, let us understand it through examples

All major landfill/MRF needs to be identified, this will help in deciding the number of samples. For cities where waste is collected and send to landfills directly the landfill will be selected, and for cities where MRF are operational these MRFs are selected. Accordingly the waste from the catchment area, catered by the facility needs to be mapped and categorised as per different socio-economic characteristic.

Scenario 1: All the waste of the city is collected and sent directly to the 1 landfill catering the entire city area. Here the landfill is identified as the major waste disposal site. Since there is only 1 landfill catering the entire city, the number of samples would be 30 – 35 to be collected over a period of five days (6-7 samples per day) on random basis, but atleast 1 sample from each socio-economic strata. And depending upon the predominance of the population (High-income, middle-income, or low income) the other sample (i.e. sample number 6 and 7) can be collected accordingly.

Scenario 2: The city is divided into 2 zones, and all the waste collected from each zone is sent to the MRF. The waste after resource recovery is send to a sanitary landfill site outside the city premises. Here MRF will be selected as the major waste disposal site.

Scenario 3: The city is served by 2 landfills, one half of the city is catered by first landfill and the other half by second landfill. The waste before going to these landfills is sent to MRF for resource recovery. In this case also the MRF will be selected as major waste disposal site, as it is the first entry point where collected waste is reaching without any recovery or cherry picking.

As a general hypothesis, in cities where only landfills are present (as in Jorhat), we will identify that. In cities where no landfill is present (as in Thiruvananthapuram), the MRF or the resource recovery centre will be identified, and in cities where both landfill and MRFs are present (as in Surat), we will select the first entry point where collected waste is reaching without any recovery or cherry picking.

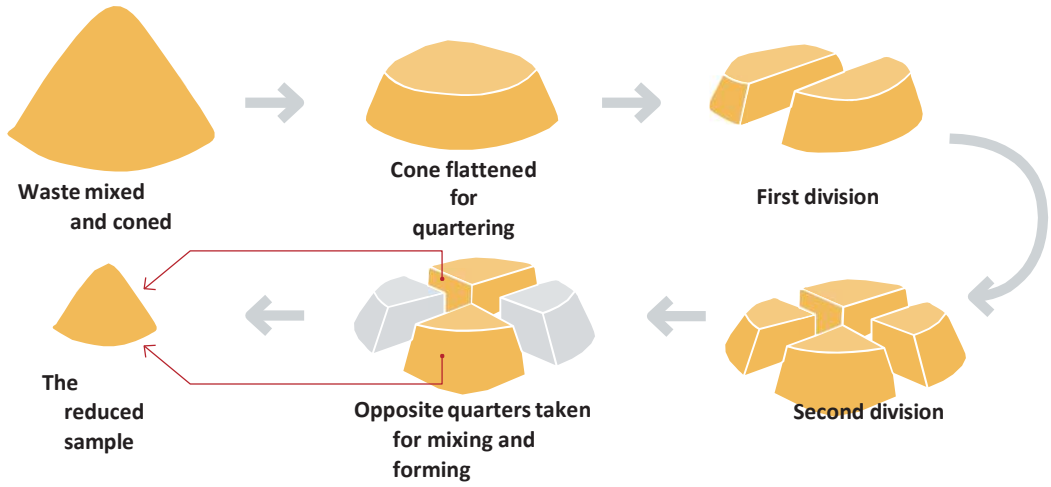
Step 4: Sample collection: Identify the vehicles collecting waste from each socio-economic strata/land use. Every day, select vehicles randomly from each socio-economic strata/land use. Make sure that the waste collectors are not removing valuable plastics/ dry wastes beforehand.

Remember:

- The number of samples from each economic stratum should remain constant on all days throughout the Inventory study.
- The assessment can be done in decentralise way also, but the assessment needs to be done on the same day and the resource requirement will increase. This will also create logistical issues, so it is advisable to carry out the entire assessment at one selected place.

Step 5: Sample preparation: The entire truckload of waste (approximately 400 - 500 kgs) should be discharged in a designated area. Use the Quartering and coning method to reduce the size of the sample to the range of 100 to 125 kg.

Method: Unload an entire truckload of waste on ground or on to a sheet, divide the waste into four parts. Select 2 samples positioned diagonally opposite to each other for the next step, and discard the other two as shown in the figure. Repeat this process once again, to reduce the size of the sample from 400-500 kg to 100-125 kg.



Sampling in cities with segregated waste collection

In cities where waste collection is being done separately i.e. dry and wet fraction is being collected separately, the following sampling procedure should be used:

- If mixed dry waste is being collected, then in that case select the vehicle of dry waste from each economic stratum. Reduce it to 100 – 125 kg by quartering and coning method.
- If all the dry waste is collected separately. That is, glass, cloth, rubber and leather, domestic hazardous, sanitary, plastic, E-waste etc. are collected separately, then in that case take 30 – 50 kg of plastic waste from each economic strata for quantification and characterisation.

Step 6: Sorting and quantifying

Sorting of sampled waste is done in 3 level;

Level 1: Dry waste sorting

The dry waste should be further sorted into seven primary sorting categories:

- Paper
- Rubber and Leather
- Metal
- Glass
- Plastics, and
- Others (including medical waste, Sanitary waste, Hazardous substances, etc). The weight fraction of each seven components should be measured.

Level 2: Plastic waste sorting

The total plastic waste, sorted and weighed from above, should further be sorted into 7 secondary categories, as per the IS 14534:1998 guidelines. Each sub-category should be weighed and registered in the data sheet.

Table 2: Categories of plastic

Category Type	Short Name	Scientific Name	Uses	Quantification (Kg/Kg of municipal waste)
1	PET	Polyethylene terephthalate	Soft drink bottles	
2	HDPE	High-density polyethylene	Bottles, carry bags, playground equipment etc.	
3	PVC	Polyvinyl chloride	Pipe, Window profile, fencing, flooring, shower curtains, lawn chairs and children's toys etc.	
4	LDPE	Low-density polyethylene	Plastic bags, carry bags, various containers, dispensing bottles, wash bottles, tubing etc.	
5	PP	Polypropylene	Auto parts, industrial fibers, food containers, dishware etc.	
6	PS	Polystyrene	Cafeteria trays, plastic utensils, toys, video cassettes and cases, clamshell containers, insulation board etc.	
7	Others	-	Multilayer Packaging and Laminates, Bakelite, Polycarbonate, Nylon SMC, FRP etc.	

Level 3: Banned SUPs waste sorting

All the 20 banned SUP products obtained from the waste samples should be separated from the plastic wastes and weighed as per the Table 3 below.

Table 3: Different categories of SUPs

Sr. No.	SUP items (banned)		Quantification (kg/kg of plastic waste)	Percentage
1	Plastic sticks	Ear buds		
2		Balloon		
3		Candy		
4		Ice-cream		
5		Straw		
6	Carry bags	< 75 μ		
7	Plastic sheets	< 50 μ		
8	Cutlery items	Plates		
9		Cups		
10		Glasses		
11		Spoons		
12		Forks		
13		Knives		
14		Trays		
15	Plastic wrapping and packaging films	Sweet Box		
16		Invitation cards		
17		Cigarette packets		
18	Others	Plastic flags		
19		PVC banners <100 μm		
20		Polystyrene for decorations		
	Total			

But before starting the sorting and quantification exercise a flat space needs to be identified and a set-up needs to be prepared, as shown in the figure below.

A. Reference how the set-up of the sorting facility should be done



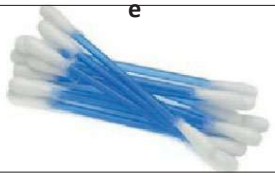
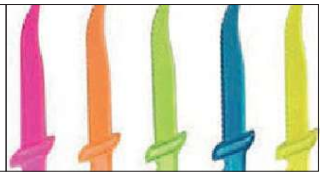
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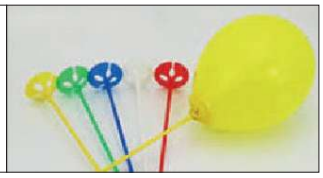
Material required for inventory

- HDPE liner
- 2 Drums (50 L)
- Weighing machine (big and small)
- Shade for workers, PPE, shovels and other equipment explained above
- Fibre, Plastic or Metal Containers or Big Sacks

The helpers and sorters should be provided with appropriate personal protection equipment (PPE) for their safety, and should be trained to identify different type of plastics and the banned SUP items, as provided in Table and chart below.

B. Single-Use Plastic reference chart

Product	Image
1. Plastic Earbuds	
2. Plastic sheets below 50 microns	
3. Carry bags below 75 microns	
4. Plastic cutlery (spoons, forks)	
5. Straws	
6. Plastic plates, cups, glasses	
7. SUP knives (mostly used for cake cutting)	
8. SUP Trays	

Product	Image
9. Wrappings on Invitation cards	
10. Thermocol decorative items	
11. Wrapping on sweet boxes (Plastic sheet wrapped on sweet boxes/fruit baskets)	
12. Wrapping/Films on cigarette packets	
13. Plastic Balloon sticks	
14. Plastic stirrers	
15. Plastic Flags	
16. Plastic Candy sticks	

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C. Guideline for classifying and identifying different types of plastics (pictorial illustration in English and Hindi)

GUIDELINES FOR PLASTIC WASTE CHARACTERISATION FOR INVENTORISATION STUDY

Classification of different types of plastics

1 PET (Polyethylene Teraphthalate)

Water bottles, softdrink bottles, Juice bottles/Rigid cosmetic jars/ Microwavable containers



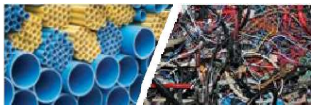
2 HDPE (High Density Polyethylene)

Shampoo Bottles/Toys/Chemical Containers/Pipe Systems/Recycling Bins/Flower Pots



3 PVC (Polyvinyl Chloride)

Water pipes/Insultation wiring and cables/Biomedical drips and tubings



4 LDPE (Low Density Polyethylene)

Carry bags (grocery, dry cleaning, bread, bin liners)/Plastic wraps/ Milk pouch/Squeezable bottles



5 PP (Polypropylene)

Bottle lids/Straws/Lunch boxes/ Take-out food containers/Ice cream containers/Syrup bottles



6 PS (Polystyrene)

Foam packaging/Teacups, plates and disposable cutlery/Containers/ Yoghurt container



7 0 (Others)

Multilayered packaging of chips, biscuits etc.



Source: As per BIS classification of plastics

HOW TO IDENTIFY THE PLASTICS FOR CARRYING OUT THE INVENTORISATION WORK

1. Most of the plastic products will have a symbol of either of the 7 categories mentioned, look out for the symbol at either the side or bottom of the plastic item.
2. If symbol is not present, identify by mentioned abbreviations.
3. If nothing is mentioned, identify by the examples of products mentioned for your reference, however, this is very unlikely.

सामान का अ?यन करने के ?लए ??? प्रकार के ?ा??क अप?श?? क? पहचान हेतु मार्गद?श?का

?व?भ? प्रकार के ?ा??क का वग?करण

1 पेट (पॉलीई?थलीन टेरफ्थलेट)

पानी, को? ?ड्र?क और जूस क? बोतल?/ स?दयर् प्रसाधन के ?ड?े (जार), माइक्रोवेव म? इ?ेमाल ?कए जाने यो? ?ड?े (बर्तन)



2 एचडीपीई (उ? घन? पॉलीई?थलीन)

शै?ू क? बोतल?/?खलौने/ रसायन के ??

पाइप/पुनचर्क्रण ?ड?े/गमले



3 पीवीसी (पॉली?वनायल ?ोरायड)

पानी के पाइप/ इंसुलेशन वाइ?र?ग और तार/ बायोमे?डकल ?ड्रप और पाइप



4 एलडीपीई (?न? घ? पॉलीई?थलीन)

?ा??क के थैले (?करााना, ड्राई?ी?न?ग, ब्रेड)/लपेटने के ?लए इ?ेमाल होने वाले



5 पीपी (पॉलीप्रोपायलीन)

आउट फू ड कं टेनर/आइसक्र?म के ?ड?े/ ?ड?ोजेबल कांटा-च?च/?ड?े/



6 पीएस (पॉली?ायरीन)

बोतल के ढ?न/स्ट्रॉ/लंच बॉ?/टेक फोम पैके ?ज?ग/ चाय के कप, ?ेट



7 ओ (अ?)

?च?, ?ब?ु ट अ?? ?ा?ीलेयडर् पैके ?ज?ग



स्रोत: ?ा??क के ?लए बीआईएस वग?करण के अनुसार

इस अ?यन के ?लए ?ा??क क? व?ु क? पहचान कैसे

1 ?ा??क क? ?ादातर व?ुओं पर ऊपर ?ाई 7 श्रे?णय? म? से ?कसी एक का ?च? अं?कत होता है। व?ु के चार? तरफ़ या नीचे क? तरफ़ इसे ढूँढने क? को?शश कर।?

2 य?द ?च? अं?कत नहो तो ऊपर बताए गए श? सं?ेप को ढूँढने क? को?शश कर।?

3 य?द ?च? या श? सं?ेप अं?कतनहो तो ऊपर बताए गाए उदाहरण? से पहचानने क? को?शश कर।? हालां?क ऐसी नौबत बहुत कम आएगी।

Step 7: Data Analysis

The results of inventory for each day should be registered on the daily basis. The wet and dry waste fraction of each day is consolidated at the end of 5 days to find out the average composition. A standard deviation check on the data from each day is done to find the outliers. Smaller value of standard deviation means the sampling is consistent. A sample sheet for daily data entry for inventory is as provided in Table 4 and 5 below.

Table 4: Daily data entry sheet

Category	**Sample 1**			**Sample 2**		**Sample 3**
	(Residential)			(Commercial area)		(Dumpsite)
	(High income)	(Middle income)	(Low income)	(Mixed commercial and residential)	(Commercial area)	
Name of the area						
Name of the volunteer coordinating the same						
Name of driver/helper						
Waste received at the facility (kg)						
Sampling waste quantity (kg)						
Total Wet waste (kg)						
Total Dry waste (kg)						
Paper (kg)						
Textile (kg)						
Rubber and Leather (kg)						
Glass (kg)						
Metals (kg)						
Others (kg)						
PET (kg)						
HDPE (kg)						
LDPE (kg)						
PVC (kg)						
PP (kg)						
PS (kg)						
MLP (kg)						
TOTAL Plastic (kg)						
% plastic of total						
% dry waste						
% wet waste						
% plastic of dry waste						

Table 5: Inventory sheet for banned SUP items to be updated daily

Sr. No.	**SUP items (banned)**		Quantity (kg) (Residential + Commercial)	Dumpsite analysis (kg)
1	**Plastic sticks**	Ear buds		
2		Balloon		
3		Candy		
4		Ice-cream		
5		Straw		
6	**Carry bags**	< 75 μ		
7	**Plastic sheets**	< 50 μ		
8	**Cutlery items**	Plates		
9		Cups		
10		Glasses		
11		Spoons		
12		Forks		
13		Knives		
14		Trays		
15	**Plastic wrapping and packaging films**	Sweet Box		
16		Invitation cards		
17		Cigarette packets		
18	**Others**	Plastic flags		
19		PVC banners <100 μm		
20		Polystyrene for decorations		
	Total (kg)			
		%age of banned SUP of total plastic waste		

Annexure 4

Comparative Analysis with earlier study conducted in 2015

In 2015 Central Pollution Control Board (CPCB) carried out a study which included assessment, quantification of plastics waste in dump sites of major 60 cities and suggesting the viable and appropriate recycling technologies (Based on "Zero" waste concept) with following Terms of References (ToR);

TERMS OF REFERENCES (ToR) OF THE STUDY

- To assess the type, nature and quantum of plastics waste in the country through field survey and physical assessment at the MSW sites at 60 towns and Cities.
- Establish a Co-ordination mechanism with local Municipal/Metro corporations in identifying the dump grounds/ Localities of higher waste generation for the physical assessment/characterization of MSW as per the prescribed methodology.
- To report on the existing methodology for collection of waste by urban local bodies/Municipal bodies in different states of the country.
- To suggest the viable and appropriate recycling technologies at major cities with investment estimation for effective Plastics waste Management (based on "Zero Waste Concept")
- Suggest Road Map/Recommendations for Plastics Waste Management as per the data available from the study for different towns and cities of the country.

The study used ASTM Method (D5231-92) method as the guiding principle for the assessment and quantification of plastics waste at Dump sites. The 1000 Kg of fresh Municipal Solid Waste (MSW) arriving at dumpsites on different days from different sources in vehicles like trucks/lorry, was used to prepare the sample for assessment and quantification. The sample was reduced to 125Kg of Municipal Solid Waste (MSW) from 1000Kg the various types of plastics like PET, PE Based (LDPE/HDPE), PVC, PP, PS and OTHER was sorted out and segregated.

Comparison of the methodology used in this study (2022) with the one used in CPCB study in 2015;

The objective of both the study was completely different where in the CPCB study the focus was on the plastic waste and its potential for recycling, whereas in this study the focus was to assess the availability of Single-Use Plastic (SUP) in the city. The focus of this study, 2022 has been two-fold to capture the supply as well as the usage of SUP in the city and thus a two-pronged methodology is used to capture the usage in waste stream and the availability in the market.

1. The CPCB study, 2015 collected samples from the dump site, whereas in this study (2022) the samples were collected from the first entry point where waste is reaching without any recovery or cherry picking. This helps in analysing the usage of SUP in the city by the households.
2. The present study, 2022 tries to capture the variation from different socio-economic strata of the city by collecting representative samples from different income group and economic activity, such as residential, commercial, and mixed residential and commercial area.
3. This study, 2022 also focuses on capturing the SUP items being used and sold in the market and its alternatives available in each city, which reflects upon the compliance of SUP ban in the city.

There are some common cities which was part of both the studies, a change from earlier study 2015 to the present condition 2022 is as reflected in the table below;

Table 1: Change in the percentage of plastic in total MSW from 2015 to 2022

Sr No	Name of the common city	Plastic waste percentage in total MSW in CPCB study, 2015	Plastic waste percentage in total MSW in this study, 2022	Change from 2015 to present (2022) in percentage increase
1	Agra	7.9	12.7	61.6
2	Lucknow	5.9	14.4	144.0
3	Dhanbad	5.0	11	119.1
4	Vadodara	4.6	13.4	193.2
5	Coimbatore	9.5	17.9	89.0
6	Indore	8.8	10.8	22.6
7	Surat	12.5	13.2	5.6
8	Bangalore	8.5	11.8	39.1
9	Guwahati	5.0	15.3	203.6
10	Bhopal	6.6	13.3	101.8

The table above shows that the usage of plastic in all cities have increased, in some cities this increase has been marginal whereas in some it has been like three folds as in Guwahati. The overall results shows that the proportion of plastics in municipal solid waste has almost doubled in India, from 6.9% in 2015 to 12.2% in 2022.

Annexure 5

Cities Case Files

Agra

The city of Agra is located on the banks of River Yamuna in the state of Uttar Pradesh in India. It is located 206 kms away from the national capital New Delhi and 378 kms west of the state capital Lucknow. Spread over an area of 10, 863 sq. km, the city houses a population of 1.58 million as per Census 2011. The total waste generation in Agra is estimated to be 900-925 TPD, as per the information shared by Agra Municipal Corporation. Residential establishments contribute 70% of this waste, and commercial establishments contribute to 30%, which is sent to the dumpsite.

1. Single-use Plastic Waste Inventory

In Agra, the municipal waste was collected from six Residential areas, High-income residential (Ward No. 81 Kamla Nagar and Ward No. 74 Jaipur House), Middle-income Residential areas (Ward No. 75 Awas Vikas and Ward No. 78 Shaheed Nagar), and Low-income residential areas (Ward No. 14-Kachchpura and Ward No. 18-Raj Nagar), and two wards each from Mixed Commercial & Residential (Ward No. 29-Khandari Ward No. 64-Belaganj), and Commercial areas (Ward No. 92-Sanjay Place/Wazirpura Ward No. 79-Motiganj) were chosen for taking the samples. A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Agra was conducted from 13 to 17 May 2022 at a designated place, near one of the transfer stations, where waste from all the selected wards were brought for inventory.

Results of inventory

Banned SUPs account for 24.7% of the total plastic waste in Agra. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 86% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 13.67% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 1%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.46
2	Carry bags	85.68
3	Plastic sheets	0.00
4	Cutlery items	13.67
5	Wrapping and film	0.18
6	Others	0.00

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month April and May 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	New Agra and Delhi Gate
2	South	Tajganj and Rajpur Chungi
3	East	Belanganj and Jeevni mandi
4	West	Bodla Market and Lohamandi

The survey covered 280 shops in the four selected markets in Agra. The results are as provided as below.

Figure 1: Sale of SUPs and alternatives in Agra

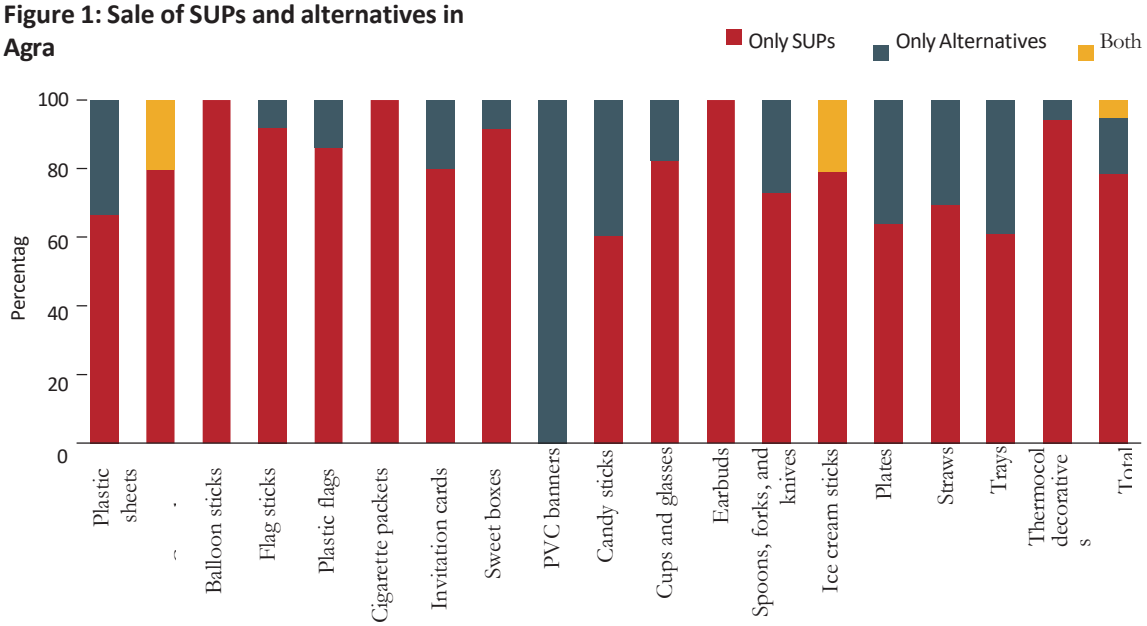
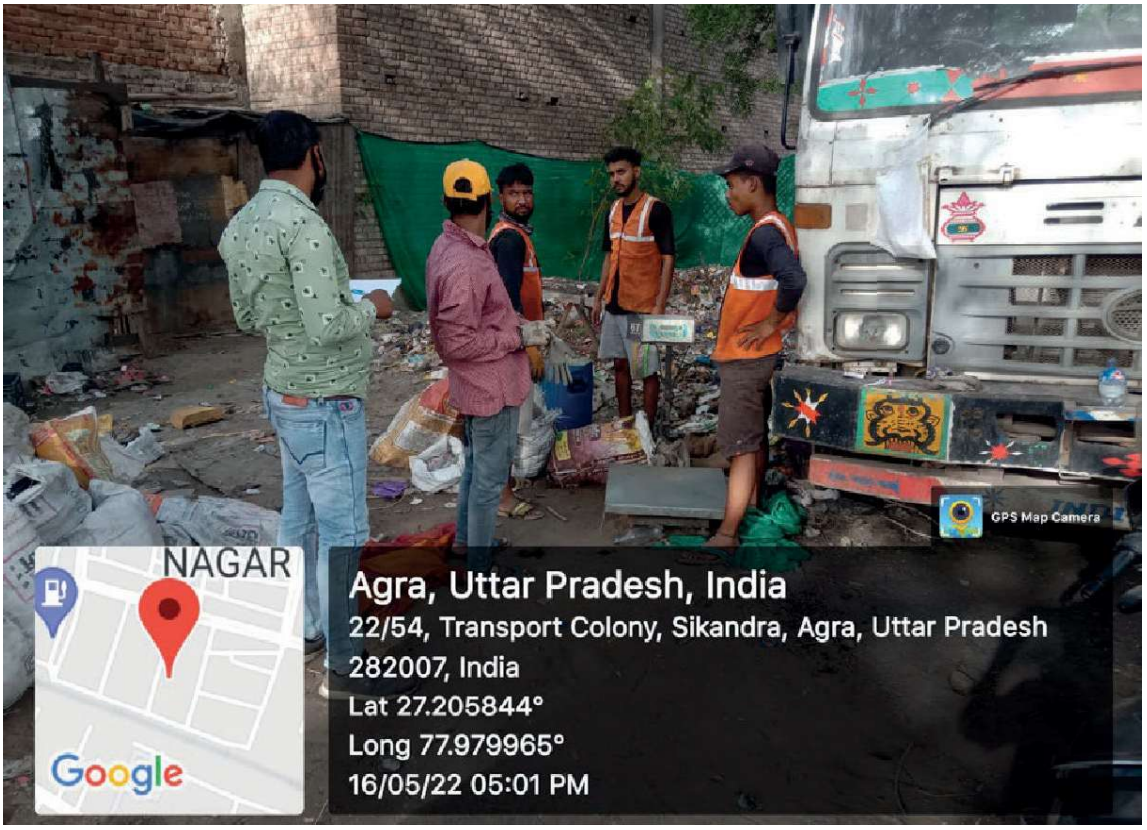


Table 3: Types of alternatives to SUPs in Agra

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	1	Paper sheets			
Plastic carry bags (below 75 microns)	2	Paper bags	Cloth Bags		
Plastic balloon sticks	0				
Plastic flag sticks	1	Wooden			
Plastic flags					
Plastic flags	1	Paper Flags			
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper invitations			
Plastic films on sweet boxes	1	Paper boxes without films			
PVC banners (below 100 microns)	1	Above 100-micron flex	Above 200 microns		
Plastic candy sticks	1	Paper			
Plastic cups and glasses	4	Ceramic Cups	Paper Cups	Sal Leaf cups	Steel Cups, Steel Glasses
Plastic earbuds	0				
Plastic spoons, forks and knives	1	Wooden stick			
Plastic Ice cream sticks	1	Wooden stick			
Plastic plates	3	Steel plates	Hard Plastic Plates	Ceramic plates	
Plastic straws	1	Paper straws			
Plastic trays	2	Steel tray	Reusable plastic tray		
Thermocol decorative	1	Tissue paper décor			


GPS Map Camera
Agra, Uttar Pradesh, India
Shop No 4 Vibhav Market Dayalbagh Road New Agra, Nagla Padi, Indra Puri, New Agra Colony, Agra, Uttar Pradesh 282005, India
Lat 27.211851°
Long 78.005284°
11/05/22 01:09 PM
Google

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GPS Map Camera
NAGAR
Agra, Uttar Pradesh, India
22/54, Transport Colony, Sikandra, Agra, Uttar Pradesh 282007, India
Lat 27.205844°
Long 77.979965°
16/05/22 05:01 PM
Google

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Alappuzha

Alappuzha, commonly known as Alleppey, is a district located in the southernmost state of Kerala. Alappuzha town is located in the district of Alappuzha. The town is located 55 km from Kochi and 155 kms away from Thiruvananthapuram. As per Census 2011, Alappuzha town has a population of 1.74 lakh. The estimated population in 2021 was 1.8 lakh with about 48,000 households, and the approximate daily floating population of the town is 20,000. The town is an attractive tourist destination, well-known for the Kerala backwaters and beautiful beaches.

1. Single-use Plastic Waste Inventory

In Alappuzha, the household waste is segregated into various categories at the household level, and are collected separately. The municipality collects the plastic waste from the households periodically, the inventory samples were taken from this collection.

The waste samples were collected from three residential wards (Ward 16, 26 and 30) and two commercial wards (Ward 31 and 24). Inventory was conducted on about 150-200 kg of plastic waste collected from residential wards, commercial wards, every day.

The city has a good rate of source segregation, and the inventorisation study was conducted from 24 to 26 July 2022 at the Material Recovery Facility managed by Harithakarma Sena.

Results of inventory

Banned SUPs account for 9.3% of the total plastic waste in Alappuzha. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 98% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for just 1.7% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 0.2%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.12
2	Carry bags	98.11
3	Plastic sheets	0.00
4	Cutlery items	1.77
5	Wrapping and film	0.00
6	Others	0.00

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of April and May 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	New Bazaar
2	South	Mullakkal
3	East	Beach market
4	West	Kalarcode

The survey covered 137 shops in four selected markets in Alappuzha. The results are provided as below.

Figure 1: Sale of SUPs and alternatives in Alappuzha

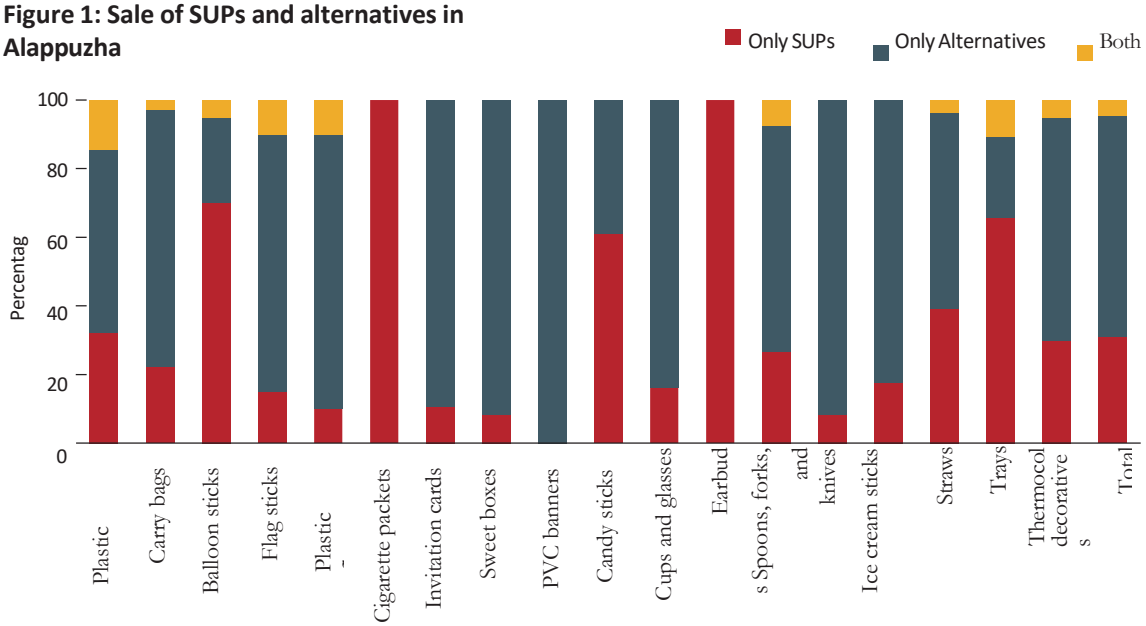


Table 3: Types of alternatives to SUPs in Alappuzha

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Paper sheets	Banana Leaves		
Plastic carry bags (<75 μ)	1	Paper bags			
Plastic balloon sticks	1	Wooden stick			
Plastic flag sticks	1	Wooden stick			
Plastic flags	1	Cotton/cloth Flags			
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards without films			
Plastic films on sweet boxes	1	Paper box without films			
PVC banners (<100 μ)	1	Cloth banners			
Plastic candy sticks	1	Paper sticks			
Plastic cups and glasses	2	Glass cups	Paper cups		
Plastic earbuds	0				
Plastic spoons, forks and knives	1	Steel cutlery			
Plastic ice-cream sticks	1	Wooden stick			
Plastic plates	3	Steel	Paper plates	Ceramic	
Plastic straws	1	Paper straws			
Plastic trays	1	Paper trays			
Thermocol decoratives	1	Paper decor			



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Bengaluru

Bengaluru is the capital of Karnataka and is located in the south eastern part of the state. In 2007, the Karnataka Government merged the Banglore Mahanagara Palike with 8 urban local bodies and 111 villages around the city to form a single administrative body, and renamed it as Bruhat Bengaluru Mahanagara Palike (BBMP). The BBMP is the administrative body in charge of civic amenities in the city and its municipal solid waste (MSW) management. BBMP consists of 198 wards, with a total area of 741 sq. km, and is the fourth largest Municipal Corporation of India.

1. Single-use Plastic Waste Inventory

In Bengaluru, the inventory was done on door to door dry waste samples collected from three residential wards, High income ward (Ward no. 174 HSR Layout), Middle income ward (Ward No. 132 Attiguppe) and Low income ward (Ward No. 146 Lakkasandra), one mixed commercial and residential ward (Ward No. 189 Hongasandra), and one commercial ward (Ward No. 190 Mangammanapalya)

(Note: ITC-WOW has been assigned to collect the dry waste from these localities and the wet waste is collected by the separate concessionaire assigned by the municipality).

The inventorisation study in Bengaluru was conducted from 30 May to 3 June 2022 at the Material Recovery Facility operated by ITC. The dry waste collected from door to door collection is brought at the facility for resource recovery.

Results of inventory

Banned SUPs account for about 17% of the total plastic waste in Bengaluru. The most common banned SUPs found in the waste stream are cutlery items, accounting for more than 30% (by weight) of all the banned SUPs. PVC banners and plastic flags (mostly from different political parties) and plastic sticks, is the other prominent banned SUPs, accounted for 19.59% and 16.34% respectively of the total banned SUPs.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	16.34
2	Carry bags	14.43
3	Plastic sheets	5.74
4	Cutlery items	30.45
5	Wrapping and film	13.44
6	Others	19.59

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected marked areas in different zones, in the month of May and June 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Yelahanka Market and Malleshwaram Market
2	South	K R Market and Madiwala Market
3	East	Russell Market and Shivaji Market
4	West	Yeshwanthpur Market and Kengeri Market

The survey covered 279 shops in four selected markets in Bengaluru. The results are provided as below.

Figure 1: Sale of SUPs and alternatives in Bengaluru

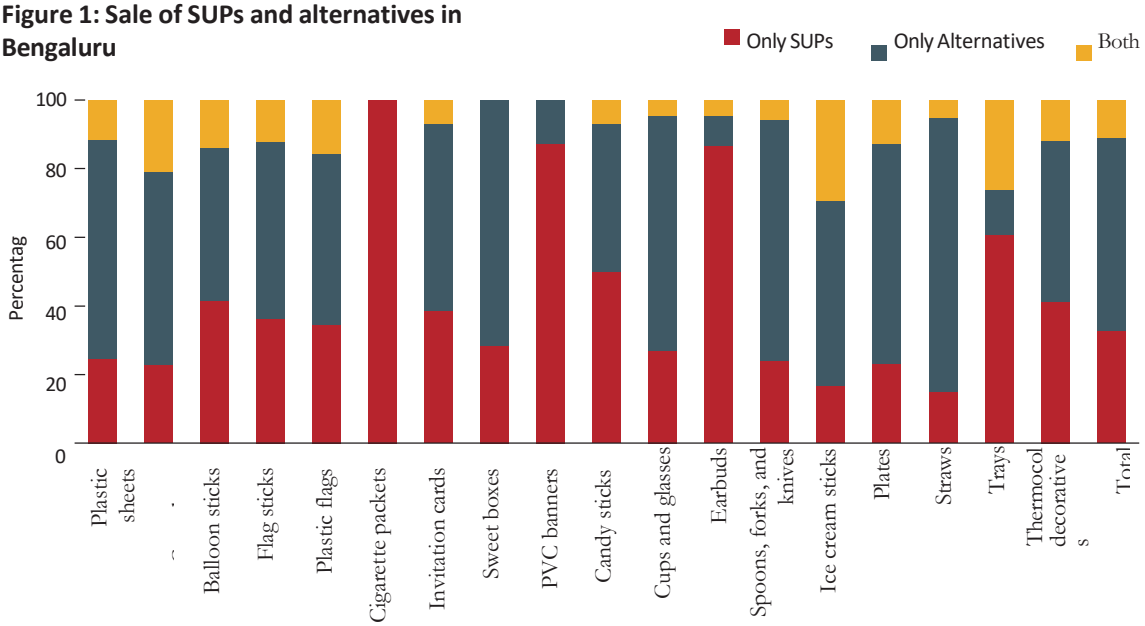


Table 3: Types of alternatives to SUPs in Bengaluru

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Aluminium sheets	Banana leaves		
Plastic carry bags (<75 μ)	4	Paper Bags	Cloth bags	Cardboard box	Handicraft bag
Plastic balloon sticks	3	Wooden sticks	Latex rubber sticks	Paper sticks	
Plastic flag sticks	3	Wooden sticks	Rubber sticks	Cloth stick	
Plastic flags	2	Cloth flags	Paper flags		
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards without films			
Plastic films on sweet boxes	1	Cardboard/ paper box without film			
PVC banners (<100 μ)	2	Cloth banners	Above 230 GSM		
Plastic candy sticks	3	Edible candy sticks	Paper stick	Wooden stick	
Plastic cups and glasses	2	Paper cups and glasses	Steel cups and glasses		
Plastic earbuds	1	Paper earbuds			
Plastic spoons, forks and knives	2	Steel cutlery	Wooden cutlery		
Plastic ice-cream sticks	1	Wooden sticks			
Plastic plates	5	Ceramic plates, reusable plastic plates	Steel	Nutwood plates, wooden plates	Earthen mud cutlery (pingani)
Plastic straws	2	Paper straws	Edible straws		
Plastic trays	1	Aluminium trays			
Thermocol decoratives	2	Paper décor	Cloth decor		


FRESH PANEER
Banaras
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Bengaluru
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India
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Hospital Rd
Avenue Rd
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Bhopal

Bhopal is the capital city of the Indian state of Madhya Pradesh and the administrative headquarters of both Bhopal district and Bhopal division. It is known for its various natural and artificial lakes. Bhopal is spread across an area of 413.5 sq km. with 19 zones and 85 wards in the corporation. Bhopal is one of the top 10 ranked cities in the Swachh Survekshan ranking 2022. As per Census 2011, the total population of the city was 19.2 lakhs, and the estimated population of the city in 2021 is about 24 lakhs.

1. Single-use Plastic Waste Inventory

In Bhopal, the municipal waste was collected from three residential wards one sample each from different economic strata, High-income residential (Ward No. 43 and 44), Middle-income Residential areas (Ward No. 4 and 8), and Low-income residential areas (Ward No. 13, 18 and 20), and one sample each from Mixed Commercial & Residential (Ward No. 4 and 7), and Commercial areas (Ward No. 32 and 44) were chosen for inventory. The rate of segregation of waste in Bhopal is high and the inventory was carried out on the dry waste collected from these areas.

The inventorisation study in Bhopal was conducted from 24 to 28 July 2022 at one of the Material Recovery Facility at Beragarh. The dry waste collected from the selected wards were brought to the facility for inventory.

Results of inventory

Banned SUPs account for about 9.8% of the total plastic waste in Bhopal. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 84% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 9.2% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 5%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	3.43
2	Carry bags	84.28
3	Plastic sheets	1.20
4	Cutlery items	9.23
5	Wrapping and film	0.26
6	Others	1.60

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected marked areas in different zones, in the month of July and August 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	New Market
2	South	M P Nagar and Vitthal Market
3	East	Chowk Bazar and Railway Station
4	West	DIG Bunglow and Beragarh

The survey covered 235 shops in four selected markets in Bhopal. The results are provided as below.

Figure 1: Sale of SUPs and alternatives in Bhopal

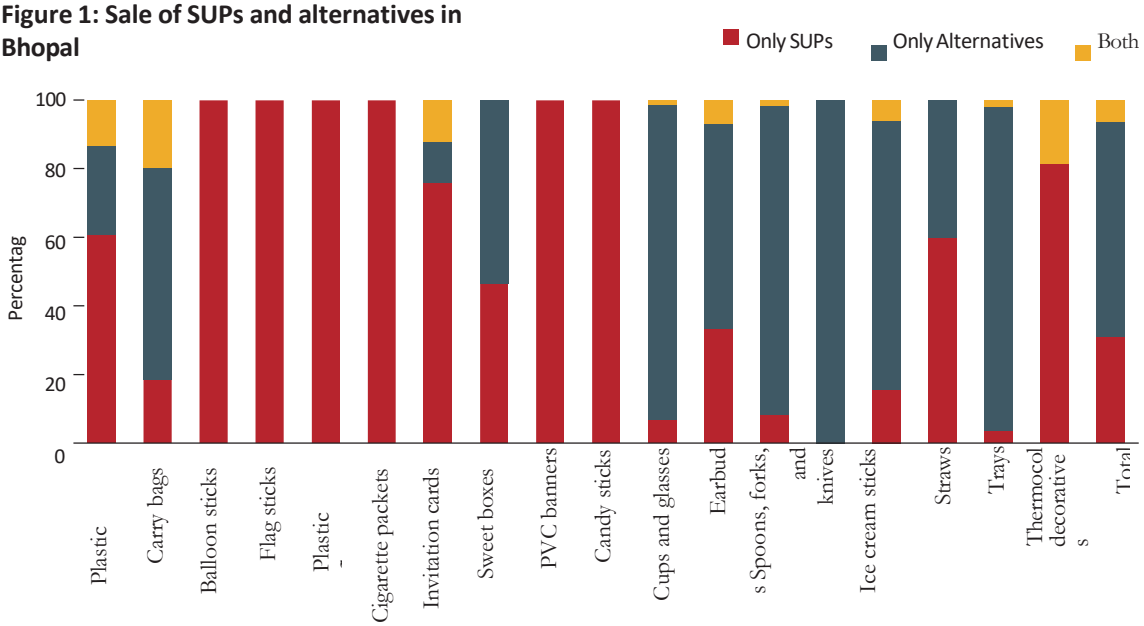


Table 3: Types of alternatives to SUPs in Bhopal

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Paper sheet	Aluminium foil		
SUP carry bags (below 75 μ) available	3	Paper bag	Cloth Bag	Woven Bag	
Plastic balloon sticks	0				
Plastic flag sticks	0				
Plastic flags	0				
Wrapping/films on cigarette packets	0				
Plastic wrapping/films on invitation cards	1	Paper envelope			
Wrapping/films on sweet boxes	2	Paper envelope	Cloth		
PVC banners below 100 μ	0				
SUP candy sticks	0				
Cups and glassess	4	Glasses made of glass	Paper cup and clay cups	Steel Glass	Reusable fibre cup and glasses
Earbuds	1	Wooden stick			
Spoons forks knives	3	Steel spoon, fork, knives	Wooden fork, spoon and knives	Fibre (reusable)	
Ice cream sticks	1	Wooden stick			
Plates	3	Steel plates	Paper plates	Fibre (reusable plates)	
Straws	3	Paper straws	Steel	Wooden	
SUP trays	2	Paper tray	Reusable tray		
Thermocol decorative	1	Paper			



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Coimbatore

Coimbatore, also known as Kovai or Covai , is one of the major metropolitan cities in the Indian state of Tamil Nadu. It is located on the banks of the Noyyal River and surrounded by the Western Ghats. Coimbatore is the second largest city in Tamil Nadu after Chennai and the 16th largest urban agglomeration in India as per the census 2011. It is administered by the Coimbatore Municipal Corporation and is the administrative capital of Coimbatore District. In 1981 Coimbatore formed as third municipal corporation in Tamil Nadu after Chennai and Madurai. As per the Census 2011, urban agglomeration population of Coimbatore was of 21.4 lakh; the estimated population for 2021 is over 28.6 lakh.

1. Single-use Plastic Waste Inventory

In Coimbatore, the municipal waste was collected from three residential wards one sample each from different economic strata, High-income residential (Ward No. 69 and 70), Middle-income Residential areas (Ward No. 43 and 39), and Low-income residential areas (Ward No. 35 and Ward No. 70 Brooke bond road back side area), and one sample each from Mixed Commercial & Residential (Ward No. 44 NSR road, and Poo market area in Ward 70 and 82), and Commercial areas (Ward No. 48, Ward No. 68 Gandhi Puram and Ward No. 67 Vada Covai) were chosen for inventory. The rate of segregation of waste in Coimbatore is high and the inventory was carried out on the dry waste collected from these areas. A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Coimbatore was conducted from 25 to 29 July 2022 at one of the transfer stations provided by the municipal corporation. The dry waste collected from the households from selected wards were brought at the transfer station for inventory.

Results of inventory

Banned SUPs account for about 5% of the total plastic waste in Coimbatore. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 93% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 3.9% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 3%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.4
2	Carry bags	93.4
3	Plastic sheets	2.1
4	Cutlery items	3.9
5	Wrapping and film	0.1
6	Others	0.1

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of July 2022.

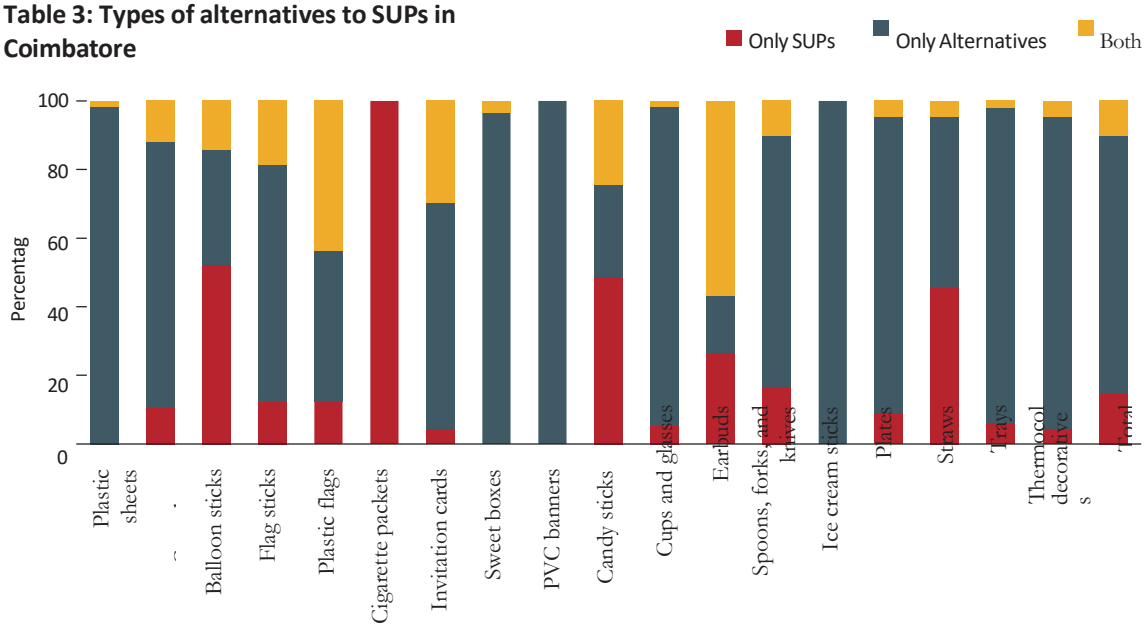
Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	Central	Railway station, Ukkadam
2	North	MTP Road, Thudiyalur
3	South	Palakkad Road, Kuniyamuthur
4	West	Venkitapuram, Vadavalli
5	East	Avinasi Road, Trichy Road

The survey covered 302 shops in four selected markets in Coimbatore. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Coimbatore

Table 3: Types of alternatives to SUPs in Coimbatore



Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4	Type 5
Plastic sheets	3	Silver foil	Banana leaf	Paper roll		
Plastic carry bags (below 75 microns)	4	Cloth bags	Biodegradable bags	Paper bags	Handicraft bags	
Plastic balloon sticks	2	Wooden sticks	Thread			
Plastic flag sticks	2	Wooden sticks	Thread			
Plastic flags	1	Paper flag				
Plastic films on cigarette packets	0					
Plastic films on invitation cards	1	Paper Envelope				
Plastic films on sweet boxes	1	Paper boxes				
PVC banners (below 100 microns)	4	Above 100-micron flex	300 GSM	Above 125 microns.	200-micron banners	
Plastic candy sticks	1	Wooden stick				
Plastic cups and glasses	4	Ceramic Cups	Hard acrylic cups	Steel cups, glass cups	Sugarcane Bagasse bio-degradable cups	
Plastic earbuds	2	Wooden stick earbuds	Paper based			
Plastic spoons, forks, and knives	2	Steel spoon, fork, knives	Wooden fork, spoon, knives			
Plastic Ice cream sticks	1	Wooden stick				
Plastic plates	5	Steel plates	Biodegradable Sugarcane Bagasse Plates	Ceramic plates	Hard Acrylic plates	Palm and bamboo tree-based plates
Plastic straws	1	Paper straws				
Plastic trays	3	Steel tray	Acrylic trays	Wooden trays		
Thermocol decorative	2	Hard Plastic décor items	Reusable foam materials			



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Delhi (SDMC)

Delhi, officially called the National Capital Territory of Delhi (NCT) is a union territory comprising New Delhi, the capital city of India. It is situated along the west bank of the Yamuna River, and is surrounded by the state of Haryana on three sides, and by Uttar Pradesh on the east.

The Municipal Corporation of Delhi is one of the largest municipal bodies in the world providing civic services to approximately 20 million citizens of Delhi. Until May 2022, it was divided into 3 civil bodies, titled, the East Delhi Municipal Corporation (EDMC), South Delhi Municipal Corporation (SDMC), and the North Delhi Municipal Corporation (NDMC). The SDMC spans an area of 656.9 sq km. and comprises a population of about 65 lakh. It is divided into 4 main zones, namely Central Zone, South Zone, West Zone, and Najafgarh Zone constituting 104 municipal wards.

1. Single-use Plastic Waste Inventory

In SDMC, the municipal waste was collected from three Residential areas, High-income residential (Ward No. 2S), Middle-income Residential areas (Ward No. 3S), and Low-income residential areas (Ward No. 4S), and one sample each from Mixed Commercial & Residential (Ward No. 1S), and Commercial areas (Ward No. 6S). A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in SDMC was conducted from 26 to 29 May 2022 at the transfer station at Raghubir Nagar. The door to door waste collected from households of selected wards was brought to the transfer station for inventory.

Results of inventory

Banned SUPs accounted for about 36% of total plastic waste in Delhi (SDMC). The most common banned SUP found in the waste stream are carry bags, accounting for more than 92% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 7.09% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 0.3%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.29
2	Carry bags	92.53
3	Plastic sheets	0.00
4	Cutlery items	7.09
5	Wrapping and film	0.09
6	Others	0.00

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of March and May 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	Najafgarh	Dwarka sector 12 and Dabri-mor market
2	West	Tilak Nagar and Rajori Garden
3	South	Malviya Nagar and Yusuf Sarai
4	Central	Lajpat Nagar and South Extension

The survey covered 277 shops in four selected markets in SDMC. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Delhi (SDMC)

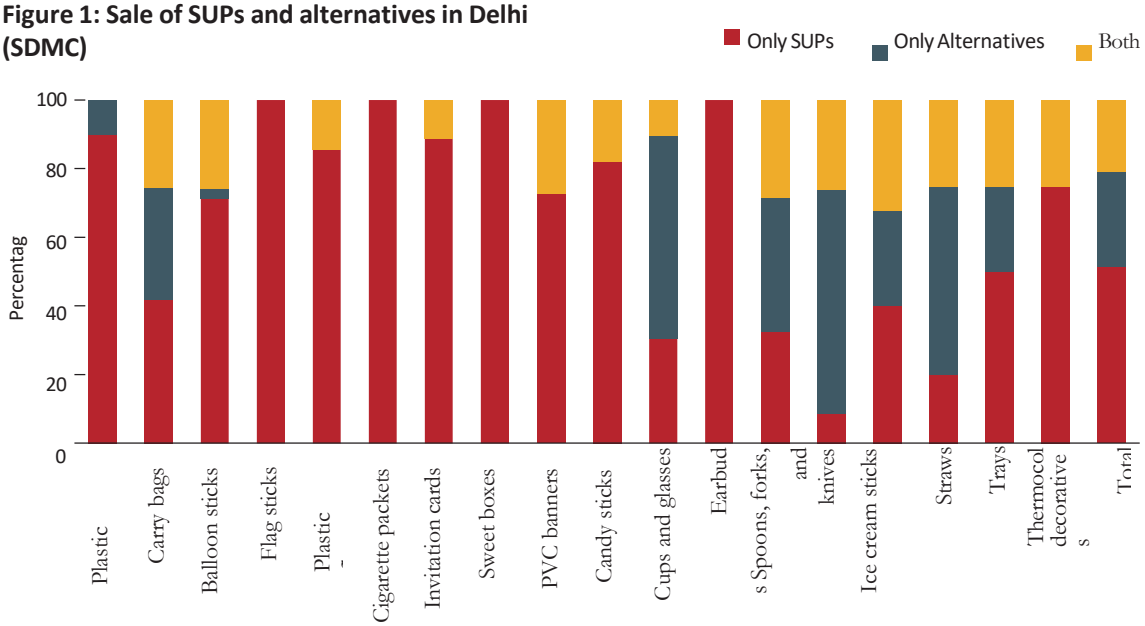


Table 3: Types of alternatives to SUPs in Delhi (SDMC)

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	1	Paper sheet			
SUP carry bags (below 75 μ) available	4	Paper bag	Paper envelope	Cloth Bag	Woven Bag
Plastic balloon sticks	1	Yarn			
Plastic flag sticks	0				
Plastic flags	1	Paper flag	Clothing Flag		
Wrapping/films on cigarette packets	0				
Plastic wrapping/films on invitation cards	1	Paper envelope			
Wrapping/films on sweet boxes	0				
PVC banners below 100 μ	2	Cloth banner	Canvas		
SUP candy sticks	1	Wooden candy sticks			
Cups and glasses	4	Clay cup	Paper cup	Steel Glass	Reusable cup
Earbuds	0				
Spoons forks knives	2	Steel spoon, fork, knives	Wooden fork, spoon and knives		
Ice cream sticks	2	Wooden stick	Bamboo stick		
Plates	2	Steel plates	Paper plates		
Straws	1	Paper straws			
SUP trays	2	Paper tray	Reusable tray		
Thermocol decorative	2	Tissue paper	Paper		



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Dhanbad

Dhanbad is located in the Eastern state of Jharkhand, and shares a border with West Bengal. Dhanbad is known as the Coal Capital of India, with more than 100 coal mines. The Dhanbad Municipal Corporation(DMC) constitutes an area of 355.77 sq km. It is divided into 55 municipal wards, and houses a population of about 2.8 million (as per Census 2011). The DMC was formed in 2006 by combining the erstwhile Dhanbad Municiaplaity, Jharia NAC, Sindri NAC, Katras NAC, Chhatandh NAC, and 27 other census towns located in and around Dhanbad. There are about 2,20,783 households in Dhanbad.

1. Single-use Plastic Waste Inventory

In Dhanbad, the municipal waste was collected from three residential wards every day. The residential wards from where waste was collected during the five study are Ward number 21, 22, 23, 25, 28. Similarly, waste was collected from two commercial wards every day. Commercial waste was collected from Ward number 23, 24 and 27. Ward 23 is a mixed ward. It has residential as well as a large commercial area from where waste is collected separately. From Ward 23, both residential and commercial samples were collected.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Dhanbad was conducted from 26 to 30 June 2022 at one of the transfer stations, where door to door waste collected from identified wards were brought for inventory.

Results of inventory

Banned SUPs account for about 24% of the total plastic waste in Dhanbad. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 92% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 7% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 1% of the total plastics by weight.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.24
2	Carry bags	92.35
3	Plastic sheets	0.06
4	Cutlery items	7.09
5	Wrapping and film	0.10
6	Others	0.16

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of April and May 2022.

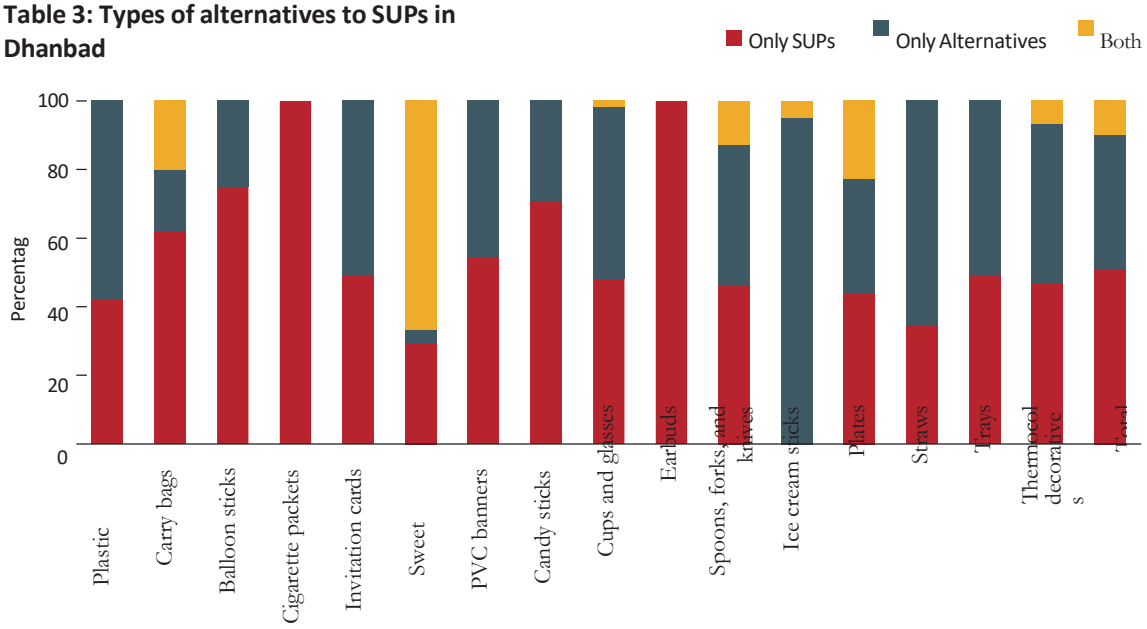
Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Hirapur, Bartand
2	South	Digwadih, Sindri
3	East	Jharia, Phusbunglow
4	West	Katrasgarh, Putki

The survey covered 259 shops in four selected markets in Dhanbad. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Dhanbad

Table 3: Types of alternatives to SUPs in Dhanbad



Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Aluminium sheets	Paper sheets		
Plastic carry bags (<75 μ)	2	Paper Bags	Cloth bags		
Plastic balloon sticks	1	Latex rubber sticks			
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards without films			
Plastic films on sweet boxes	1	Cardboard/ paper box without film			
PVC banners (<100 μ)	1	Above 100 microns			
Plastic candy sticks	1	Paper stick			
Plastic cups and glasses	3	Paper cups and glasses	Steel cups and glasses	Hard plastic/ ceramic cups	
Plastic earbuds	0				
Plastic spoons, forks and knives	2	Steel cutlery	Wooden cutlery		
Plastic ice-cream sticks	1	Wooden sticks			
Plastic plates	2	Ceramic plates, reusable plastic plates	Steel		
Plastic straws	1	Paper straws			
Plastic trays	2	Aluminium trays	Paper trays		
Thermocol decorative items	1	Paper décor			
Thermocol decorative items.	1	Paper decorative items			

 # Plastic flags and flag sticks was not found during the survey.



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Guwahati

Guwahati, the capital city of Assam, is also known as the gateway of North-East and is the largest city in the entire North-Eastern Region. It is situated between the southern bank of the Brahmaputra River and the foothills of the Shillong plateau. Dispur, a part of Guwahati, serves as the capital of Assam. The Guwahati municipal corporation (GMC) is the administrative body that looks after civic amenities, including the town's municipal solid waste (MSW) management. It consists of 60 wards (delimited from 31 wards), with a total area of 216.79 sq km.

1. Single-use Plastic Waste Inventory

In Guwahati, the municipal waste was collected from six residential wards, High-income residential (Ward Nos. 33 and 37), Middle-income residential areas (Ward Nos. 26 and 31), and Low-income residential areas (Ward Nos. 20 and 23), two mixed commercial and residential wards (Ward 18 and 32), and two commercial wards (Ward 17 and 39).

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Guwahati was conducted from 7 to 10 May 2022 at a designated place where all the waste were brought and characterised. The rate of segregation in Guwahati is poor.

Results of inventory

Banned SUPs accounted for about 30% of total plastic waste in Guwahati. The most common banned SUP found in the waste stream are carry bags, accounting for more than 76% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 23% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 1%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.32
2	Carry bags	76.18
3	Plastic sheets	0.00
4	Cutlery items	23.45
5	Wrapping and film	0.05
6	Others	0.00

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of April and May 2022. In each zone, major markets, which represented diversity in economic activities, were selected.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Fancy Bazar and Lakhtokia
2	South	Six Mile
3	East	Ganeshguri
4	West	Maligaon and Adabari

The survey covered 172 shops in four selected markets in Guwahati. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Guwahati

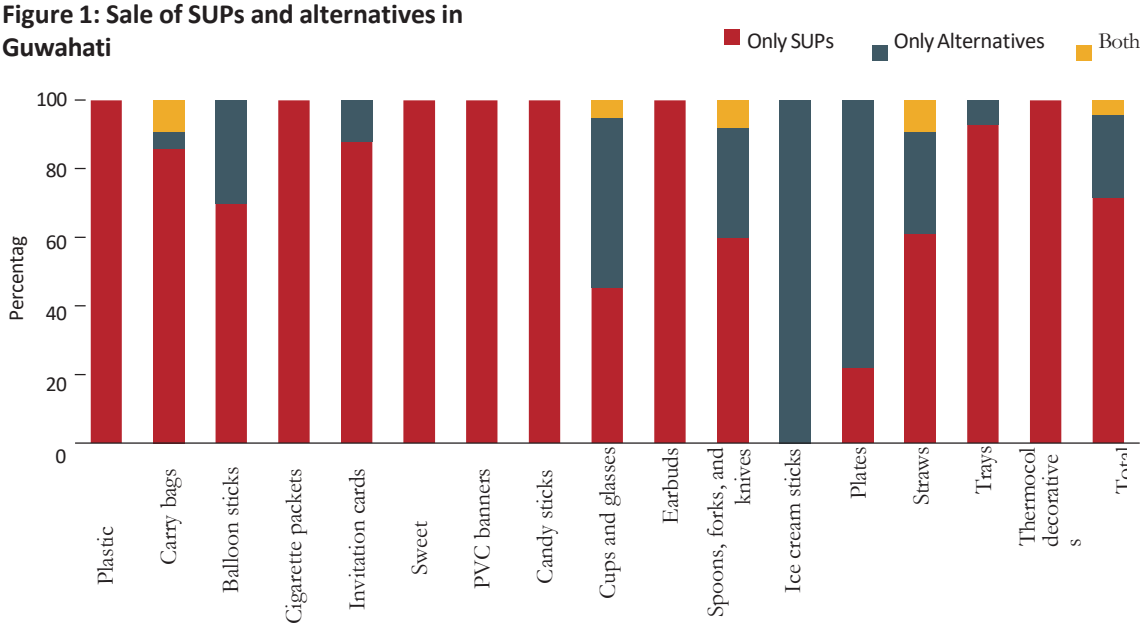


Table 3: Types of alternatives to SUPs in Guwahati

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4	Type 5
Plastic sheets	0					
Plastic carry bags (below 75 microns)	4	Paper bag	Paper envelope	Cloth Bag	Woven Bag	
Plastic balloon sticks	2	Thread	Ribbon			
Plastic films on cigarette packets	0					
Plastic films on invitation cards	1	Paper cards without lamination				
Plastic films on sweet boxes	0					
PVC banners (below 100 microns)	0					
Plastic candy sticks	0					
Plastic cups and glasses	3		Paper cup and glasses	Steel Glass	Reusable cup and glasses	
Plastic earbuds	0					
Plastic spoons, forks and knives	2	Steel spoon, fork, knives	Wooden fork, spoon and knives			
Plastic Ice cream sticks	1	Wooden stick				
Plastic plates	5	Steel plates	Paper plates	Areca nut leaf plates	Ceramic plates	Aluminium foils
Plastic straws	1	Paper straws				
Plastic trays	1		Reusable tray			
Thermocol decorative	0					
Plastic sheets	0					
Thermocol decoratives	2	Paper décor	Cloth decor			


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Indore

It is the largest city in Madhya Pradesh, and is regarded as the commercial capital of the state. It is located at a distance of 190km from the capital city of Bhopal and is spread over an area of 3898 sq km. As per the Census 2011, the population of Indore is estimated to be 32,76,697. Indore city presents a happy blend of historical past and promises of rapid future modernisation. Indore has been part of the Swachh Survekshan survey since its inception and ranked 25th place in 2016. It has been ranked as India's cleanest city for three years in a row as per the Swachh Survekshan for 2017, 2018 and 2019.

1. Single-use Plastic Waste Inventory

In Indore, the municipal waste was collected from six residential wards High-income residential (Ward Nos. 45 and 47), Middle-income Residential areas (Ward Nos. 26 and 27), and Low-income residential areas (Ward Nos. 24 and 46), two mixed commercial and residential wards (Ward 25, 43) and two commercial areas from (Ward 57 and 47). Before the characterisation study, the waste collectors were trained not to take out any valuable dry waste from the sample.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Indore was conducted from 7 to 12 May 2022 at the Material Recovery Facility, the town mostly collects segregated waste and all the collected waste is send to this facility for resource recovery.

Results of inventory

Banned SUPs accounted for approximately 12% of total plastic waste in Indore. The most common banned SUP product found in the waste stream are carry bags, accounting for 56.9% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 36.9% of the total banned SUPs. The contribution of the rest of the banned SUPs like plastic sheets with thickness less than 50 microns, plastic wrappings on Invitation cards and sweet boxes, plastic films on cigarette packets, and other products adds up to 6% of the total weight.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.72
2	Carry bags	56.89
3	Plastic sheets	1.48
4	Cutlery items	36.90
5	Wrapping and film	1.71
6	Others	2.31

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of April and May 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North East	56 dukaan, Patnipura square, Malwa Mill
2	South East	Bhawarkua market, Sapnasangeeta Road
3	North West	Sangam Nagar, Banganga Side Market
4	South West	Bada Ganpati, Kalani Nagar

The survey covered 250 shops in four selected markets in Indore. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Indore

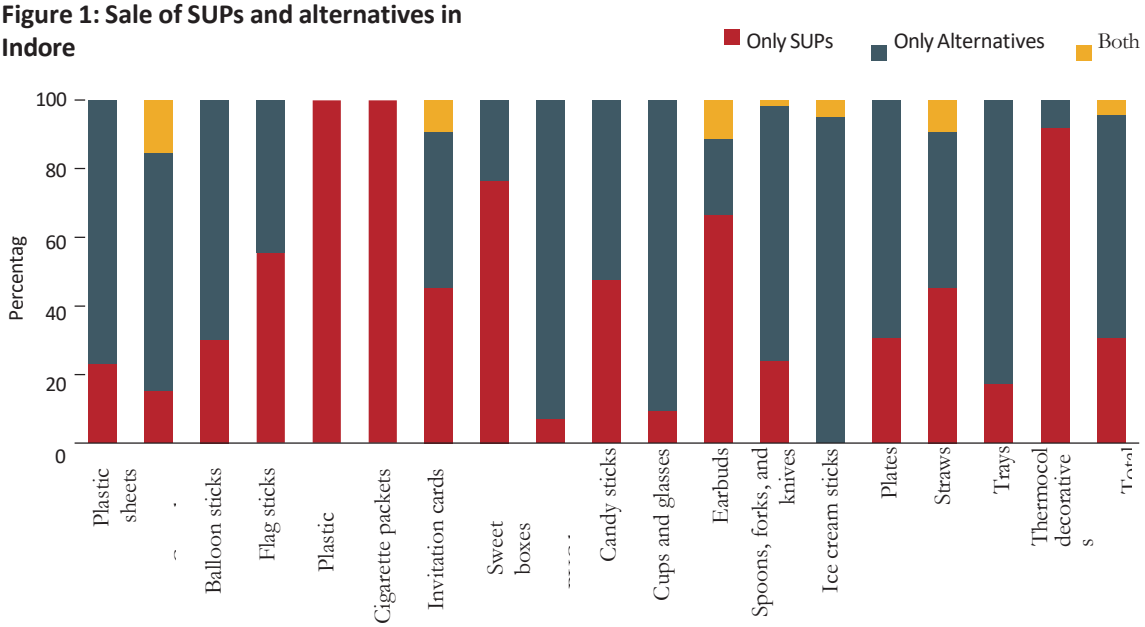


Table 3: Types of alternatives to SUPs in Indore

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	1	Silver foil paper roll			
Plastic carry bags (below 75 microns)	1	Non-woven Carry bags			
Plastic balloon sticks	2	Wooden sticks	Thread		
Plastic flag sticks	2	Wooden sticks	Thread		
Plastic flags	0				
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper Envelope			
Plastic films on sweet boxes	1	Paper boxes			
PVC banners (below 100 microns)	4	Above 100-micron flex	300 GSM	Above 125 microns.	200-micron banners
Plastic candy sticks	1	Wooden stick			
Plastic cups and glasses	4	Ceramic Cups	Hard acrylic cups	Steel cups, glass cups	Sugarcane Bagasse bio-degradable cups
Plastic earbuds	1	Wooden stick earbuds			
Plastic spoons, forks, and knives	1	Steel spoon, fork, knives			
Plastic Ice cream sticks	1	Wooden stick			
Plastic plates	4	Steel plates	Biodegradable Sugarcane Bagasse Plates	Ceramic plates	Hard Acrylic plates
Plastic straws	1	Paper straws			
Plastic trays	3	Steel tray	Acrylic trays	Wooden trays	
Thermocol decorative	1	Hard Plastic décor items			



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Jorhat

Jorhat is about 300 km away from the state capital Guwahati, situated on the southern bank of the Brahmaputra river. One of the major commercial hubs of Assam, Jorhat is also known as the cultural capital of the state. Bhogdoi river, a tributary of the Brahmaputra, passes through the city and is the primary source of water for its residents. As per the Census 2011, Jorhat Municipal Board (covering the outgrowth area) had a population of 1.27 lakh; the estimated population for 2020 is over 2.2 lakh.

1. Single-use Plastic Waste Inventory

In Jorhat, the municipal waste was collected from three residential wards (Ward No. 3, 7 and 17), one mixed commercial and residential, and one commercial wards (Ward No. 8 and 12). Before the characterisation study, the waste collectors were trained not to take out any valuable dry waste from the sample. See Figure 3 for the location of the selected wards.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Jorhat was conducted from 7 to 11 April 2022 at the landfill site. The waste segregation rate in the city is very poor.

Results of inventory

Banned SUPs account for about 46% of the total plastic waste in Jorhat. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 91% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 8.5% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 0.2%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.02
2	Carry bags	91.34
3	Plastic sheets	0.00
4	Cutlery items	8.49
5	Wrapping and film	0.14
6	Others	0.00

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of April and May 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Chowk Bazaar
2	South	Tarazan Market
3	East	Gar Ali Market
4	West	Baruah Chariali

The survey covered 123 shops in four selected markets in Jorhat. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Jorhat

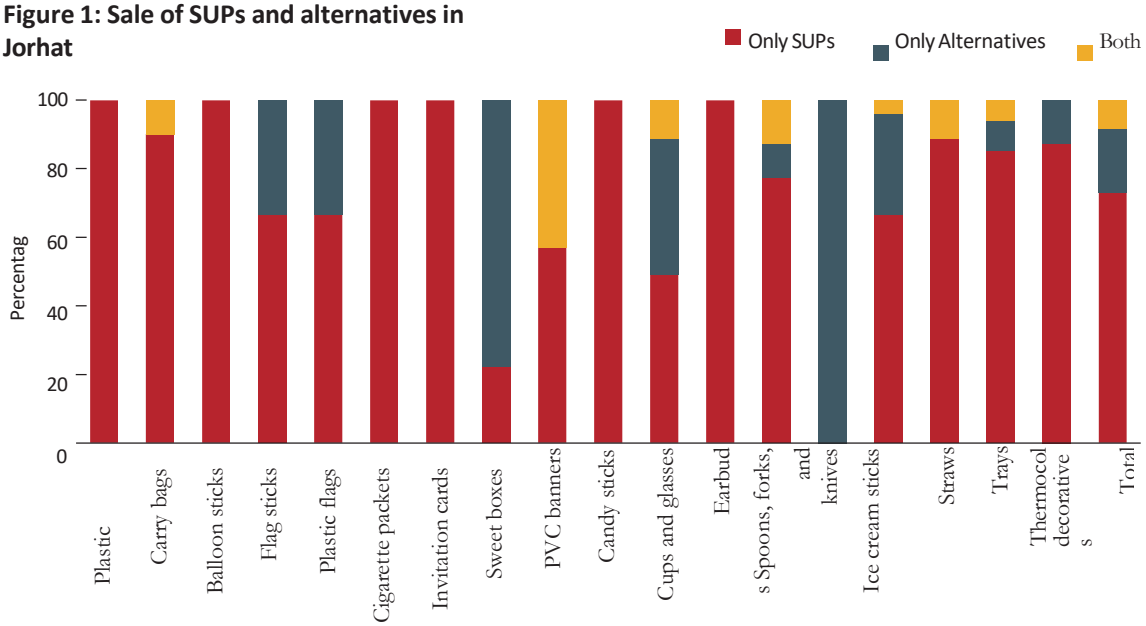


Table 3: Types of alternatives to SUPs in Jorhat

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	0				
Plastic carry bags (<75 μ)	1	Paper bags			
Plastic balloon sticks	0				
Plastic flag sticks	1	Wooden			
Plastic flags	1	Paper			
Plastic films on cigarette packets	0				
Plastic films on invitation cards	0				
Plastic films on sweet boxes	1	Paper boxes without film			
PVC banners (<100 μ)	1	>100 μ flex			
Plastic candy sticks	0				
Plastic cups and glasses	4	Ceramic cups	Paper cups	Steel glasses and glass (material) glasses	Steel cup, ceramic cup and reusable ceramic cups
Plastic earbuds	0				
Plastic spoons, forks and knives	1	Steel spoon, fork and knife			
Plastic ice-cream sticks	1	Wooden stick			
Plastic plates	3	Steel plate	Laminated paper plates	Ceramic plates	
Plastic straws	1	Paper straws			
Plastic trays	2	Steel tray	Reusable plastic trays		
Thermocol decoratives	2	Tissue paper	Paper items		



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Karaikal

Karaikal is a small coastal town located in the Union Territory of Puducherry. It is surrounded by Nagapattinam and Tiruvarur districts of Tamil Nadu and the Bay of Bengal in the North, South, West and East, respectively. It lies at a distance of 140 kms from Puducherry and about 300 kms south of Chennai. The Arasalar river, a tributary of the Cauvery River flows through Karaikal, making it a part of the fertile Cauvery delta. According to 2011 Census, Karaikal is home to 21,320 households and has a total population of 86,838. The current estimated number of households in 2022 in Karaikal is 25,653 with a population is 1 Lakh. The town is spread over an area of 52 sq km. and is divided into 18 municipal wards.

1. Single-use Plastic Waste Inventory

In Karaikal, the municipal waste was collected randomly from six residential wards per day (Ward Nos. 15, 17, 4, 12, 11, 9 in 5 days) and two vehicles collecting commercial waste from wards 1 to 16.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Karaikal was conducted from 4 to 8 July 2022 at the Material Recovery Facility, since the town mostly collects segregated waste and all the waste is collected and send to this facility for resource recovery before going to the dumpsite.

Results of inventory

Banned SUPs account for 17.6% of the total plastic waste in Karaikal. The most common banned SUPs found in the waste stream are carry bags, accounting for 90% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 7.58% of the total banned SUPs. The contribution of the rest of the banned SUPs was about 3%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	1.48
2	Carry bags	89.43
3	Plastic sheets	0.08
4	Cutlery items	7.58
5	Wrapping and film	0.12
6	Others	1.32

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and their alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of June and July 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Keezhakasakudy Market
2	South	Polican Street
3	East	Nehru Market
4	West	Dargah Market

The survey covered 140 shops in four selected markets in Karaikal. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Karaikal

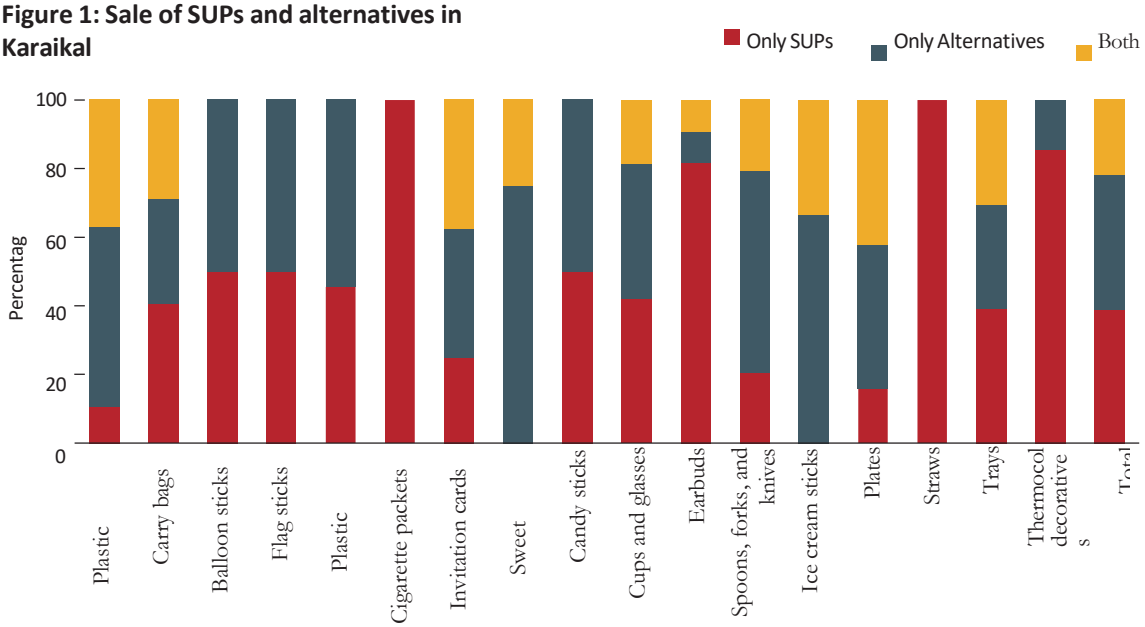


Table 3: Types of alternatives to SUPs in Karaikal

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Banana Leaves	Aluminium sheet (Silver cover sheets		
Plastic carry bags (<75 μ)	3	Paper bags	Cloth bags	Bio-degradable carry bags	
Plastic balloon sticks	1	Wooden sticks			
Plastic flag sticks	1	Wooden sticks			
Plastic flags	2	Paper flags	Cotton cloth flags		
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards			
Plastic films on sweet boxes	1	Cardboard/ Paper boxes			
PVC banners (<100 μ)	1	Cloth banners			
Plastic candy sticks	1	Wooden sticks			
Plastic cups and glasses	1	Steel cups and glasses			
Plastic earbuds	1	Bamboo earbuds			
Plastic spoons, forks and knives	1	Steel cutlery			
Plastic ice-cream sticks	2	Manufactured Wooden sticks	Tree sticks(twigs)		
Plastic plates	1	Steel plates			
Plastic straws	0				
Plastic trays	1	Aluminium trays			
Thermocol decoratives	1	Paper décor			



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Lucknow

Lucknow is the state capital and the second largest urban agglomeration in the state of Uttar Pradesh. The Lucknow Municipal Corporation (LMC) is the administrative body in charge of civic amenities in the city and its municipal solid waste (MSW) management. LMC consists of 8 zones and 110 wards, with a total area of 248 sq km. The city is ranked 12th in the Swachh Survekshan ranking 2021, the Central Government's annual cleanliness survey. As per Census 2011, Lucknow Municipal Corporation had a population of 28.17 lakh, the estimated population for 2021 is over 37.9 lakh.

1. Single-use Plastic Waste Inventory

Fresh municipal waste samples were collected directly from the vehicles transporting waste from various wards. In Lucknow, the municipal waste was collected randomly from five residential wards (Ward 27, 42, 66, 92 and 99), one sample each from different economic strata, one sample from three mixed commercial and residential wards (Ward 55, 102 and 104) on different days, and one commercial ward (Ward 21).

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Lucknow was conducted from 15 to 19 September 2022 at one of the transfer stations on Seth Ramjas Road, near Lucknow zoo. The door to door waste collected from the identified wards were brought at the transfer station for inventory.

Results of inventory

Banned SUPs account for about 11% of the total plastic waste in Lucknow. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 93% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 5.11% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 2%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.35
2	Carry bags	93.42
3	Plastic sheets	0.05
4	Cutlery items	5.11
5	Wrapping and film	0.50
6	Others	0.56

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of August and September 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Gayatri market and Gol market
2	South	Bangla Bazar/Telibagh and Sadar Bazaar/ Kaka market
3	East	Chinhat and Bhootnath market
4	West	Rahmani market, Chanda market

The survey covered 333 shops in four selected markets in Lucknow. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Lucknow

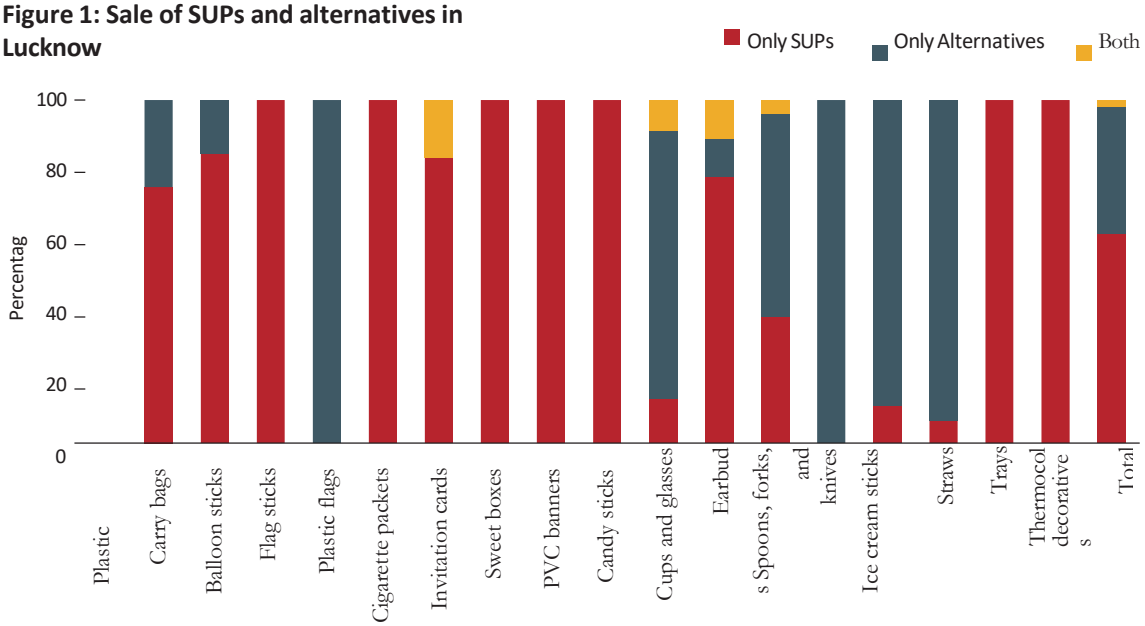


Table 3: Types of alternatives to SUPs in Lucknow

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets					
Plastic carry bags (<75 μ)	3	Paper bag	Cloth Bag	>75 microns	
Plastic balloon sticks	1	Wooden stick			
Plastic flag sticks	0				
Plastic flags	2	Paper	Cloth		
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards without any wrapping			
Plastic films on sweet boxes	0				
PVC banners (<100 μ)	0				
Plastic candy sticks	0				
Plastic cups and glasses	4	Paper	Steel Glass	Ceramic	Glass
Plastic earbuds	1	Wooden stick			
Plastic spoons, forks and knives	2	Steel spoon, fork, knives	Wooden fork, spoon and knives		
Plastic ice-cream sticks	1	Wooden stick			
Plastic plates	4	Steel plates	Paper plates	Pattal (leaf plates)	aluminium foil
Plastic straws	1	Paper straws			
Plastic trays	0				
Thermocol decoratives	0				



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Mamallapuram

Mamallapuram also known as Mahabalipuram, is a coastal town located in the Chengalpattu district of the southern state of Tamil Nadu. It is situated on the Coromandel coast of Bay of Bengal, at a distance of 56 km south from Chennai, the capital city of Tamil Nadu. The town is spread across an area of 12.85 sq km. As per the SECC of 2011, the total population of the town is around 15,000. A total of 5,994 households reside in Mamallapuram. The current population (Census 2021) is around 20,000. It is best known for the UNESCO World Heritage Site of the Hindu Group of monuments at Mahabalipuram belonging to the 7th and 8th centuries.

1. Single-use Plastic Waste Inventory

Fresh municipal waste samples were collected directly from the vehicles transporting waste from various wards. As the population size in Mamallapuram is very small, one vehicle had the capacity to collect municipal waste from two to three municipal wards based on the size and population in the wards. Hence, five vehicles, three from Residential areas, High-income residential (Ward Nos. 4, 5, and 8), Middle-income Residential areas (Ward Nos. 9, 14, and 15), and Low-income residential areas (Ward Nos. 10, 11, 12, and 13), and 1 vehicle each from Mixed Commercial & Residential (Ward Nos. 6 & 7), and Commercial areas (Ward Nos. 2,7, and 3) were chosen for taking the samples.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Mamallapuram was conducted from 1 to 5 July 2022 at the Material Recovery Facility, since the town mostly collects segregated waste and all the waste is collected and send to this facility for resource recovery.

Results of inventory

Banned SUPs account for about 20.6% of the total plastic waste in Mamallapuram. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 85% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 12.9% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 2%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	1.96
2	Carry bags	85.02
3	Plastic sheets	0.02
4	Cutlery items	12.90
5	Wrapping and film	0.10
6	Others	0.00

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of June and July 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Kovalam Road
2	South	Poonchery
3	East	Mahabalipuram Sea shore market
4	West	Tirukkallukundram Road

The survey covered 111 shops in four selected markets in Mamallapuram. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Mamallapuram

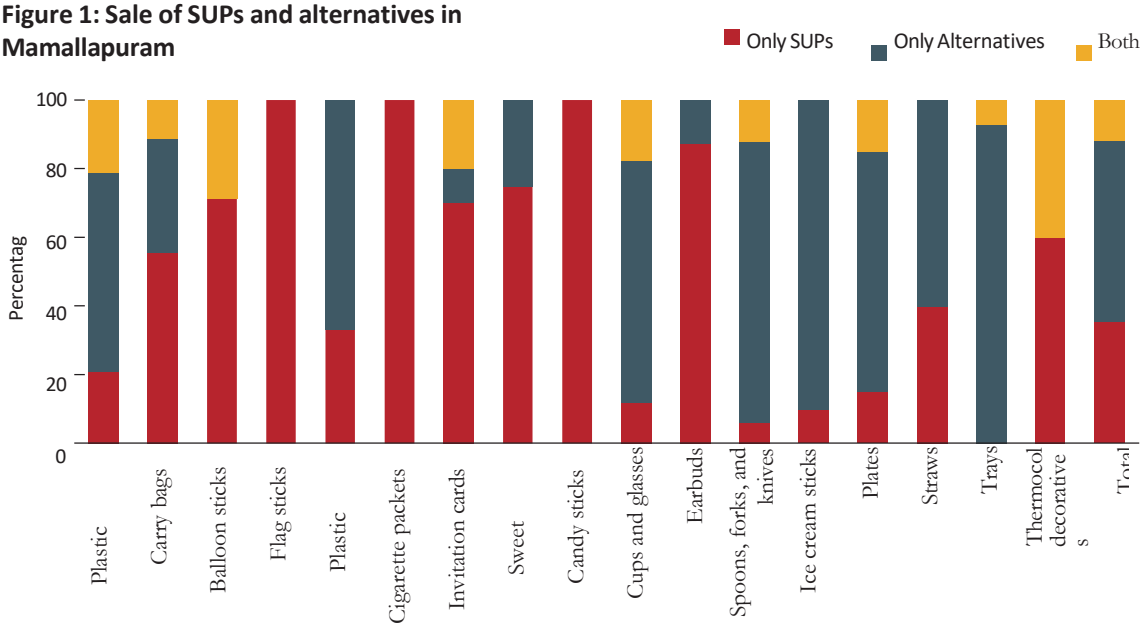


Table 3: Types of alternatives to SUPs in Mamallapuram

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Banana Leaves	Aluminium sheet		
Plastic carry bags (<75 μ)	3	Paper bags	Cloth bags	Aluminium pouches	
Plastic balloon sticks	1	Thread			
Plastic flag sticks	0				
Plastic flags	1	Paper flags			
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Cards without films			
Plastic films on sweet boxes	1	Cardboard boxes without plastic film			
Plastic candy sticks	0				
Plastic cups and glasses	3	Steel cups and glasses	Glass crockery	Paper cups and glasses	
Plastic earbuds	1	Wooden earbuds			
Plastic spoons, forks and knives	2	Aluminium cutlery	Wooden knives		
Plastic ice-cream sticks	1	Wooden sticks			
Plastic plates	3	Steel plates	Paper plates	Aluminium foil	
Plastic straws	1	Paper straws			
Plastic trays	1	Aluminium trays			
Thermocol decorative items.	1	Paper decorative items			

 # Shops printing PVC banners could not be found in the town. Locals explain that they are generally purchased from Chennai or other nearby towns.



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Mysuru

Mysuru is a city located in the southern part of the Indian State of Karnataka. It is located in the foothills of the Chamundi Hills of the Western Ghats, and at a distance of 145 kms south-west from Bangalore, the IT hub of India. The Kaveri River and its tributary, the Kabini river flows through the northern and southern boundaries of the city, respectively. As per Census 2011, the total number of households in Mysuru is 2,15,061 with a population of 9,20,550.

1. Single-use Plastic Waste Inventory

In Mysuru, the inventory was done on door to door dry waste samples collected from three Residential areas, High-income residential (Ward No. 59), Middle-income Residential areas (Ward No. 5), and Low-income residential areas (Ward No. 10), and one from Mixed Commercial & Residential (Ward No. 63), and Commercial areas (Ward No. 49) were chosen for taking the samples.

(Note: ITC-WOW has been assigned to collect the dry waste from these localities and the wet waste is collected by the separate concessionaire assigned by the municipality).

The inventorisation study in Bengaluru was conducted from 02 to 06 July 2022 at the Material Recovery Facility operated by ITC. The dry waste collected from door to door collection is brought at the facility for resource recovery.

Results of inventory

Banned SUPs account for about 12.2% of the total plastic waste in Mysuru. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 57.93% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 23.62% of the total banned SUPs. Other SUPs like plastic flags, PVC banners and thermocol decorative items account for 8.6% of the total banned SUPs (by weight). The contribution of the rest of the banned SUPs was around 10%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	3.39
2	Carry bags	57.93
3	Plastic sheets	3.04
4	Cutlery items	23.62
5	Wrapping and film	3.42
6	Others	8.60

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and their alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of May and June 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Maheshwara Layout,
2	South	Vidyaranyapura, Kuvempu Nagara
3	East	Rajeev Nagar, Udayagiri circle
4	West	Saraswathi puram
5	Central	Mandi mohalla, Lokanayaka nagar circle

The survey covered 280 shops in four selected markets in Mysuru. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Mysuru

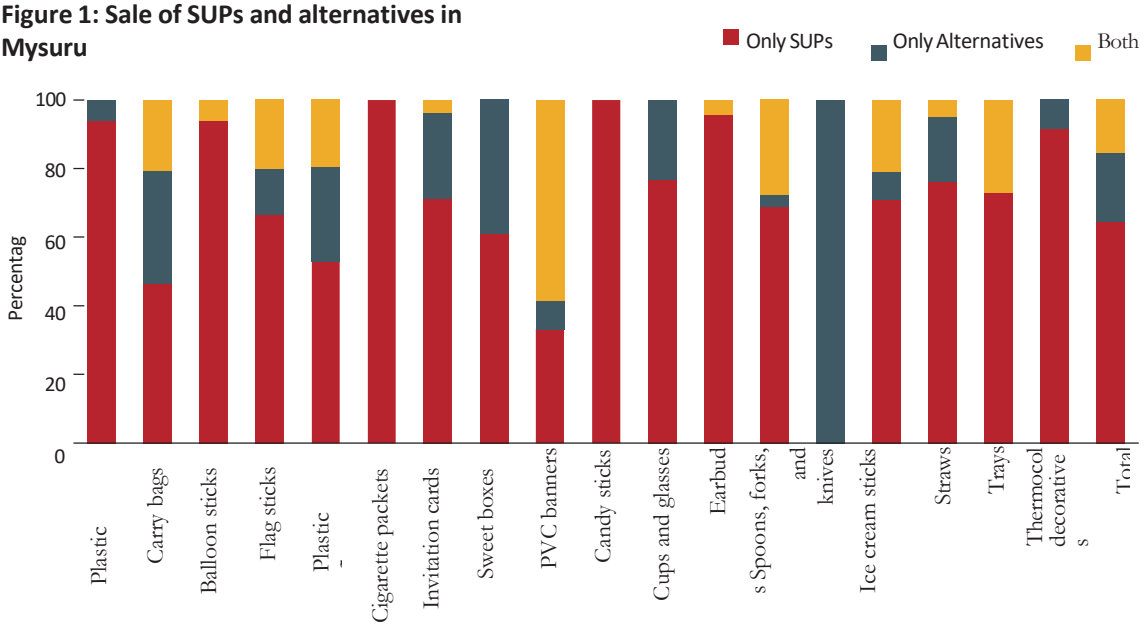


Table 3: Types of alternatives to SUPs in Mysuru

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Aluminium sheets	Banana leaves		
Plastic carry bags (<75 μ)	2	Paper Bags	Cloth bags		
Plastic balloon sticks	1	Wooden sticks			
Plastic flag sticks	3	Wooden sticks	Rubber sticks	Cloth stick	
Plastic flags	2	Cloth flags	Paper flags		
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards without films			
Plastic films on sweet boxes	1	Cardboard/ paper box without film			
PVC banners (<100 μ)	2	Cloth banners	Above 230 GSM		
Plastic candy sticks	0				
Plastic cups and glasses	2	Paper cups and glasses	Steel cups and glasses		
Plastic earbuds	1	Wooden earbuds			
Plastic spoons, forks and knives	2	Steel cutlery	Wooden cutlery		
Plastic ice-cream sticks	1	Wooden sticks			
Plastic plates	2	Ceramic plates, reusable plastic plates	Steel plates		
Plastic straws	1	Paper straws			
Plastic trays	1	Aluminium trays			
Thermocol decoratives	2	Paper décor			


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Surat

Surat is the second most populous city of Gujarat, which is situated on the bank of River Tapi. The Surat Municipal Corporation (SMC) is the administrative body in charge of civic amenities in the city and its municipal solid waste (MSW) management. SMC consists of 8 zones and 30 wards, with a total area of 461.6 sq km. The city is ranked second in the Swachh Survekshan ranking 2021, the Central government annual cleanliness survey. As per Census 2011, Surat Municipal Corporation had a population of 44.6 lakh; the estimated population for 2021 is over 57.3 lakh.

1. Single-use Plastic Waste Inventory

In Surat, the waste for inventory was collected from three residential areas, High-income residential (Vesu), Middle-income Residential areas (Bhatar), and Low-income residential areas (Dumas), and one from Mixed Commercial & Residential (Piplod), and one from Commercial areas (City Light) were chosen for taking the samples.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Surat was conducted from 02 to 06 August 2022 at one of the Material Recovery Facility at Bhatar. The door to door collected waste, first goes to the MRF for resource recovery and then to the dumpsite at Khajod.

Results of inventory

Banned SUPs account for about 18% of the total plastic waste in Surat. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 85% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 10.8% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 4%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	1.57
2	Carry bags	85.91
3	Plastic sheets	0.40
4	Cutlery items	10.78
5	Wrapping and film	0.12
6	Others	1.22

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of August and September 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Railway station and Chauta bazar
2	South	Sachin market and Vesu
3	East	Varacha and Hirabaug
4	West	Jahangirpura and Adajan

The survey covered 274 shops in total within these four selected markets in Surat. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Surat

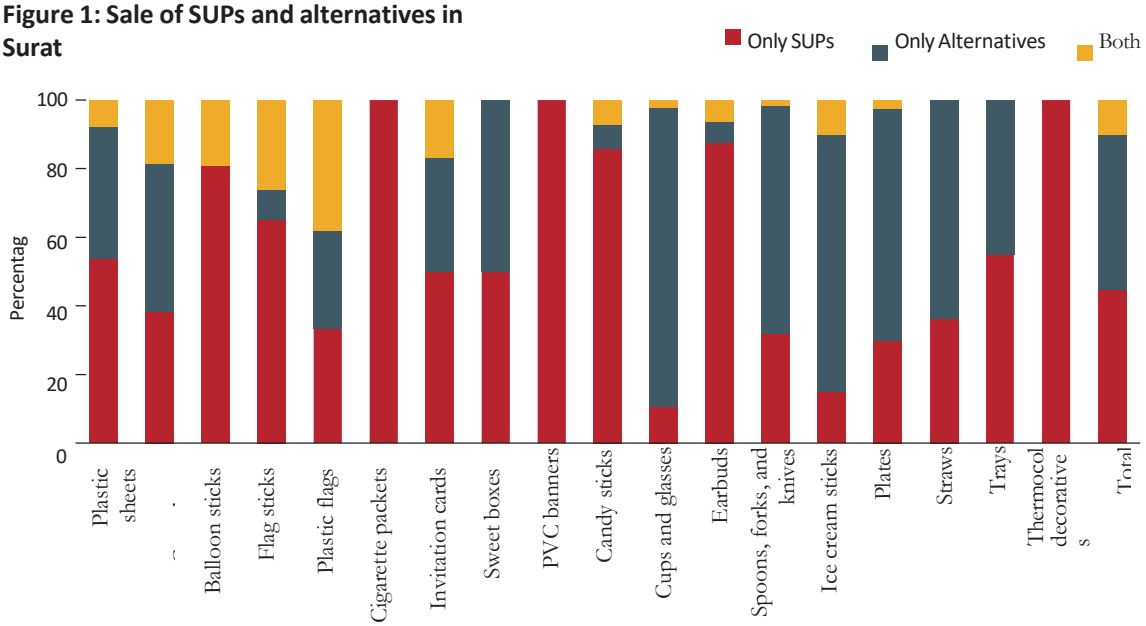


Table 3: Types of alternatives to SUPs in Surat

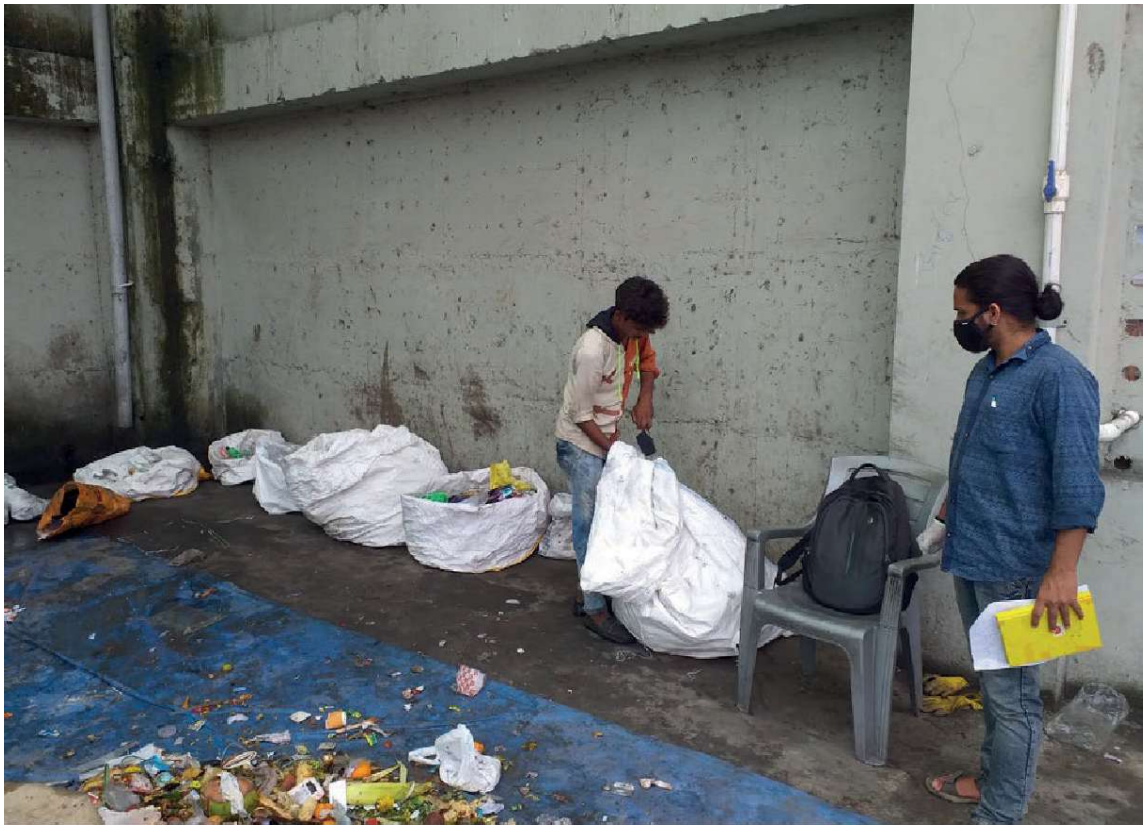
Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Paper	Butter paper		
SUP carry bags (below 75 μ) available	4	Paper bag	Cloth Bag	>75 microns	Biodegradable bags
Plastic balloon sticks	1	thread			
Plastic flag sticks	1	Wooden stick			
Plastic flags	2	Paper	Cloth		
Wrapping/films on cigarette packets	0				
Plastic wrapping/films on invitation cards	1	Paper cards without any wrapping			
Wrapping/films on sweet boxes	2	Paper	Butter paper		
PVC banners below 100 μ	0				
SUP candy sticks	1	Wooden stick			
Cups and glassess	4	Glasses made of glass	Paper	Steel Glass	Ceramic
Earbuds	1	Wooden stick			
Spoons forks knives	2	Steel spoon, fork, knives	Wooden fork, spoon and knives		
Ice cream sticks	1	Wooden stick			
Plates	4	Steel plates	Paper plates	Ceramic	Aluminium foil
Straws	1	Paper straws			
SUP trays	2	wooden	Reusable tray		
Thermocol decorative	0				



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Tirupati

Tirupati city is located in the southeastern part of Andhra Pradesh. It falls under the Chittoor district of A.P and is situated at the foothills of the Eastern Ghats. The city is spread over an area of 27.44 sq km. It is located 550 kms from the capital city of A.P. The estimated population of the city in 2021 was 4.61 lakhs and a floating population of 1 lakh. There are 1,04,252 households and almost 10,000 commercial and industrial establishments in the city. The city is divided into 50 election wards in the municipality.

1. Single-use Plastic Waste Inventory

In Tirupati, the municipal waste samples were randomly collected from residential wards (Ward 5,6,8,13,14,19, 42, 43 and 47) and commercial wards (Ward 8, 10, 21, 28, 32, and 34). A high rate of source segregation was observed in Tirupati. Most of the vehicles collecting municipal waste were seen to be receiving segregated waste. Hence the inventory process was conducted on dry waste only.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Tirupati was conducted from 30 June to 4 July 2022 at the Material Recovery Facility, since the town mostly collects segregated waste and all the waste is collected and send to this facility for resource recovery.

Results of inventory

Banned SUPs account for about 6.9% of the total plastic waste in Tirupati. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 95.3% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 2.6% of the total banned SUPs, which is relatively lower than most other cities of India. The contribution of the rest of the banned SUPs was less than 2%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.22
2	Carry bags	95.27
3	Plastic sheets	1.44
4	Cutlery items	2.62
5	Wrapping and film	0.18
6	Others	0.27

Note:
- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of June and July 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Anna Rao circle
2	South	Gandhi Road
3	East	Renigunta Road
4	West	S V Nagar

The survey covered 140 shops in total within these four selected markets in Tirupati. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Tirupati

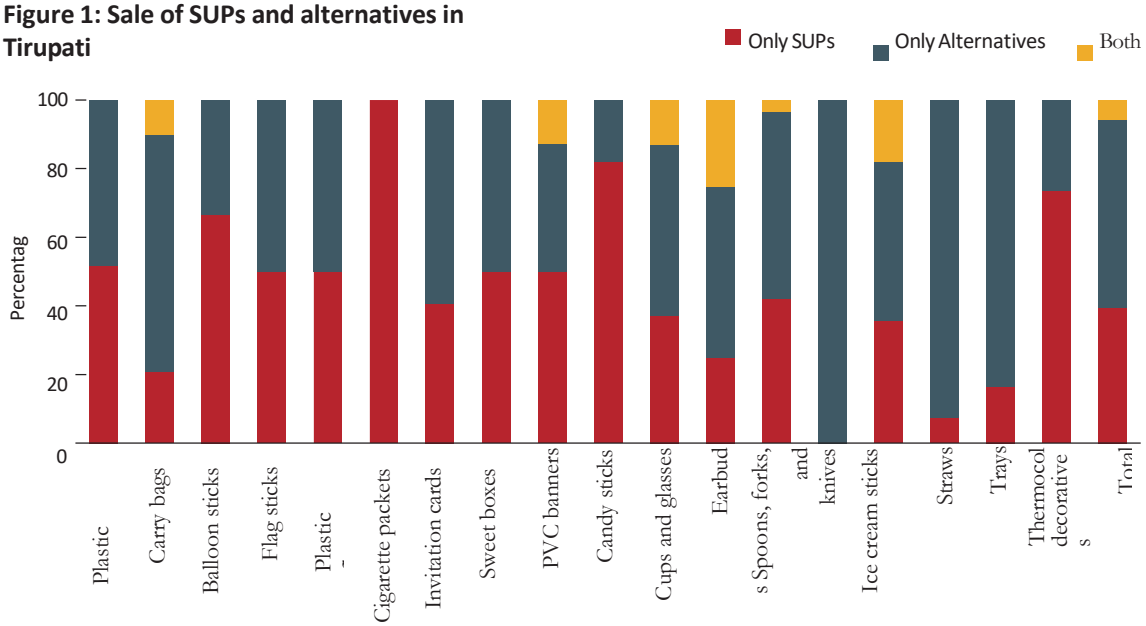


Table 3: Types of alternatives to SUPs in Tirupati

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3
Plastic sheets	2	Silver Foil	Paper sheets	
Plastic carry bags (<75 μ)	3	Paper bags	Jute carry bags	Cloth bags
Plastic balloon sticks	1	Thread		
Plastic flag sticks	1	Paper stick		
Plastic flags	2	Cloth flags	Paper flags	
Plastic films on cigarette packets	0			
Plastic films on invitation cards	1	Paper card without films		
Plastic films on sweet boxes	1	Cardboard boxes		
PVC banners (<100 μ)	2	230 GSM	Cloth banners	
Plastic candy sticks	1	Paper sticks		
Plastic cups and glasses	2	Steel glasses	Paper glasses	
Plastic earbuds	1	Wooden earbuds		
Plastic spoons, forks and knives	2	Steel cutlery	Wooden spoons, forks and knives	
Plastic ice-cream sticks	1	Wooden sticks		
Plastic plates	3	Steel Plates	Reusable plastic plates	Paper plates
Plastic straws	1	Paper straws		
Plastic trays	2	Cardboard box/ trays	Aluminium trays	
Thermocol decorative items	2	Paper décor	Inflatable balloon décor	


GPS Map Camera
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Trivandrum

Trivandrum city also called the 'Evergreen city of India', is the capital of India's most literate and socially developed state, Kerala. It is located on the west coast of India and has national strategical importance, in terms of economy, defence and education. The Trivandrum Municipal Corporation (TMC) is the administrative body in charge of civic amenities in the city and its municipal solid waste (MSW) management. TMC is divided into 25 zones and consists of 100 wards, with a total area of 214.86 sq km.

1. Single-use Plastic Waste Inventory

In Trivandrum, at present more than 40% of the households in the city are managing the biodegradable waste by themselves. For non-biodegradable waste the TMC has a calendar where they have disclosed what kind of waste they will collect in which month, the plastics waste is collected on a weekly basis.

For the waste inventory purpose, dry waste (non-biodegradable waste) being collected on weekly basis i.e. largely plastic waste was collected directly from the households. The team went with SHGs volunteers continuously for 5 days and collected the sample from different areas depending upon the economic strata. The list of wards and areas from where the waste was collected for sampling is provided in Table 1.

Table 1: Banned SUPs in the waste stream

High income	Middle income	Low income	Mixed commercial & residential	Commercial
PTP Nagar- 38	Vattiyoorkkavu-36	Kanjirampara-30	Nettayam-33	Palayam-27
Thirumala-40	Peroorkkada-31	Jagathy-44	Fort-80	Chalai-71
Sasthamangalam-22	Mannanthala-13	Pathirappally-20	Karamana-45	Manacaud-72
Kadakampally-92	Karikakom-91	Anamukham-95	Sanghumugham-89	Chakkai-86
Poojappura-42	Mudavanmugal-47	Thrickannapuram-48	Thambanoor-81	Beamapally-77
Ulloor-6	Sreekaryam-4	Chanthavila-2	Kesavadasapuram-15	Kazhakoottam-1

The inventorisation study was conducted from 21 to 25 June 2022 at the Material Recovery Facility, since all the collected waste is send to MRFs for resource recovery.

Results of inventory

Banned SUPs account for about 8.2% of the total plastic waste in Trivandrum. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 90% (by weight) of all the banned SUPs. The contribution of the rest of the banned SUPs was less than 8%. Cutlery items, the other prominent banned SUPs, accounted for 3.5% of the total banned SUPs.

Table 2: Banned SUPs in the waste stream*

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	0.86
2	Carry bags	92.28
3	Plastic sheets	0.00
4	Cutlery items	3.55
5	Wrapping and film	0.49
6	Others	2.82

*The categories of banned SUPs are same as for other cities.

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of April and May 2022.

Table 3: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Kazhakoottam market area, Palayam connemara market (central)
2	South	Venganoor Market, Vizhinjam market area
3	East	Nettayam Market, Peroorkada Junction market area
4	West	Manacaud market area, Chalai market

The survey covered 250 shops in four selected markets in Trivandrum. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Trivandrum

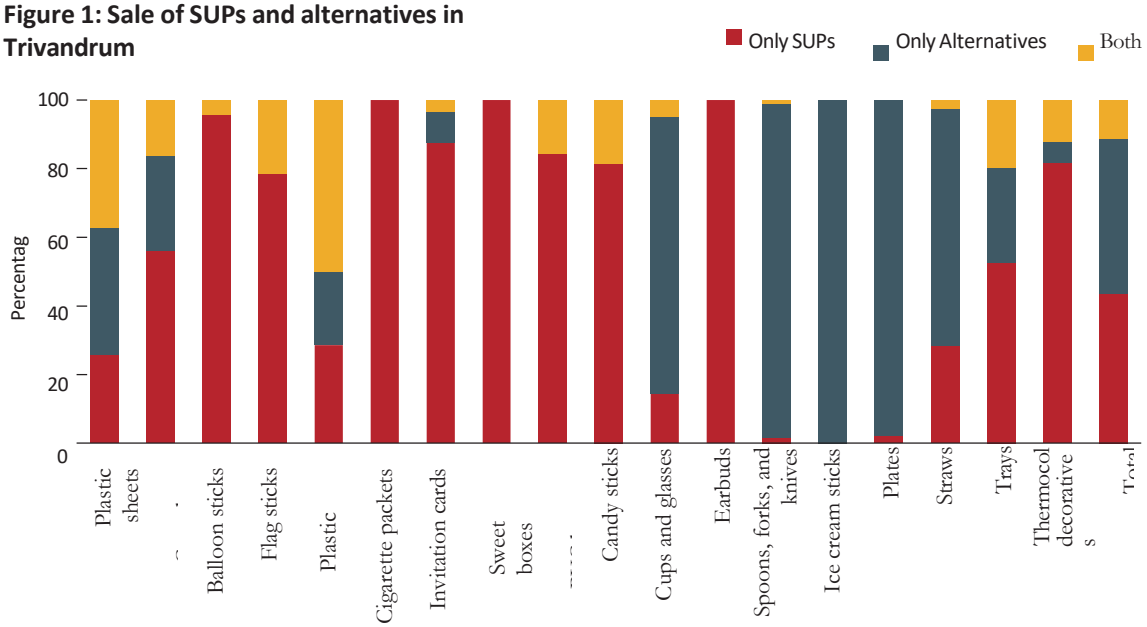


Table 3: Types of alternatives to SUPs in Trivandrum

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	4	Silver foil paper roll	Banana Leaf	Paper Sheets	Aluminium foils
Plastic carry bags (<75 μ)	3	Paper bags	Biodegradable plastics	Cloth Bags	
Plastic balloon sticks	1	Wooden sticks			
Plastic flag sticks	2	Wooden sticks	Paper		
Plastic flags	2	Cloth flags	Paper flags		
Plastic films on cigarette packets	0				
Plastic films on invitation cards	0				
Plastic films on sweet boxes	0				
PVC banners (<100 μ)	1	Cloth Banners			
Plastic candy sticks	1	Wooden sticks			
Plastic cups and glasses	5	Ceramic Cups, paper cups	Earthen cups	Steel cups, glass cups	Hard plastic cups
Plastic earbuds	0				
Plastic spoons, forks and knives	2	Steel spoon, fork, knives	Wooden cutlery (disposable)		
Plastic ice-cream sticks	2	Wooden stick	Edible cones		
Plastic plates	4	Steel plates	Leaf plates	Ceramic plates	Hard Acrylic plates
Plastic straws	2	Paper straws	Steel straws		
Plastic trays	3	Steel tray	Wooden trays	Aluminium trays	
Thermocol decoratives	1	Paper décor			



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Vadodara

Vadodara also known as Baroda, is the second largest city in the Indian state of Gujarat. It serves as the administrative headquarters of the Vadodara district and is situated on the banks of the Vishwamitri River, 141 kilometres (88 mi) from the state capital of Gandhinagar. The city is spread across 220.33 sq km. and there are 19 wards. As per Census 2011, the total population of the city was 17.4 lakhs, and the estimated population of the city in 2021 is 22.4 lakhs.

1. Single-use Plastic Waste Inventory

In Vadodara, the municipal waste was collected from three residential wards one sample each from different economic strata, High-income residential areas (Akota, Neelambar circle and New Gotri), Middle-income Residential areas (Gorwa and Manjalpur), and Low-income residential areas (Laxmipura), and one sample each from Mixed Commercial & Residential (Wasna and Narayan garden road), and Commercial areas (R C Dutta road and Airport road) were chosen for inventory.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Vadodara was conducted from 08 to 13 August 2022 at one of the transfer stations near Gadhera market. The door to door waste collected from the identified areas were brought at this station for the inventory study.

Results of inventory

Banned SUPs account for about 14.8% of the total plastic waste in Vadodara. The most common banned SUPs found in the waste stream are carry bags, accounting for more than 87% (by weight) of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 9.9% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 3%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	1.46
2	Carry bags	87.86
3	Plastic sheets	0.27
4	Cutlery items	9.90
5	Wrapping and film	0.11
6	Others	0.40

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of August and September 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Khanderao and Karelibaug
2	South	Manjalpur and Makarpura
3	East	Waghodiya
4	West	Gotri
5	Central	Akota and Alkapuri

The survey covered 280 shops in four selected markets in Vadodara. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Vadodara

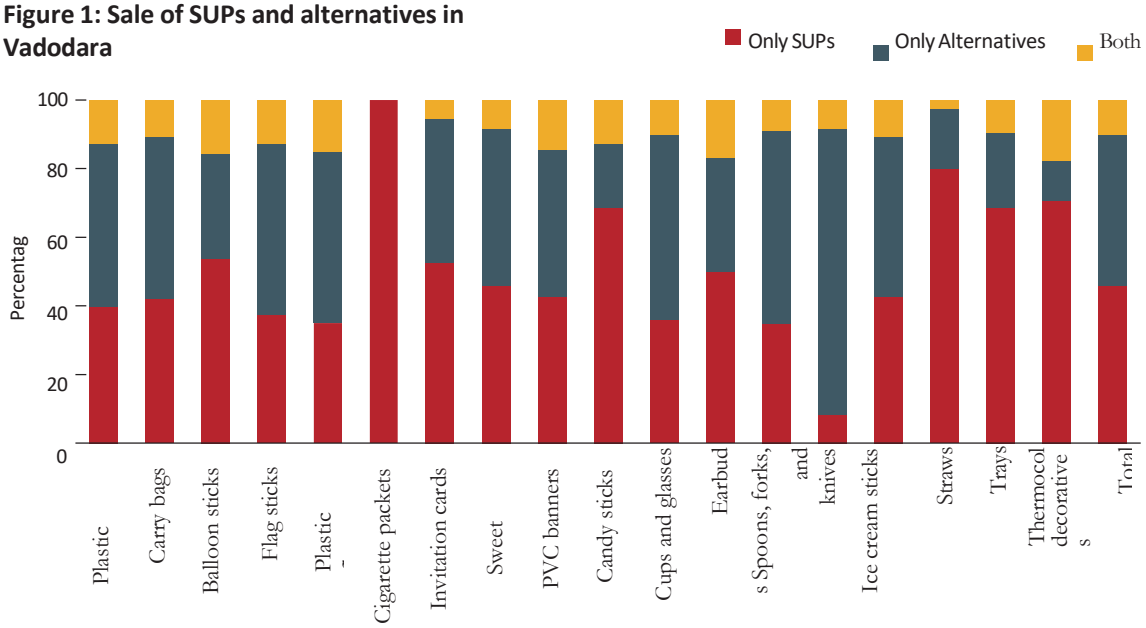


Table 3: Types of alternatives to SUPs in Vadodara

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Paper/ butter paper	Aluminium foil		
SUP carry bags (below 75 μ) available	4	Paper bag	Cloth Bag	>75 microns	Biodegradable bags
Plastic balloon sticks	1	thread			
Plastic flag sticks	1	Wooden stick			
Plastic flags	2	paper	Cloth		
Wrapping/films on cigarette packets	0				
Plastic wrapping/films on invitation cards	1	Paper cards without any wrapping			
Wrapping/films on sweet boxes	2	Paper	Butter paper		
PVC banners below 100 μ	1	Cloth banners			
SUP candy sticks	1	Wooden stick			
Cups and glassess	4	Glasses made of glass	Paper	Steel Glass	Ceramic
Earbuds	1	Wooden stick			
Spoons forks knives	2	Steel spoon, fork, knives	Wooden fork, spoon and knives		
Ice cream sticks	1	Wooden stick			
Plates	4	Steel plates	Paper plates	Ceramic	Aluminium foil
Straws	1	Paper straws			
SUP trays	2	Wooden	Reusable tray		
Thermocol decorative	1	paper			



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Vijayawada

Vijayawada also known as Bezawada is a part of Andhra Pradesh States' Capital Region. It is the administrative headquarters of the NTR district. It belonged to the erstwhile Krishna district. Vijayawada lies on the bank of the Krishna River surrounded by the Eastern Ghats (locally known as Indrakeeladri Hills). Vijayawada is a well- established commercial, political, educational and cultural centre of Andhra Pradesh. The total area under the VMC is 61.88 sq. kms. The city divided into 64 political wards, houses a population of 10,39,518 as per the 2011 census. The city is divided into 34 sanitary divisions.

1. Single-use Plastic Waste Inventory

In Vijayawada, the municipal waste was collected from three residential wards one sample each from different economic strata, High-income residential (Ward Nos. 32 and 12), Middle-income Residential areas (Ward Nos. 41 and 5), and Low-income residential areas (Ward Nos. 63 and 64), and one sample each from Mixed Commercial & Residential (Ward Nos. 33 and 21), and Commercial areas (Ward Nos. 23 and 48) were chosen for taking the samples.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Vijayawada was conducted from 03 to 07 July 2022 at the Material Recovery Facility. The door to door waste collected from selected wards were brought to this facility for inventory.

Results of inventory

Banned SUPs account for about 26% of the total plastic waste in Vijayawada. The most common banned SUPs found in the waste stream are carry bags and plastic sheets, accounting for more than 38% (by weight) each of all the banned SUPs. Cutlery items, the other prominent banned SUPs, accounted for 16% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 9%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	4.21
2	Carry bags	37.54
3	Plastic sheets	37.93
4	Cutlery items	16.04
5	Wrapping and film	0.79
6	Others	3.48

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 µ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of June and July 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	Bhavanipuram
2	South	Patamata
3	East	Gunadhala
4	West	Krishnalanka

The survey covered 144 shops in four selected markets in Vijayawada. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Vijayawada

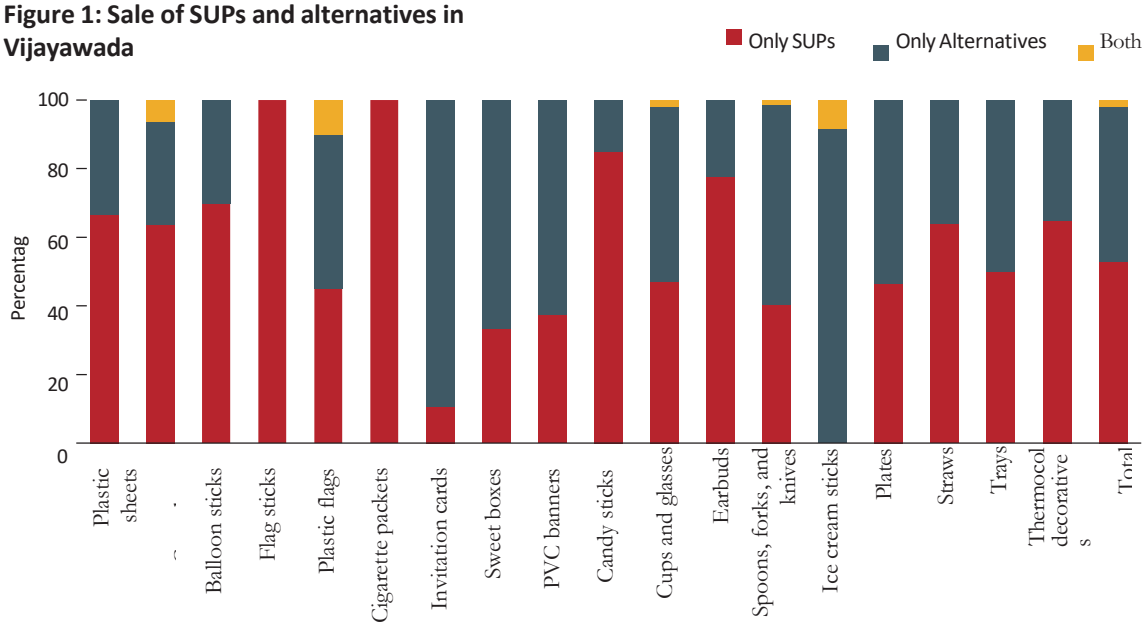
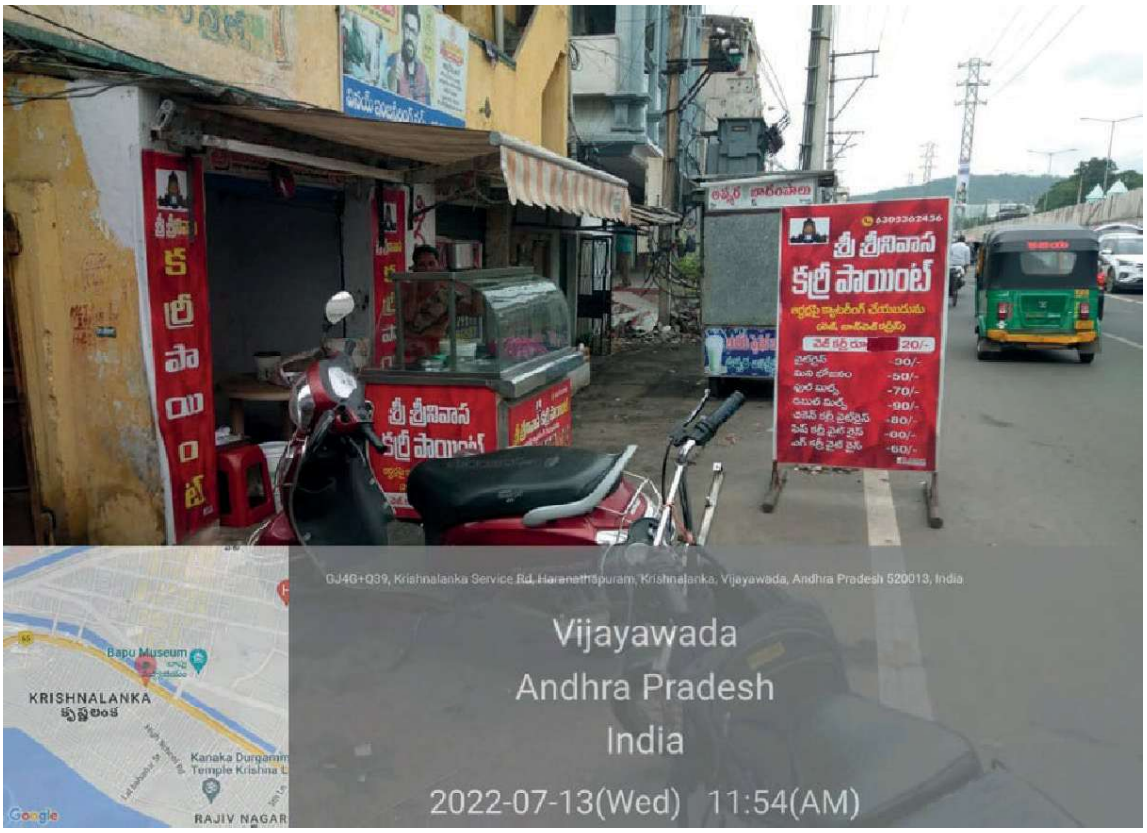
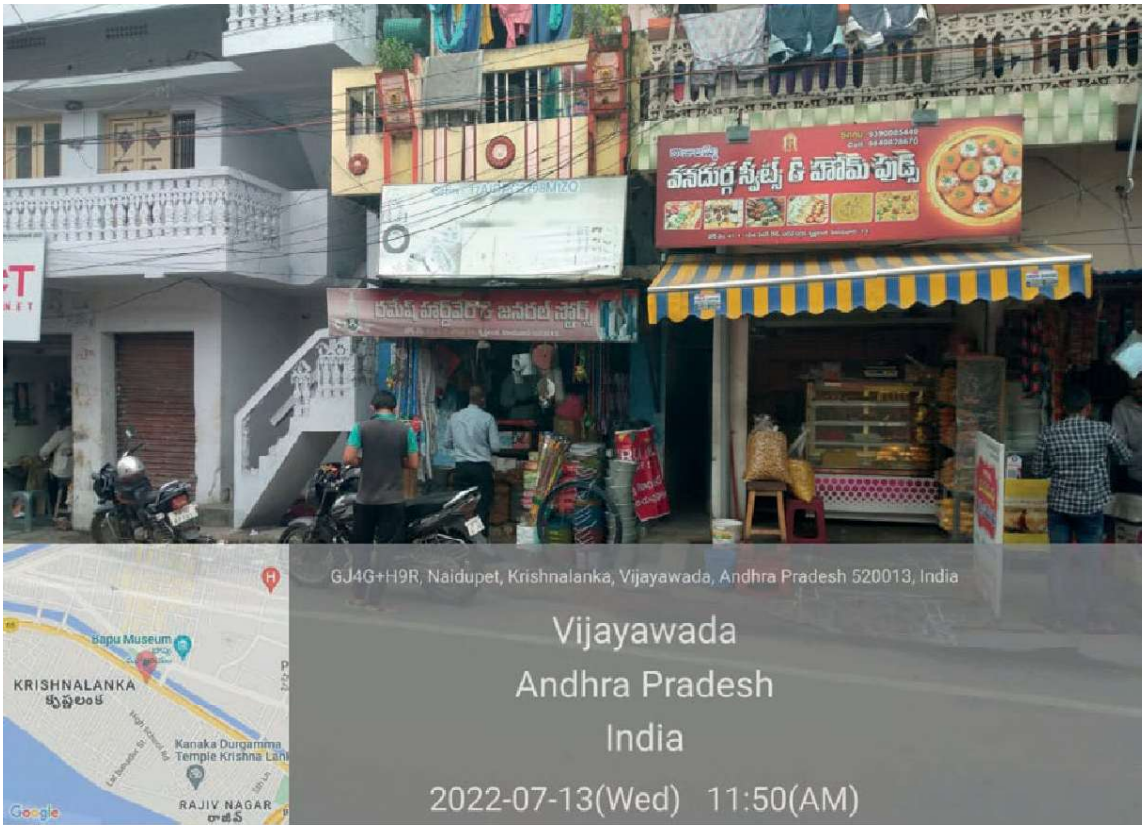


Table 3: Types of alternatives to SUPs in Vijayawada

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	1	Banana Leaves			
Plastic carry bags (<75 μ)	2	Paper bags	Cloth bags		
Plastic balloon sticks	1	Rubber balloon sticks			
Plastic flag sticks	0				
Plastic flags	2	Paper flags	Cloth bags		
Plastic films on cigarette packets	0				
Plastic films on invitation cards	1	Paper cards without film			
Plastic films on sweet boxes	1	Cardboard boxes			
PVC banners (<100 μ)	1	Above 230 GSM			
Plastic candy sticks	1	Wooden sticks			
Plastic cups and glasses	3	Steel Cups and glasses	Ceramic crockery	Glass crockery	
Plastic earbuds	1	Wooden earbuds			
Plastic spoons, forks and knives	2	Steel cutlery	Wooden disposable cutlery		
Plastic ice-cream sticks	1	Wooden sticks			
Plastic plates	3	Wooden plates	Fibre, rigid plastic plates	Banana leaves	
Plastic straws	1	Paper straws			
Plastic trays	1	Paper trays			
Thermocol decoratives	1	Paper décor			


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Bapu Museum
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Warangal

Warangal (urban) district is located in the northern region of Telangana. It consists of three urban cities, Kazipet, Hanamkonda, and Warangal, together known as the Warangal Tri-cities. The district occupies an area of 1,304.5 sq km. The district houses a total population of 10,80,858, as per the 2011 census. There are no major rivers flowing in and around the city, therefore the city relies on the Kakatiya canal originating from the Sriram Sagar project to meet its water requirements.

1. Single-use Plastic Waste Inventory

In Warangal, the municipal waste was collected from three residential wards, High-income residential (Ward No. 38), Middle-income Residential areas (Ward No. 50), and Low-income residential areas (Ward No. 60), and one sample each from Mixed Commercial & Residential (Ward No. 49), and Commercial areas (Ward No. 48) were chosen for inventory.

A sample from the dumpsite was also collected and characterised to assess the quantity of plastic and SUPs taken out for recycling/reuse.

The inventorisation study in Warangal was conducted from 30 June to 4 July 2022 at one of the transfer stations. The door to door since the town mostly collects segregated waste and all the waste is collected and send to this facility for resource recovery.

Results of inventory

Banned SUPs account for about 22% of the total plastic waste in Warangal. The most common banned SUPs found in the waste stream are carry bags, accounting for 88.2% (by weight) of all the banned SUPs. Cutlery items, the other most prominent banned SUP, accounted for 10% of the total banned SUPs. The contribution of the rest of the banned SUPs was less than 2%.

Table 1: Banned SUPs in the waste stream

Sl. no.	Banned SUPs	Percentage of total banned SUPs (%)
1	Plastic sticks	1.1
2	Carry bags	88.2
3	Plastic sheets	0.0
4	Cutlery items	10.0
5	Wrapping and film	0.2
6	Others	0.5

Note:

- Plastic sticks include earbuds, balloon sticks, candy sticks, ice-cream sticks, straws and stirrers
- Cutlery items include plates, trays, cups, glasses, spoons, forks and knives
- Wrapping and film include films on the sweet box, invitation card and cigarette packet
- Others include plastic flags, PVC banners (<100 μ) and thermocol decorations

2. Market Survey of Single-use Plastics

To assess the availability of banned SUP items and its alternatives within the municipal boundaries, a market survey was carried out in selected market areas in different zones, in the month of June and July 2022.

Table 2: Markets selected for the survey

Sl. No.	Zone	Market name
1	North	K.U Cross roads, Hanamkonda Chowrasta
2	South	Nakkalagutta, MGM Hospital Road
3	East	Pochamma maidan, Warangal Chowrasta
4	West	Somidi Road, Kadipikonda

The survey covered 271 shops in total within these four selected markets in Mamallapuram. The results are as provided below.

Figure 1: Sale of SUPs and alternatives in Warangal

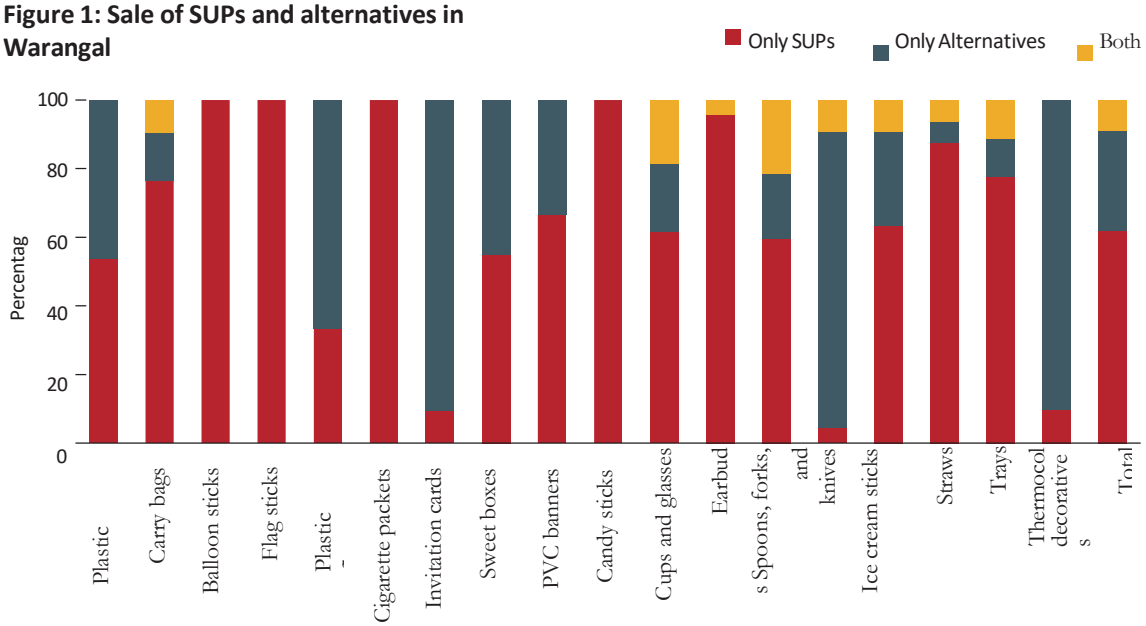


Table 3: Types of alternatives to SUPs in Warangal

Banned SUP items	No. of alternatives available	Type 1	Type 2	Type 3	Type 4
Plastic sheets	2	Silver Foil	Paper sheets		
SUP Carry bags (below 50 microns)	4	Paper bags	Jute carry bags	Reusable carry bags	Non-woven carry bags
Plastic balloon sticks	0				
Plastic flag sticks	0				
Plastic flags	2	Paper flags	Metal flags with pin		
Wrapping/films on cigarette packets	0				
Plastic wrapping/films on invitation cards	1	Paper cards without any film			
Wrapping/films on sweet boxes	1	Cardboard boxes			
PVC banners below 100 μ	1	Above 230 GSM			
SUP candy sticks	0				
Cups and glasses	3	Steel glasses	Glass crockery	Paper glasses	
Earbuds	1	Reusable Steel earbuds			
Spoons, forks and knives	2	Steel cutlery	Wooden spoons, forks and knives		
Ice cream sticks	1	Wooden sticks			
Plates	3	Steel Plates	Reusable plastic plates	Paper plates	
Straws	1	Paper straws			
SUP trays	2	Cardboard box/ trays	Aluminium covers		
Thermocol decorative	2	Paper décor	Inflatable balloon décor		



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ANNEXURE IV

Designation: D 5231 – 92 (Reapproved 2003)

Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste[1]

This standard is issued under the fixed designation D 5231; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes procedures for measuring the composition of unprocessed municipal solid waste (MSW) by employing manual sorting. This test method applies to determination of the mean composition of MSW based on the collection and manual sorting of a number of samples of waste over a selected time period covering a minimum of one week.

1.2 This test method includes procedures for the collection of a representative sorting sample of unprocessed waste, manual sorting of the waste into individual waste components, data reduction, and reporting of the results.

1.3 This test method may be applied at landfill sites, waste processing and conversion facilities, and transfer stations.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 6.

2. Terminology

2.1 *Definitions:*

2.1.1 *composite item*—an object in the waste composed of multiple waste components or dissimilar materials, such as disposable diapers, bi-metal beverage containers, electrical conductors composed of metallic wire encased in plastic insulation, etc.

2.1.2 *solid waste composition or waste composition*—the characterization of solid waste as represented by a breakdown of the mixture into specified waste components on the basis of mass fraction or of weight percent.

2.1.3 *sorting sample*—a 200 to 300-lb (91 to 136-kg) portion deemed to represent the characteristics of a vehicle load of MSW.

2.1.4 *unprocessed municipal solid waste*—solid waste in its discarded form, that is, waste that has not been size reduced or otherwise processed.

2.1.5 *waste component*—a category of solid waste, composed of materials of similar physical properties and chemical composition, which is used to define the composition of solid waste, for example, ferrous, glass, newsprint, yard waste, aluminum, etc.

3. Summary of Test Method

3.1 The number of samples to be sorted is calculated based on statistical criteria selected by the investigators.

3.2 Vehicle loads of waste are designated for sampling, and a sorting sample is collected from the discharged vehicle load.

3.3 The sample is sorted manually into waste components. The weight fraction of each component in the sorting sample is calculated from the weights of the components.

3.4 The mean waste composition is calculated using the results of the composition of each of the sorting samples.

4. Significance and Use

4.1 Waste composition information has widespread applications and can be used for activities such as solid waste planning, designing waste management facilities, and establishing a reference waste composition for use as a baseline standard in both facility contracts and acceptance test plans.

4.2 The method can be used to define and report the composition of MSW through the selection and manual sorting of waste samples. Where applicable, care should be taken to consider the source and seasonal variation of waste.

4.3 After performing a waste composition analysis, laboratory analyses may be performed on representative samples of waste components, or mixtures of waste components, for purposes related to the planning, management, design, testing, and operation of resource recovery facilities.

5. Apparatus

5.1 *Metal, Plastic, or Fiber Containers*, sufficient for storing and weighing each waste component, labeled accordingly. For components that will have a substantial moisture content (for example, food waste), metal or plastic containers are recommended in order to avoid absorption of moisture by the

[1] This test method is under the jurisdiction of ASTM Committee D34 on Waste Disposal and is the direct responsibility of Subcommittee D34.01.06 on Analytical Methods.

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container and thus the need for a substantial number of weighings to maintain an accurate tare weight for the container.

5.2 *Mechanical or Electronic Weigh Scale*, with a capacity of at least 200 lb (91 kg) and precision of at least 0.1 lb (0.045 kg).

5.3 *Heavy-Duty Tarps, Shovels, Rakes, Push Brooms, Dust Pans, Hand Brooms, Magnets, Sorting Table, First Aid Kit, Miscellaneous Small Tools, Traffic Cones, Traffic Vests, Leather Gloves, Hardhats, Safety Glasses, and Leather Boots*.

6. Hazards

6.1 Review the hazards and procedures with the operating and sorting personnel prior to conducting the field activities.

6.2 Sharp objects, such as nails, razor blades, hypodermic needles, and pieces of glass, are present in solid waste. Personnel should be instructed of this danger, and they should brush waste particles aside while sorting rather than projecting their hands with force into the mixture. Personnel handling and sorting solid waste should wear appropriate protection, such as heavy leather gloves, dust masks, hardhats, safety glasses, and safety boots.

6.3 During the processes of unloading waste from collection vehicles and handling waste with heavy equipment, projectiles may issue from the mass of waste. The projectiles can include flying glass particles from breaking glass containers and metal lids from plastic and metal containers that burst under pressure when run over by heavy equipment. The problem is particularly severe when the waste handling surface is of high compressive strength, for example, concrete. Personnel should be informed of this danger and wear eye and head protection if in the vicinity of either the collection vehicle unloading point or heavy equipment, or both.

6.4 Select a location for the discharge of designated loads, manual sorting activities, and weighing operations that is flat, level, and away from the normal waste handling and processing areas.

6.5 Weigh storage containers each day, or more frequently, if necessary, in order to maintain an accounting of the tare weight.

6.6 Loss of mass from the sorting sample can occur through the evaporation of water. Samples should thus be sorted as soon as possible after collection.

6.7 Containers of liquids or other potentially dangerous wastes shall be put aside and handled by the crew chief.

7. Calibration

7.1 All weigh scale equipment shall be calibrated according to the manufacturer's instructions. Take appropriate corrective action if the readings are different from those of the calibration weights.

8. Procedure

8.1 Secure a flat and level area for discharge of the vehicle load. The surface should be swept clean or covered with a clean, durable tarp prior to discharge of the load.

8.2 Position the scale on a clean, flat, level surface and adjust the level of the scale if necessary. Determine the accuracy and operation of the scale with a known (that is, reference) weight.

8.3 Weigh all empty storage containers and record the tare weights.

8.4 Determine the number of samples to be sorted. The determination is a function of the waste components to be sorted and the desired precision as applied to each component. Weights of 200 to 300 lb (91 to 136 kg) for sorting samples of unprocessed solid waste are recommended. The number of samples is determined using the calculational method described in 9.1.

8.5 A comprehensive list of waste components for sorting is given in Table 1. A description of some of the waste component categories is given in Table 2. Other waste components can be defined and sorted, depending on the purpose of the waste composition determination. The list in Table 1 is comprised of those components most commonly used to define and report the composition of solid waste. It is recommended that, at a minimum, the complement of left-justified categories in Table 1 be sorted. Similar breakdowns of solid waste composition are therefore available for purposes of comparison, if desired. Label the storage containers accordingly.

8.6 Vehicles for sampling shall be selected at random during each day of the one-week sampling period, or so as to be representative of the waste stream as agreed upon by the affected parties. With respect to the random selection of vehicles, any method is acceptable that does not introduce a bias into the selection. An acceptable method is the use of a random number generator. For a weekly sampling period of k days, the number of vehicles sampled each day shall be approximately n/k, where n is the total number of vehicle loads to be selected for the determination of waste composition. A weekly period is defined as 5 to 7 days.

8.7 Direct the designated vehicle containing the load of waste to the area secured for discharge of the load and collection of the sorting sample.

8.8 Collect any required information from the vehicle operator before the vehicle leaves the discharge area. Direct the vehicle operator to discharge the load onto the clean surface in one contiguous pile, that is, to avoid gaps in the discharged load in order to facilitate collection of the samples.

8.9 Using a front-end loader with at least a 1-yd ^{3}(0.765-m^3) bucket, remove the material longitudinally along one entire side of the discharged load in order to obtain a representative cross-section of the material. The mass of material shall be sufficient to form a mass of material which, on a visual basis, is at least four times the desired weight of the sorting sample

TABLE 1 List of Waste Component Categories

Mixed paper	Other organics
High-grade paper	Ferrous
Computer printout	Cans
Other office paper	Other ferrous
Newsprint	Aluminum
Corrugated	Cans
Plastic	Foil
PET bottles	Other aluminum
HDPE bottles	Glass
Film	Clear
Other plastic	Brown
Yard waste	Green
Food waste	Other inorganics
Wood	

TABLE 2 Descriptions of Some Waste Component Categories

Category	Description
Mixed paper	Office paper, computer paper, magazines, glossy paper, waxed paper, and other paper not fitting the categories of newsprint and corrugated
Newsprint	Newspaper
Corrugated	Corrugated medium, corrugated boxes or cartons, and brown (kraft) paper (that is, corrugated) bags
Plastic	All plastics
Yard waste	Branches, twigs, leaves, grass, and other plant material
Food waste	All food waste except bones
Wood	Lumber, wood products, pallets, and furniture
Other organics/ combustibles	Textiles, rubber, leather, and other primarily burnable materials not included in the above component categories
Ferrous	Iron, steel, tin cans, and bi-metal cans
Aluminum	Aluminum, aluminum cans, and aluminum foil
Glass	All glass
Other inorganics/ non-combustibles	Rock, sand, dirt, ceramics, plaster, non-ferrous non-aluminum metals (copper, brass, etc.), and bones

(that is, approximately 1000 lb (454 kg)). Mix, cone, and quarter the material, and select one quarter to be the sorting sample, using a random method of selection or a sequence agreed by all affected parties, for the purpose of eliminating or minimizing biasing of the sample. If an oversize item (for example, water heater) composes a large weight percent of the sorting sample, add a notation on the data sheet and weigh it, if possible. Unprocessed solid waste is a heterogeneous mixture of materials. Care must thus be taken during application of the procedures for sample collection in order to obtain a representative sample.

8.10 One sorting sample is selected from each collection vehicle load designated for sampling. All handling and manipulation of the discharged load and longitudinal and sorting samples shall be conducted on previously cleaned surfaces. If necessary, remove the sorting sample to a secured manual sorting area. The sorting sample may be placed on a clean table for sorting for the convenience of the sorting personnel. The sorting area shall be a previously cleaned, flat, level surface.

8.11 Position the storage containers around the sorting sample. Empty all containers from the sorting sample, such as capped jars, paper bags, and plastic bags of their contents. Segregate each waste item and place it in the appropriate storage container.

8.12 In the case of composite items found in the waste, separate the individual materials where practical, and place the individual materials into the appropriate storage containers. Where impractical, segregate the composite items for classification by the crew chief according to the following order:

8.12.1 If there are many identical composite items (for example, plastic-sheathed aluminum electrical conductor), place them into the waste component containers corresponding to the materials present in the item, and in the approximate proportions according to the estimated mass fraction of each material in the item.

8.12.2 If there are only a few of the identical composite item, place them in the storage container corresponding to the material that comprises, on a weight basis, the majority of the item (for example, place bi-metal beverage cans in the ferrous container).

8.12.3 If composite items represent substantial weight percents of the sorting sample, a separate category should be established, for example, composite roofing shingles.

8.12.4 If none of the above procedures is appropriate, place the item(s) (or proportion it (them)) in the storage container labeled“ other non-combustible” or “other combustible,” as appropriate.

8.13 Sorting continues until the maximum particle size of the remaining waste particles is approximately 0.5 in. (12.7 mm). At this point, apportion the remaining particles into the storage containers corresponding to the waste components represented in the remaining mixture. The apportionment shall be accomplished by making a visual estimate of the mass fraction of waste components represented in the remaining mixture.

8.14 Record the gross weights of the storage containers and of any waste items sorted but not stored in containers. The data sheet shown in Fig. 1 can be used to record both gross and tare weights.

8.15 After recording the gross weights, empty the storage containers and weigh them again, if appropriate. Re-weighing is important and necessary if the containers become moisture-laden, for example, from wet waste.

8.16 Clean the sorting site, as well as the load discharge area, of all waste materials.

9. Calculation

9.1 *Number of 200 to 300-lb (91 to 136-kg) Samples*:

9.1.1 The number of sorting samples (that is, vehicle loads) (n) required to achieve a desired level of measurement precision is a function of the component(s) under consideration and the confidence level. The governing equation for n is as follows:

$$n = (t^* \, s/e\cdot\bar{x})^2 \tag{1}$$

where:

t^* = student t statistic corresponding to the desired level of confidence,
s = estimated standard deviation,
e = desired level of precision, and
$\bar{x}$ = estimated mean.

9.1.1.1 All numerical values for the symbols are in decimal notation. For example, a precision value (e) of 20 % is represented as 0.2.

9.1.1.2 One sorting sample is chosen per vehicle load.

9.1.1.3 Suggested values of s and of $\bar{x}$ for waste components are listed in Table 3. Values of t^* are given in Table 4 for 90 and 95 % levels of confidence, respectively.

9.1.2 Estimate the number of samples (n') for the selected conditions (that is, precision and level of confidence) and components using (Eq 1). For the purposes of estimation, select from Table 4 the t^* value for $n = \infty$ for the selected level of confidence. Since the required number of samples will vary among the components for a given set of conditions, a compromise will be required in terms of selecting a sample size, that is, the number of samples that will be sorted. The component that is chosen to govern the precision of the composition measurement (and therefore the number of

Waste Composition Data Sheet

Day/Date: _____ Collection Company: _____
Site: _____ Vehicle Type: _____
Weather: _____ Route No: _____
Recorded by: _____

Component	Weight in Pounds			Percent of Total
	Gross	Tare		
Mixed Paper				
High Grade Paper				
Computer Printout				
Other Office Paper				
Newsprint				
Corrugated				
Plastic				
PET bottles				
HDPE bottles				
Film				
Other Plastic				
Food Waste				
Wood				
Other Organics				
Ferrous				
Cans				
Other Ferrous				
Aluminum				
Cans				
Foil				
Other Aluminum				
Glass				
Clear				
Brown				
Green				
Other Inorganics				

TOTALS _____

NOTES: _____

Lab sample taken? Yes _____ No _____

FIG. 1 Waste Composition Data Sheet

samples required for sorting) is termed the "governing component" for the purposes of this method.

9.1.3 After determining the governing component and its corresponding number of samples (n_o), return to Table 4 and select the student t statistic (t^*_o) corresponding to n_o. Recalculate the number of samples, that is, n', using t^*_o.

9.1.4 Compare n_o to the new estimate of n, that is, n', which was calculated for the governing component. If the values differ by more than 10 %, repeat the calculations given in 9.1.2 and 9.1.3.

9.1.5 If the values are within 10 %, select the larger value as the number of samples to be sorted. Refer to Appendix X1 for a sample calculation of n.

9.2 *Component Composition*:

9.2.1 The component composition of solid waste is reported on the basis of the mass fraction (expressed as a decimal) or percent of waste component i in the solid waste mixture. The

TABLE 3 Values of Mean ($\bar{x}$) and Standard Deviation(s) for Within-Week Sampling to Determine MSW Component Composition[A]

Component	Standard Deviation(s)	Mean ($\bar{x}$)
Newsprint	0.07	0.10
Corrugated	0.06	0.14
Plastic	0.03	0.09
Yard waste	0.14	0.04
Food waste	0.03	0.10
Wood	0.06	0.06
Other organics	0.06	0.05
Ferrous	0.03	0.05
Aluminum	0.004	0.01
Glass	0.05	0.08
Other inorganics	0.03	0.06
		1.00

[A]The tabulated mean values and standard deviations are estimates based on field test data reported for MSW sampled during weekly sampling periods at several locations around the United States.

TABLE 4 Values of *t* Statistics (*t) as a Function of Number of Samples and Confidence Interval**

Number of Samples, n	90 %	95 %
2	6.314	12.706
3	2.920	4.303
4	2.353	3.182
5	2.132	2.776
6	2.015	2.571
7	1.943	2.447
8	1.895	2.365
9	1.860	2.306
10	1.833	2.262
11	1.812	2.228
12	1.796	2.201
13	1.782	2.179
14	1.771	2.160
15	1.761	2.145
16	1.753	2.131
17	1.746	2.120
18	1.740	2.110
19	1.734	2.101
20	1.729	2.093
21	1.725	2.086
22	1.721	2.080
23	1.717	2.074
24	1.714	2.069
25	1.711	2.064
26	1.708	2.060
27	1.706	2.056
28	1.703	2.052
29	1.701	2.048
30	1.699	2.045
31	1.697	2.042
36	1.690	2.030
41	1.684	2.021
46	1.679	2.014
51	1.676	2.009
61	1.671	2.000
71	1.667	1.994
81	1.664	1.990
91	1.662	1.987
101	1.660	1.984
121	1.658	1.980
141	1.656	1.977
161	1.654	1.975
189	1.653	1.973
201	1.653	1.972
∞	1.645	1.960

reporting is on the basis of wet weight, that is, the weight of materials immediately after sorting.

9.2.2 The mass fraction of component *i*, mf_i, is defined and computed as follows:

$$mf_i = \frac{w_i}{\sum_{i=1}^{j} w_i} \quad (2)$$

where:
w_i = weight of component i and
j = number of waste components.

In those cases in which a container is used to store and weigh the materials,

$$w_i = \text{gross weight} - \text{tare weight of container} \quad (3)$$

9.2.3 The percent of component *i*, P_i, is defined and computed as follows:

$$P_i = mf_i \times 100 \quad (4)$$

9.2.4 For the data analysis to be correct, the denominator of (Eq 2) must be unity, and

$$\sum_{i=1}^{j} P_i = 100 \quad (5)$$

9.3 The mean component composition for the one-week period is calculated using the component composition results from each of the analysis samples. The mean mass fraction of component *i*, $\overline{mf_i}$, is calculated as follows:

$$\overline{mf_i} = \frac{1}{n}\sum_{k=1}^{n} (mf_i)_k \quad (6)$$

and the mean percent of component *i*, P_i, is calculated as follows:

$$\bar{P}_i = \frac{1}{n}\sum_{k=1}^{n} (P_i)_k \quad (7)$$

where:
n = number of samples.

10. Precision and Bias

10.1 A precision and bias statement cannot be made for this test method at this time. However, the committee is interested in conducting an interlaboratory test program and encourages interested parties to contact ASTM Headquarters.[2]

11. Keywords

11.1 composition; municipal solid waste; waste characterization

[2] ASTM Headquarters, 1916 Race Street, Philadelphia, PA 19103.

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE CALCULATION OF THE NUMBER OF SAMPLES FOR ANALYSIS

X1.1 *Example Assumptions:*

X1.1.1 Corrugated is selected as the governing component.
X1.1.2 A 90 % confidence level is selected.
X1.1.3 A precision of 10 % is desired.
X1.1.4 Therefore:

s = 0.06 (from Table 3),
$\bar{x}$ = 0.14 (from Table 3),
e = 0.10, and
$t^*(n = \infty)$ = 1.645 (from Table 4).

Using (Eq 1):

$$n = [t^* s/(e\cdot\bar{x})]^2 = \left[\frac{1.645\ (0.06)}{0.1\ (0.14)}\right]^2 = 50 = n_o \quad (X1.1)$$

Referring again to Table 4, for $n = 50$,

$$t^*_{90}\,(n = 50) = 1.677 \quad (X1.2)$$

and,

$$n = \left[\frac{1.677\ (0.06)}{0.1\ (0.14)}\right]^2 = 52 = n' \quad (X1.3)$$

Since 52 (that is, n') is within 10 % of 50 (that is, n_o), 52 samples should be selected for analysis.

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ANNEXURE V

Determination of Sorting Sample size, number of vehicle loads, Vehicle load size and no. of days for sampling

The first step in characterization of the waste is to fix the sorting sample size, vehicle load size, number of vehicle loads to be sampled (n) duration of sampling (k). As per ASTM D 5231-92 (hereafter referred to as Standard) , sorting samples size should be in the range of 91-136 kg. Weekly sampling period (k) has been specified in the range of 5-7 days in the Standard. Further, vehicle load size should be at least four times the desired weight of the sorting sample size.

Further as per the ASTM standard (Section 9)

$$n=(t*s/(e*x))^2$$

Where,

s : Estimated standard deviation = 0.03 for Plastic (Table 3 of the Standard)

x : Estimated mean= 0.09 for Plastic (Table 3 of the Standard)

e : Desired level of precision (If desired level of Precision is 10% then e=0.1)

t : Student t statistic corresponding to the desired level of confidence is calculated as per Table 4 of the ASTM standards

"n" is calculated using iteration method as per the Standard. An example illustrating the same is given below

s = 0.03

e = 0.10

x = 0.09

t (For n=∞ and Confidence level = 90% = 1.645 (from Table 4 of the Standard)

$n'=(t*s/(e*x))^2=30$

For n'= 30; t' = 1.699 (for Confidence level= 0.9) (from Table 4 of the Standard)

$n= ((1.645*0.03)/(0.1*0.09))^2=32$

Hence, number of vehicle load should vary between 30-32 as determined by the aforementioned calculations. However, the volume of waste generated in a city is subject to variations influenced by factors such as population density, geographic location, the sampling and analysis capabilities of the local governing body, and others. The computation of the number of vehicle loads is adjusted based on the need for a higher confidence level and lower precision level, especially in the case of larger cities.

ANNEXURE VI

Example 1: Distribution of Sample Location (Refer Section 2.2)

In a city (XYZ) with a population of approx. from 5,01,500 a dynamic urban landscape unfolds where the majority of residents belong to the middle-income group. Apart from residential areas there are few slum areas within the city, one old temple working as tourist spot for the city and some market hubs including wholesale and retail shops. To efficiently manage the generated waste, Nagar Nigam has signed and MOU with waste management agency. All generated waste is collected by Nagar nigam from various dhalauns and localized waste collection points and being transported to MRF facility installed by Waste Management Agency. Recyclable material are manually separated and remaining is being sent to the only available disposal site of the city.

Key points of above description:

- Population between 100000 to 999999
- Majority of the people are middle income group and no high income groups
- All the waste generated in the city is being transported to the one disposal site
- One Material recover facility are installed
- There are multiple dhalaun and collection points near by the various wards to collect waste.

Step one: Determination of parameter for waste Characterization

As per Table 1 of SOP following parameter can be determining

- No. of Vehicle to be sampled (n): 45
- Duration of sampling (No of Days) (k): 6
- Vehicle load size: 480 kg
- Sorting Sample size: 120 kg

Step Two: Distribution of the sampling locations

City area is divided into four zones East, West, North & South and subsequently various wards in the zone are divided into Middle-income residential wards, Economically Weaker Section (EWS) residential wards/slums and Commercial

wards (Market Area) and others. In addition, one disposal point is also identified in each Zone. Location distribution is given below:

Table 1: Sample location distribution

	Zone 1					**Zone 2**					**Zone 3**					**Zone 4**					**Total**
Day	MI	EWS	CW	MX	DS	MI	EWS	CW	MX	DS	MI	EWS	CW	MX	DS	MI	EWS	CW	MX	DS	
1	1	0	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	1	1	8
2	0	1	0	0	1	0	0	1	0	1	0	0		1	1	1	0	0	0	1	8
3	0	0	1	0	1	0	0	0	1	1	0	1	0	0	1	0	1	0	0	1	8
4	0	0	0	1	1	1	0	0	0	1	1	0	0	0	1	0	0	1	0	1	8
5	0	0	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	1	1	7
6	0	1	0	0	1	0	0	0	0	1	0	0		0	1	1	0	0	0	1	6
Total	**1**	**2**	**1**	**1**	**6**	**1**	**2**	**1**	**1**	**6**	**1**	**1**	**2**	**1**	**6**	**2**	**1**	**1**	**2**	**6**	
																					45

Middle-income residential wards: MI

Economically Weaker Section (EWS) residential wards/slums: EWS

Commercial wards (Market Area): CW

Mixed commercial and residential wards: Mx

Disposal Point: DS

The sample is required to be collected at waste generation points excluding the one to be collected at the Disposal point.

Note: In the absence of predefined economic distinctions in a town, the allocation of wards was determined by the predominant socio-economic nature of the areas. For instance, if a ward has more than 50% high-income residences, it is designated as a high-income ward. Conversely, if a ward has over 50% low-income residents, it is categorized as a low-income ward, and so forth. Vehicles from these identified categories may be selected.

Step 3: Sample collection and Sample preparation

Sample collection: Vehicles collecting waste from each socio-economic strata of each zone to be identified. Every day, select vehicles randomly from each socio-economic strata of each zone. Make sure that the waste collectors are not removing valuable plastics/ dry wastes beforehand.

Sample preparation: The entire vehicle load of waste i.e 480 Kgs should be discharged in a designated area. Use the Quartering and coning method to reduce the size of the shorting sample to 120 kg.

Waste characterisation:

First waste should be characterise into two categories Plastic waste and others Subsequently The total plastic waste be sorted and weighed into 4 categories, as per the EPR guidelines. Each sub-category should be weighed and registered in the data sheet as given below:

Table 2A: **Plastic Waste characterization (Plastic Packaging category wise) : Generation points**

Vehicle Load No. (1)	**Sorting Sample Size (Kg) (2)**	**Total PW(Kg) (3)**	**Category 1 PW (kg) (4)**	**Category 2 PW (kg)(5)**	**Category 3 PW (kg) (6)**	**Category 4 PW (kg) (7)**
1	120	10	2	4	2.5	0
2	120	8	1.5	2	2	0.05
3	120	9	1.5	3	1	0.02
4	120	10	1.7	2.5	1.5	0.01
5	120	9	1.5	3	1	0
6	120	7	1	2	1	0.03
7	120	8.5	2	2	1.5	0
8	120	9	1	3	2	0.005
9	120	8	1.5	2	1.5	0
10	120	7	1	2	1.5	0.02
11	120	6.5	1	2	0.8	0
12	120	10	3	2	1	0.02
13	120	9	1.5	4	1	0.02

Vehicle Load No. (1)	Sorting Sample Size (Kg) (2)	Total PW(Kg) (3)	Category 1 PW (kg) (4)	Category 2 PW (kg)(5)	Category 3 PW (kg) (6)	Category 4 PW (kg) (7)
14	120	10	1.7	4	1.5	0.01
15	120	9.5	1.5	3	1	0
16	120	8.5	1	2	1	0.03
17	120	10	2	2	2	0
18	120	9	1	3	2	0.005
19	120	11	2.5	3	2	0
20	120	7	1	2	1.5	0.02
21	120	8	1	2	1.5	0
	2520	184	31.9	54.5	30.8	0.24

Table 2B: **Plastic Waste characterization (Plastic Packaging category wise) : Disposal points**

Vehicle Load No. (1)	Sorting Sample Size (Kg) (2)	Total PW(Kg) (3)	Category 1 PW (kg) (4)	Category 2 PW (kg)(5)	Category 3 PW (kg) (6)	Category 4 PW (kg) (7)
1	120	6	0.5	2	2	0.01
2	120	7	0.25	3	1	0
3	120	6.5	0.7	1	1	0
4	120	7	1	0.5	1	0.001
5	120	7.1	0.5	1	0.5	0
6	120	6.8	0.75	1.5	0.5	0
7	120	6	0.5	2	2	0.01
8	120	7	0.25	3	1	0
9	120	6.5	0.7	1	1	0
10	120	7	1	0.5	1	0.001
11	120	7.1	0.5	1	0.5	0

Vehicle Load No. (1)	Sorting Sample Size (Kg) (2)	Total PW(Kg) (3)	Category 1 PW (kg) (4)	Category 2 PW (kg)(5)	Category 3 PW (kg) (6)	Category 4 PW (kg) (7)
12	120	6.8	0.75	1.5	0.5	0
13	120	6	0.5	2	2	0.01
14	120	7	0.25	3	1	0
15	120	6.5	0.7	1	1	0
16	120	7	1	0.5	1	0.001
17	120	7.1	0.5	1	0.5	0
18	120	6.8	0.75	1.5	0.5	0
19	120	6	0.5	2	2	0.01
20	120	7	0.25	3	1	0
21	120	6.5	0.7	1	1	0
22	120	7	1	0.5	1	0.001
23	120	7.1	0.5	1	0.5	0
24	120	6.8	0.75	1.5	0.5	0
	2880	161.6	14.8	36	24	0.044

Banned SUPs waste sorting

The total plastic waste also to be sorted into all the 20 banned SUP products and should be weighed and registered in the data sheet as given below:

Table 3A : **Plastic waste characterization (Single Use Plastic) – Generation point**

	Vehicle Load No. 1(kg)	Vehicle Load No 2(kg)	VL3	…VL21	Total	Average Kg/Kg of waste
Sorting Sample Size (kg)	120	120	120	120	2520	

	Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**VL3**	**…VL21**	**Total**	**Average Kg/Kg of waste**
Plastic Waste (kg)	10	8	9	8	184	0.07302
SUPs					0	0.00000
Earbuds(kg)	0.0001	0.0002	0	0.0001	0.00185	0.00000
Balloons(kg)	0.001	0	0	0.001	0.006	0.00000
Candy(kg)	0.01	0	0	0.01	0.061	0.00002
Ice-cream(kg)	0.02	0.01	0	0.02	0.17	0.00007
Straws(kg)	0.15	0.14	0.1	0.15	2.65	0.00105
Plates(kg)	0.2	0.18	0.2	0.2	4	0.00159
Cups(kg)	0.21	0.15	0.1	0.21	3.31	0.00131
Glass(kg)	0.17	0.15	0.2	0.17	3.42	0.00136
Forks(kg)	0.1	0.05	0.1	0.1	1.45	0.00058
Spoons(kg)	0.08	0.07	0.1	0.08	1.23	0.00049
Knives(kg)	0.05	0.03	0	0.05	0.6	0.00024
Trays(kg)	0.02	0.015	0	0.02	0.315	0.00013
Sweet box(kg)	0.001	0	0	0.001	0.01	0.00000
Invitation (kg) cards	0.0001	0	0	0.0001	0.0006	0.00000
Cigarette (kg) Packets	0.002	0.001	0	0.002	0.027	0.00001
<120 microns(kg)	1.5	1.2	1	1.5	25	0.00992

	Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**VL3**	**…VL21**	**Total**	**Average Kg/Kg of waste**
<50 microns(kg)	1	0.8	1.1	1	21	0.00833
Plastic flags(kg)	0.0001	0.0002	0	0.0001	0.0016	0.00000
PVC banners < 100 µm,	0.001	0	0	0.001	0.006	0.00000
polystyrene for decoration(kg)	0.02	0.01	0	0	0.19	0.00008
	3.5353	2.80635	2.88	3.5153	63.44905	

Table 3B : **Plastic waste characterization (Single Use Plastic) – Disposal point**

	Vehicle Load No. 1(kg)	**Vehicle Load No 2(kg)**	**VL 3**	**..VL24**	**Total**	**Average Kg/Kg of waste**
Sorting Sample Size (kg)	120	120	120	120	2880	0.0561
Plastic Waste (kg)	6	7	6.5	6.8	161.6	0.0000
SUPs						
Earbuds(kg)	0.0001	0.0002	0	0.00012	0.00222	0.0000
Balloons(kg)	0.0002	0	0.001	0.0001	0.0078	0.0000
Candy(kg)	0.005	0	0.0001	0.001	0.0366	0.0001

	Vehicle Load No. 1(kg)	Vehicle Load No 2(kg)	VL 3	..VL24	Total	Average Kg/Kg of waste
Ice-cream(kg)	0.01	0.015	0	0.015	0.24	0.0010
Straws(kg)	0.15	0.14	0.1	0.09	2.88	0.0012
Plates(kg)	0.12	0.18	0.15	0.14	3.54	0.0013
Cups(kg)	0.18	0.15	0.12	0.15	3.6	0.0010
Glass(kg)	0.11	0.14	0.15	0.1	3	0.0005
Forks(kg)	0.05	0.05	0.05	0.07	1.32	0.0005
Spoons(kg)	0.08	0.07	0.03	0.08	1.56	0.0003
Knives(kg)	0.05	0.03	0.01	0.05	0.84	0.0001
Trays(kg)	0.01	0.015	0.012	0.01	0.282	0.0000
Sweet box(kg)	0.001	0	0.0002	0.001	0.0132	0.0000
Invitation (kg) cards	0.0001	0	0	1E-04	0.0012	0.0000
Cigarette (kg) Packets	0.0001	0.0002	0.0001	1E-04	0.003	0.0095
<120 microns(kg)	1.2	1.1	1	1.25	27.3	0.0076
<50 microns(kg)	0.7	0.8	1.15	1	21.9	0.0000
Plastic flags(kg)	0.0001	0	0	1E-04	0.0012	0.0000
PVC banners < 100 µm,	0.0001	0	0	1E-04	0.0012	0.0000

	Vehicle Load No. 1(kg)	Vehicle Load No 2(kg)	VL 3	..VL24	Total	Average Kg/Kg of waste
polystyrene for decoration(kg)	0.002	0.001	0.001	0	0.024	0.0231
	2.6687	2.69135	2.7744	2.95762	66.55242	0.0561

Step 4.: Assessment of Plastic Waste is given below:

1. **Quantity of Plastic Waste Generation**

   Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste) (data sheet at Table 2A & Table 3A)

   Q1= (∑Row 1b) / (∑ Row 1a)

   OR

   Q1= (∑Column 3) / (∑ Column 2)

   = (184/2520)

   Considering Quantity of Mixed Waste generated in the town (TPA) (Q)

   = 1,50,000 Tons per annum

   Quantity of Plastic Waste Generated (TPA) (Q_T)

   = Q1*Q = 1,50,000 x (184/2520)

   = 10,952.3 Ton per Annum

2. **Quantity of Plastic Packaging Waste Generation**

- Average quantity of plastic packaging waste generated (kg of plastic packaging waste / kg of mixed waste)

  (Q2)= (∑ (Column 4)+∑ (Column 5) +∑ (Column 6)+ ∑ (Column 7))/ (∑ (Column 2)

  (data sheet at Table 2A)

  = (31.9+54.5 +30+0.24)/ 2520

= 116.64/2520

= 0.0462

- Quantity of Mixed Waste generated (TPA) = 1,50,000 Tons per annum
- Quantity of Plastic Packaging Waste Generated (Q_{pack})(TPA)

  = 0.0419x150000

  = 6942.8 Tons per Annum

3. **Quantity of SUP Waste Generation**

- Average quantity of SUP waste generated (SUP in kg / kg of mixed waste)

  (Q3) = (∑ (Row 2a… 7c) / (∑ (Row 1a) (data sheet Table 3A)

  Q3 =66.55/2520

  = 0.0264
- Quantity of Mixed Waste generated (TPA) = 1,50,000 tons per annum
- Quantity of Plastic Packaging Waste Generated (TPA) (Q_{SUP}) = Q3*Q

  = 3961.3 tons per annum

4. **Quantity of Other (Non-packaging waste)**

$Q_{other} = Q_T - Q_{pack}$

= 150,000- 10,952.3

=1,39,048 tons per annum

5. **Quantity of Plastic Waste Disposed**

- Average quantity of plastic waste generated (kg of plastic waste/ kg of mixed waste)

  $Q1_d$= (∑Column 3) / (∑ Column 2) – *refer Table 2B*

  OR

  $Q1_d$= (∑Row 1b) / (∑ Row 1a) – *refer Table 3B*

  = (115/2880)
- Considering Quantity of Mixed Waste Disposed (TPA) (Q_D)= 50,000 Tons per annum
- Quantity of Plastic Waste Disposed (TPA) (Q_{TD}) = $Q1_d$*Q_D

  = 50,000 x (184/2520)

  = 1996.5 Ton per Annum

6. **Quantity of Plastic Packaging Waste Disposed**

- Average quantity of plastic packaging waste Disposed (kg of plastic packaging waste / kg of mixed waste)

  $(Q2_d)$ = (∑ (Column 4) +∑ (Column 5) +∑ (Column 6) + ∑ (Column 7)) / (∑ (Column 2)----(*refer Table 2B*)

  = (14.8+36 + 24 +0.044)/ 2880

  = 74.88/2880

  = 0.0259

- Quantity of Mixed Waste Disposed (TPA) Q_D= 50,000
- Quantity of Plastic Packaging Waste Disposed ($Q_{pack\ D}$)(TPA) = $Q2_d$*Q_D

  =1299.37 Tonnes per Annum

7. **Quantity of SUP Waste at Disposal**

- Average quantity of SUP waste at Disposal (SUP in kg / kg of mixed waste)

  $(Q3_d)$ = (∑ (Row 2a… 7c) / (∑ (Row 1a) ---(*refer Table 3B*)

  = 66.552/2880

  =0.0231

- Quantity of Mixed Waste Disposed (TPA) = 50, 000 Ton per Annaum
- Quantity of SUP Waste Disposed (TPA) $(Q_{SUP})_D$ = $Q3_d$*Q_D

  =0.0231 x 50,000= 1155.41 Ton per Annum

8. **Quantity of Other (Non-packaging waste) Disposed**

   $Q_{other\ D}$ = Q_{TD}-$Q_{pack\ D}$

   = 50,000- 1996.5

   =48844.5 tons per Annum

9. **Quantity of Plastic waste Utilised/Processed**

   $Q_{\ utilised/processed}$ = Q_T-Q_{TD}

   = 10,952.3 - 1996.5

   = 8955.5 Tons per Annum

ANNEXURE VII

Quick Verification Test to distinguish Compostable Plastics from Conventional Plastics

S No	Experiment	Observation	Inference
1	Take Dichloromethane (DCM) in test tube. Dissolve 2x2 cm film sample or few granules in Dichloromethane (DCM)	Dissolution of samples*	Confirm the presence of PLA and PBAT. PE and PP will not undergo dissolution.
2	Dissolve 2x2 cm film sample or few granules in boiled xylene	Dissolution of samples.	Confirm the presence of PE and PP. PLA and PBAT will not undergo dissolution.
3	Immerse few granules of sample in distilled water at ambient temperature	Float/Sink	Samples made from PLA and PBAT will sink and samples made from PE and PP will float on water.

***Note:**

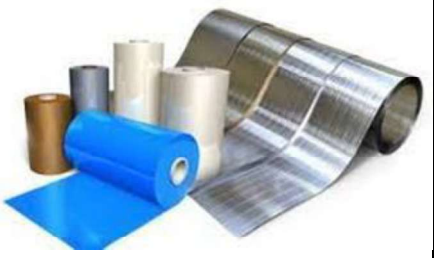
- Styrene based polymers undergo dissolution in DCM and may appear as compostable plastics. Dense black smoke with soot in air will be observed on burning of Styrene based samples. In addition to that, identification by FTIR & DSC shall be carried out for confirmation of Styrene based polymers.

- The film sample containing starch and other additives may not undergo complete dissolution in DCM.

ANNEXURE VIII

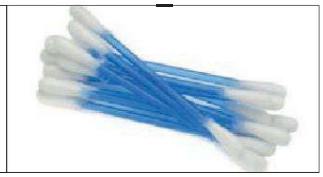
Plastic packaging and SUP References

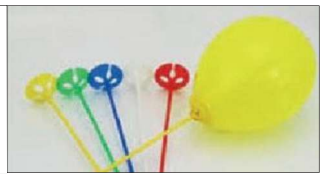
A. Plastic Packaging

Category	Plastic type	Description	Examples	Representative pictures
Category -1	Rigid	The packaging which are rigid in nature	Soft drink bottles. Water bottles (PET) & juice bottles Transportable & storage-able Food containers, Shampoo bottles Plastic containers for cooking oil, vinegar, sauces, pickles. Clamshell packaging for fruits, vegetable & etc.	
Category -2	Flexible	Flexible plastic packaging of single layer or multilayer (more than one layer with different types of plastic), plastic sheets or like and covers made of plastic sheet, carry bags, plastic sachet or pouches	Plastic Carry bag, Plastic sheet Plastic grocery bags, wrap/cling film, shrink film, Plastic packaging for toiletries (shampoo sachets, lotion pouches), rozen foods (freezer bags, plastic film on frozen food trays) Plastic packaging for medical supplies (sterile pouches, medication blister packs) Plastic packaging for electronic devices (bubble wrap, anti-static bags) Plastic packaging for clothing (garment bags, polyethylene garment covers) Plastic packaging for pharmaceuticals (pill packets, blister packs) Plastic packaging for toys (toy packaging, bubble wrap) Plastic packaging for stationery items (pencil case, document pouches)	

Category -3	Multi layer	Multilayered plastic packaging (at least one layer of plastic and at least one layer of material other than plastic)	Milk products & juice storage boxes such as fruiti Packets of biscuit, namkeen mixture, chips, kurkure etc. & other multilayer packaging.	
Category -4	Compostable	Plastic sheet or like used for packaging as well as carry bags made of compostable plastics	Compostable shopping bags, food packaging, sheets and others	

B. Single-Use Plastic

Product	
1. Plastic Earbuds	
2. Plastic sheets below 50 microns	
3. Carry bags below 120 microns	
4. Plastic cutlery (spoons, forks)	
5. Straws	
6. Plastic plates, cups, glasses	
7. SUP knives (mostly used for cake cutting)	
8. SUP Trays	

Product	
9. Wrappings on Invitation cards	
10. Thermocol decorative items	
11. Wrapping on sweet boxes (Plasticsheet wrapped on sweet boxes/fruit baskets)	
12. Wrapping/Films on cigarette packets	
13. Plastic Balloon sticks	
14. Plastic stirrers	
15. Plastic Flags	
16. Plastic Candy sticks	