**Annex 7. Solid Waste Generation**

***Note: based on the Preinvestment Technical Design Study (in Spanish: Estudio de Diseño Técnico de Preinversión (EDTP)) the following information is presented as a reference.***

To have a better understanding of the organic and recyclable waste generation, next, the generation of solid waste for the project is presented:

1. **Solid Waste Generation**

The total waste generation of the municipality, whether in urban or rural areas, is obtained by summing household and non-household waste generation. Non-household waste generation includes food establishments, institutions, educational units, etc., present in the study area.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **Category** | **Population (Inhabitants)** | **PPC (kg/inhabitant-day)** | **Generation (Ton/day)** | **Total** |
| **Household** | Housing | 1,133 | 0.330 | 0.374 | 0.374 |
| **Non-household** | Food establishments | 42 | 0.170 | 0.007 | 0.033 |
| Institutions | 46 | 0.180 | 0.008 |  |
| Lodging facilities | 22 | 0.150 | 0.003 |  |
| Educational units | 616 | 0.023 | 0.014 |  |
| **Total** |  |  |  | **0.407** |  |

As a result, a summary table of the values obtained for the urban area is presented below:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Obtained Value** |
| Per capita household waste production | Kg/inhab-day | 0.330 |
| Per capita municipal waste production | Kg/inhab-day | 0.359 |
| Total household waste generation | Ton/day | 0.374 |
| Ton/year | 136.470 |
| Total non-household waste generation | Ton/day | 0.033 |
| Ton/year | 12.004 |
| Total municipal waste generation | Ton/day | 0.407 |
| Ton/year | 148.474 |

As observed, the annual waste generation in the urban area of Yamparáez is **148.474 Ton/year**.

For the rural area, household waste generation units and non-household generation units (which in this case correspond to educational units in the project area) have been considered. The results are summarized in the following tables:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source** | **Category** | **Population (Inhabitants)** | **PPC (kg/inhab-day)** | **Generation (Ton/day)** | **Total** |
| **Household** | Housing | 2,587 | 0.292 | 0.755 | 0.755 |
| **Non-household** | Educational units | 176 | 0.023 | 0.004 | 0.004 |
| **Total** |  |  |  | **0.759** |  |

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Obtained Value** |
| Per capita household waste production | Kg/inhab-day | 0.292 |
| Per capita municipal waste production | Kg/inhab-day | 0.294 |
| Total household waste generation | Ton/day | 0.755 |
| Ton/year | 275.722 |
| Total non-household waste generation | Ton/day | 0.004 |
| Ton/year | 1.478 |
| Total municipal rural project waste generation | Ton/day | 0.759 |
| Ton/year | **277,200.00** |

As observed, the rural waste generation amounts to **277,200.00 Ton/year**.

For the airport, the following summary is provided:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Obtained Value** |
| General per capita waste production | Kg/inhab-day | 0.054 |
| General population | Persons/day | 671 |
| Total airport waste generation | Ton/day | 0.036 |
| Ton/year | 13.225 |

As observed, the total annual waste generation is **13.225 Ton/year**. Considering the operational conditions of 2020, data from the serviced population in 2019 was used.

1. **Waste Composition**

In the field study, the physical composition of the waste was determined based on weight percentages, following the NB 743/2019 standard. This allowed for identifying the types of solid waste generated in the Municipality of Yamparáez, classified into five groups as established by Ministerial Resolution 432, which approves the Annex on Waste Classification of Law No. 755. Household Waste Composition

* 1. **Household waste urban and rural**

The information obtained for both the urban and rural areas is presented in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Composition** | **Urban Area** | | **Rural Area** | |
| (%) | Ton/year | (%) | Ton/year |
| Organic Waste | 51,99% | 70,95 | 45,97% | 126,75 |
| Paper and Cardboard | 6,90% | 9,42 | 5,89% | 16,24 |
| Plastic Waste | 12,46% | 17,00 | 16,29% | 44,92 |
| Metal Waste | 1,94% | 2,65 | 1,66% | 4,58 |
| Glass Waste | 1,46% | 1,99 | 1,30% | 3,58 |
| Poly-laminated Waste | 0,11% | 0,15 | 0,14% | 0,39 |
| Fabric and Textile Waste | 0,80% | 1,09 | 3,21% | 8,85 |
| Non-Recyclable Waste | 22,61% | 30,86 | 22,99% | 63,39 |
| Special Waste | 1,12% | 1,53 | 2,02% | 5,57 |
| Hazardous Waste | 0,61% | 0,83 | 0,53% | 1,46 |

As observed in the preceding table, the percentage of organic waste is 52% in the urban area, which is higher than the 46% in the concentrated rural project area. This difference may be due to rural families reusing this material as animal feed.

The proportion of recyclable material is 24% in the urban area and 28% in the rural area. In both cases, non-recyclable waste represents 23%.

* 1. **Composition of solid waste from non-homestead sources**

In the case of non-domestic sources, values have also been generated for urban and rural areas, as shown in the table below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Composition** | **Urban Area** | | **Rural Area** | |
| (%) | Ton/year | (%) | Ton/year |
| Organic Waste | 62,53% | 7,506 | 7,60% | 0,112 |
| Paper and Cardboard | 10,73 | 1,288 | 11,50% | 0,170 |
| Plastic Waste | 9,69 | 1,163 | 35,10% | 0,519 |
| Metal Waste | 2,92 | 0,351 | 0,00% | 0,000 |
| Glass Waste | 1,06% | 0,127 | 0,00% | 0,000 |
| Poly-laminated Waste | 0,00% | 0,000 | 0,00% | 0,000 |
| Fabric and Textile Waste | 0,06% | 0,007 | 0,00% | 0,000 |
| Non-Recyclable Waste | 12,18% | 1,462 | 45,80% | 0,677 |
| Special Waste | 0,60% | 0,072 | 0,00% | 0,000 |
| Hazardous Waste | 0,23% | 0,028 | 0,00% | 0,000 |

The non-domestic source for the urban area includes food outlets, institutions, lodging, and educational units. In this last case, since the study was not conducted during the characterization period, values were taken from the SGAB-Conseil study “Generation of solid waste in educational units in the city of Cochabamba”, 2008.

Consequently, a disaggregated detail is presented for waste from non-home sources in urban areas, while in the case of rural areas the information is presented.

1. **Composition of waste from non-home sources in urban areas**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Composition** | **Restaurants** | | **Hostels** | | **Institutions** | | **Educational units** | |
| **%** | **Ton/año** | **%** | **Ton/año** | **%** | **Ton/año** | **%** | **Ton/año** |
| Organic Waste | 82,77% | 2,157 | 0,00% | 0,000 | 48,14% | 1,455 | 7,60% | 0,393 |
| Paper and Cardboard | 1,07% | 0,028 | 5,03% | 0,061 | 28,37% | 0,857 | 11,50% | 0,595 |
| Plastic Waste | 7,24% | 0,189 | 13,84% | 0,167 | 7,71% | 0,233 | 35,10% | 1,815 |
| Metal Waste | 4,43% | 0,115 | 1,89% | 0,023 | 1,08% | 0,033 | 0,00% | 0,000 |
| Glass Waste | 1,22% | 0,032 | 8,18% | 0,099 | 0,00% | 0,000 | 0,00% | 0,000 |
| Poly-laminated Waste | 0,00% | 0,000 | 0,00% | 0,000 | 0,00% | 0,000 | 0,00% | 0,000 |
| Fabric and Textile Waste | 0,05% | 0,001 | 0,00% | 0,000 | 0,09% | 0,003 | 0,00% | 0,000 |
| Non-Recyclable Waste | 3,21% | 0,084 | 58,49% | 0,705 | 13,80% | 0,417 | 45,80% | 2,368 |
| Special Waste | 0,00% | 0,000 | 8,81% | 0,106 | 0,63% | 0,019 | 0,00% | 0,000 |
| Hazardous Waste | 0,00% | 0,000 | 3,77% | 0,045 | 0,18% | 0,005 | 0,00% | 0,000 |

Among the various non-household sources included in the study, food outlets generate the highest amount of organic waste, followed by institutions, and finally educational units. In the case of the lodging facility, no organic fraction value was recorded because the same location also houses a restaurant that is open to the general public, so it was not considered specific to lodging services.

Regarding recyclable materials, production is significant in institutions, followed by the lodging center, and finally food outlets.

As for the generation of special and hazardous waste, production is low in food outlets. However, these values increase in institutions and lodging centers.

Finally, in terms of non-recyclable waste, the results are generally below 30%, except for the lodging facility, where the value is higher due to the amount of sanitary waste found.

1. **Composition of waste from non-home sources in urban areas**

In the case of rural area waste from non-home sources, only educational units were considered.

|  |  |  |
| --- | --- | --- |
| **Composition** | **Educational units** | |
| **%** | **Ton/yea** |
| Organic Waste | 7,60% | 0,393 |
| Paper and Cardboard | 11,50% | 0,595 |
| Plastic Waste | 35,10% | 1,815 |
| Metal Waste | 0,00% | 0,000 |
| Glass Waste | 0,00% | 0,000 |
| Poly-laminated Waste | 0,00% | 0,000 |
| Fabric and Textile Waste | 0,00% | 0,000 |
| Non-Recyclable Waste | 45,80% | 2,368 |
| Special Waste | 0,00% | 0,000 |
| Hazardous Waste | 0,00% | 0,000 |

1. **Composition of airport solid waste**

In the case of the airport, the following information has been generated:

|  |  |  |
| --- | --- | --- |
| **Composition** | **Airport** | |
| **%** | **Ton/year** |
| Organic Waste | 26,78% | 3,542 |
| Paper and Cardboard | 11,66% | 1,542 |
| Plastic Waste | 15,84% | 2,095 |
| Metal Waste | 3,91% | 0,517 |
| Glass Waste | 0,52% | 0,069 |
| Poly-laminated Waste | 0,54% | 0,071 |
| Fabric and Textile Waste | 1,47% | 0,194 |
| Non-Recyclable Waste | 23,29% | 3,080 |
| Special Waste | 0,74% | 0,098 |
| Hazardous Waste | 15,25% | 2,017 |

The main recyclable fractions correspond to paper and cardboard (12%), plastics (16%), metals (4%), and glass (0.5%). The organic fraction accounts for 27%. In the case of hazardous waste, it reaches 15.25%, and the non-recyclable fraction accounts for 23.29%.

1. **Organic and recyclable quantity**

The amount of organic and recyclable material considered to be recovered is described next.

* 1. **Recyclable waste**

According to a market study regarding the types of marketable waste in the city of Sucre or other cities in the country are considered, the following waste fractions are not considered for the project's purposes: other types of paper, polystyrene, other plastics, and flat glass, as there are no potential buyers in the Sucre market. Taking this into account, the following table has been generated:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Total Recyclable Waste Generated (Tn/year)** | **Total Waste Generated Without RSRD (Tn/year)** | **Recovery Percentage (%)** | **Annual Recovered Quantity (Tn/year)** | **Final Production Percentage (%)** | **Approx. Final Production Quantity (Tn/year)** |
| 0 | 119.67 | 114.06 | 15% | 17.11 | 60% | 10.27 |
| 1 | 120.41 | 114.76 | 15% | 17.21 | 60% | 10.33 |
| 2 | 121.17 | 115.49 | 15% | 17.32 | 60% | 10.39 |
| 3 | 121.91 | 116.19 | 15% | 17.43 | 60% | 10.46 |
| 4 | 122.66 | 116.90 | 15% | 17.54 | 60% | 10.52 |
| 5 | 123.44 | 117.64 | 15% | 17.65 | 60% | 10.59 |
| 6 | 124.19 | 118.36 | 30% | 35.51 | 70% | 24.86 |
| 7 | 124.95 | 119.08 | 30% | 35.72 | 70% | 25.01 |
| 8 | 125.74 | 119.84 | 30% | 35.95 | 70% | 25.17 |
| 9 | 126.51 | 120.57 | 30% | 36.17 | 70% | 25.32 |
| 10 | 127.28 | 121.31 | 30% | 36.39 | 70% | 25.47 |
| 11 | 128.09 | 122.08 | 45% | 54.94 | 80% | 43.95 |
| 12 | 128.87 | 122.83 | 45% | 55.27 | 80% | 44.22 |
| 13 | 129.67 | 123.58 | 45% | 55.61 | 80% | 44.49 |
| 14 | 130.49 | 124.36 | 45% | 55.96 | 80% | 44.77 |
| 15 | 131.32 | 125.16 | 45% | 56.32 | 80% | 45.06 |
| 16 | 132.13 | 125.93 | 60% | 75.56 | 90% | 68.00 |
| 17 | 132.97 | 126.73 | 60% | 76.04 | 90% | 68.43 |
| 18 | 133.79 | 127.51 | 60% | 76.50 | 90% | 68.85 |
| 19 | 134.61 | 128.29 | 60% | 76.97 | 90% | 69.28 |
| 20 | 135.46 | 129.10 | 60% | 77.46 | 90% | 69.72 |

It is considered that the first 5 years 15% of the waste will be recovery, then 30%, following by 45% and 60% to the end of the 20 years.

* 1. **Organic waste**

Similarly, the quantities allocated for compost production have been determined according to the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **Total Organic Waste (Tn/year)** | **Annual Recovery Percentage (%)** | **Annual Recovered Quantity (Tn/year)** | **Final Production Percentage (%)** | **Approx. Final Production Quantity (Compost) (Tn/year)** |
| 0 | 205.36 | 15% | 30.80 | 20% | 6.16 |
| 1 | 206.61 | 15% | 30.99 | 20% | 6.20 |
| 2 | 207.91 | 15% | 31.19 | 20% | 6.24 |
| 3 | 209.18 | 15% | 31.38 | 20% | 6.28 |
| 4 | 210.46 | 15% | 31.57 | 20% | 6.31 |
| 5 | 211.79 | 15% | 31.77 | 20% | 6.35 |
| 6 | 213.08 | 30% | 63.93 | 20% | 12.79 |
| 7 | 214.38 | 30% | 64.31 | 20% | 12.86 |
| 8 | 215.75 | 30% | 64.73 | 20% | 12.95 |
| 9 | 217.07 | 30% | 65.12 | 20% | 13.02 |
| 10 | 218.39 | 30% | 65.52 | 20% | 13.10 |
| 11 | 219.78 | 45% | 98.90 | 20% | 19.78 |
| 12 | 221.12 | 45% | 99.51 | 20% | 19.90 |
| 13 | 222.48 | 45% | 100.12 | 20% | 20.02 |
| 14 | 223.89 | 45% | 100.75 | 20% | 20.15 |
| 15 | 225.33 | 45% | 101.40 | 20% | 20.28 |
| 16 | 226.71 | 60% | 136.03 | 20% | 27.21 |
| 17 | 228.15 | 60% | 136.89 | 20% | 27.38 |
| 18 | 229.55 | 60% | 137.73 | 20% | 27.55 |
| 19 | 230.96 | 60% | 138.57 | 20% | 27.71 |
| 20 | 232.43 | 60% | 139.46 | 20% | 27.89 |