# Integrated Solid Waste Management

Novo Hamburgo Brazil

UNEP

INSTITUTO VENTURI para Estudos Ambientais

# Strategic Action Plan

**Volume I** **June 2009**


Prepared by
United Nations Environment Programme
Instituto Venturi Para Estudos Ambientais

# Strategic Action Plan
## for
# Integrated Solid Waste
# Managment Plan,
## Novo Hamburgo

## (Volume I)

**Prepared by**

**UNEP DTIE IETC**

**and**

**Instituto Venturi Para Estudos Ambientais**

**With collaboration of the postgraduate students of the**

**Course of Specialization in Environmental Planning (group NH)**

**June 2009**

## Content

# Preamble

The destination of the waste is currently a major concern of our society, since it has increased the number of news related to environmental liabilities arising from inadequate disposal of waste, made in the past. Usually the solutions to the environmental liabilities associated with large costs and long periods of time may even endanger the continuity of operational activity producer.

Data on current and future trends of the various categories of solid waste generated in municipalities make clear that there are large quantities of recyclable materials. According to the Overview of Solid Waste in Brazil (Abrelpe, 2006), only the Rio Grande do Sul generates an average of 7,347 tonnes per day of Solid waste (MSW). Whereas the average composition of waste in Brazil, 57.41% of these are organic matter, 13.16% paper/cardboard, 16.49% plastic, 2.34% glass, 0.51% aluminum, 1.56% ferrous materials, 0.46% inert, 8.08% others. Despite this scenario, approximately 82% of all waste generated in Brazil ends up in landfills and dumping sites.

According to World Waste Survey (2006) "From waste to resources", each year the world produces as much waste as producing grain (2 billion tons) and produces more than steel (1 billion tonnes). The survey also estimated the market for recyclable materials at 600 million tonnes and more than $ 100 billion a year. There opportunities to be exploited. Although the markets for paper and scrap metal are well established, the rates of recycling plastic are still low and electronic components are beginning to stimulate the market for materials recovery. Also, two different categories of waste attention recycling industry by volumes generated: waste generated by construction and demolition industry and agricultural activities.

Therefore it is more important than ever working to establish an integrated system of waste management ranging from its original disposal to end use. The task is particularly difficult because the definitions vary, the statistics are scarce and incomplete and an overview is scarce. In this context, the Plan of Integrated Management of solid waste for Novo Hamburgo, which was developed from data collected that follow this Strategic Action Plan, it is essential and necessary.

The inability to fully grasp the problems of waste generation and characterization have resulted in transforming Solid Waste Management as one of the most compelling problem of urban environmental degradation. Individual or fragmented approach is bound to become unsustainable in view of increasing complexity of the waste streams, increased urbanization and industrialization. The approach of managing these waste streams has to be in the integrated format with due consideration not only to the various forms of wastes but also to the existing systems. Integrated Solid Waste Management (ISWM) refers to a strategic initiative for the sustained management of solid waste through the use of a comprehensive integrated format generated through sustained preventive & consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner.

Instituto Venturi Para Estudos Ambientais (IVB) and International Environmental Technology Centre (IETC) of the United Nations Environment Programme (UNEP) are in the process of formulating the Integrated Solid Waste Management (ISWM) Plan for Novo Hamburgo. The Plan for Novo Hamburgo has been developed using the Strategic Planning Process. This Report for the ISWM project aims to present the Strategic Action Plan to Novo Hamburgo Municipality with the view to take it forward to implementation at the

same time to demonstrate the application of the Strategic Planning process relevant to NHM and other stakeholders. The Report illustrates the methodology for developing Strategic Action Plans using a consultation and consensus driven approach.

The Strategic Action Plan Report is thus based on outcomes of the workshops conducted with Environmental Planning Students, IVB, NHM, other the stakeholders and the numerous discussions and brainstorming sessions with its officers. The Report has been compiled within limited time and resources. The information sources are Annual Reports of Environmental Service Providers, Municipal City Hall, Environmental Status Reports, other relevant research and survey reports that were made available and could be accessed, regional and issue-specific environmental research papers etc. Information has been collected from personal interviews/discussions with NHM staff, various technology providers working in the waste sector, NGOs, Citizen Activists and other local corporations. The data collected thus represents the "state of affairs" over the last two years and the same has been used to develop a model Strategic Action Plan.

The Strategic Planning framework discussed in this report can be used by the Novo Hamburgo Municipality to develop their individual Strategic Action Plans. Allocation of budget, time and human resources for primary data collection, data update and data management to periodically update the action plan should be developed. Action Plans are dynamic and need to be tracked, updated and strengthened as demanded by the external and internal situations. This requires that the Action Plans are well supported through appropriate institutional adoption with work instructions and proper allocation of responsibilities. The reader of this document is thus advised to concentrate more on the process of action planning and its application to an organization such as the NHM.

# List of Tables

## List of Figures

# INTRODUCTION

Novo Hamburgo is a municipal district lying in the *Vale dos Sinos*, located 43 km from *Porto Alegre*, capital of *Rio Grande do Sul*, in an area of 223.6 km$^2$, bordered to the north by the municipalities of *Estância Velha* and *Dois Irmãos*, by the city of *Campo Bom* to the west, by the city of *Portão* to the east, by the municipality of São Leopoldo to the south. The City has its headquarters location at 29°40'40''S and 51°07'51''W. Novo Hamburgo has illiteracy rate (2000): 5.01%; infant mortality rate (2006): 10.44 for thousand live births; life expectancy (2000): 70.12 years; GDP (2006): R$3,897,297 and GDP per capita (2006): R$15,062.[1]

City of colonization predominantly German, immigrants arrived in RS in 1824. A century later, in 1927, Hamburger Berg, as it was called, emancipate itself from political office, which was the city of São Leopoldo. Currently the city's economic indicators are significant, and the 5th largest GDP of the state of the RS, with strong participation in the national leather-footwear industry.

The city of Novo Hamburgo has a population of 255,945.00 inhabitants and the rates of population growth are 1.6 % in the total, 1.7 % in the urban area and zero in the rural area (FEE/RS, 2008). This population generates about 200 tons of Municipal Solid Wastes per day. From a total of 35 districts are collected and unloaded in the Central Facility of "Roselândia" daily 131 tons MSW, by the private service provider contracted by the Local Authority. From that amount only 2% are recyclable materials selected by the scavengers (COOPREL) and the residual wastes are transferred to the Sanitary Landfill of the Recreation, a private landfill located approximately

[1] Sources: FEE/Centro de Informações Estatísticas/Núcleo de Contabilidade Social. IBGE/Diretoria de Pesquisas/Coordenação de Contas Nacionais.

130km of Novo Hamburgo. Based on the estimated data collection and questionnaires applied, the Residential sector generates about 177 tons/day and commercial sector, 23 tons/day, from which the majority of this quantity is collected by informal scavengers or sold by generator for recycling businesses.

# 1. CHARACTERIZATION AND QUANTIFICATION OF THE SOLID WASTE

This chapter contains the information on the overall solid waste and waste streams including how much of which type of waste is disposed by each generator sector, what are the demographic and socioeconomic characters influencing the current and future solid waste generation trends. The characteristics and quantities of solid waste are vital to develop the current and projected scenario for:

**a)** Developing an integrated solid waste management plan;

**b)** Generating comprehensive information on the quantity and type of recyclable and recoverable materials/energy to prioritize the recovery opportunities;

**c)** Developing baseline for continued long-term measurement of system performance;

**d)** Generating information on the different sub-streams of waste to design, implement and monitor an effective and efficient system for collection, transportation, recycling, treatment, recovery, and disposal of various streams of solid waste; and

**e)** Providing comparison of waste composition and waste diversion accomplishments for continuing improvements in integrated solid waste management.

The database on estimated waste quantities and its predominant destination disclosed during the data collection in NH is summarized below.

| SECTOR | ESTIMATED QUANTITY (ton/year) | PREDOMINANT DESTINATION |
|---|---|---|
| **Residential** | 63,512.52 | Landfill |
| **Commercial** | 7,191.60 | Recycling |
| **Industrial** | 5,345.95 | Landfill |
| **Healthcare** | 6,924.18 | Landfill |
| **Construction & Demolition** | 65,286.80 | Landfill |
| **TOTAL** | 148,261.05 | Landfill = 95.15%<br>Recycling = 4.85% |

Table 01 - Estimated waste generation and its predominant destination by sector.

## 1.1 Municipal Solid Waste

### 1.1.1 Residential Waste

*From Generator*

The data collection on residential solid waste characterization and quantification was carried out in the following steps:

Step 1-Defining the socio-economic conditions:

This was done through a questionnaire circulated to a number of residents to find their income levels, and value/rent of their condominium and family status (single-family or multi-family).

Based on the responses from the questionnaire, as stated in Step 1, it was analyzed that the residents in the city can be divided into 3 socio-economic groups: A (high class), B (middle class), and C (low class). In all the three classes there were both single-family type and multi-family type residents.

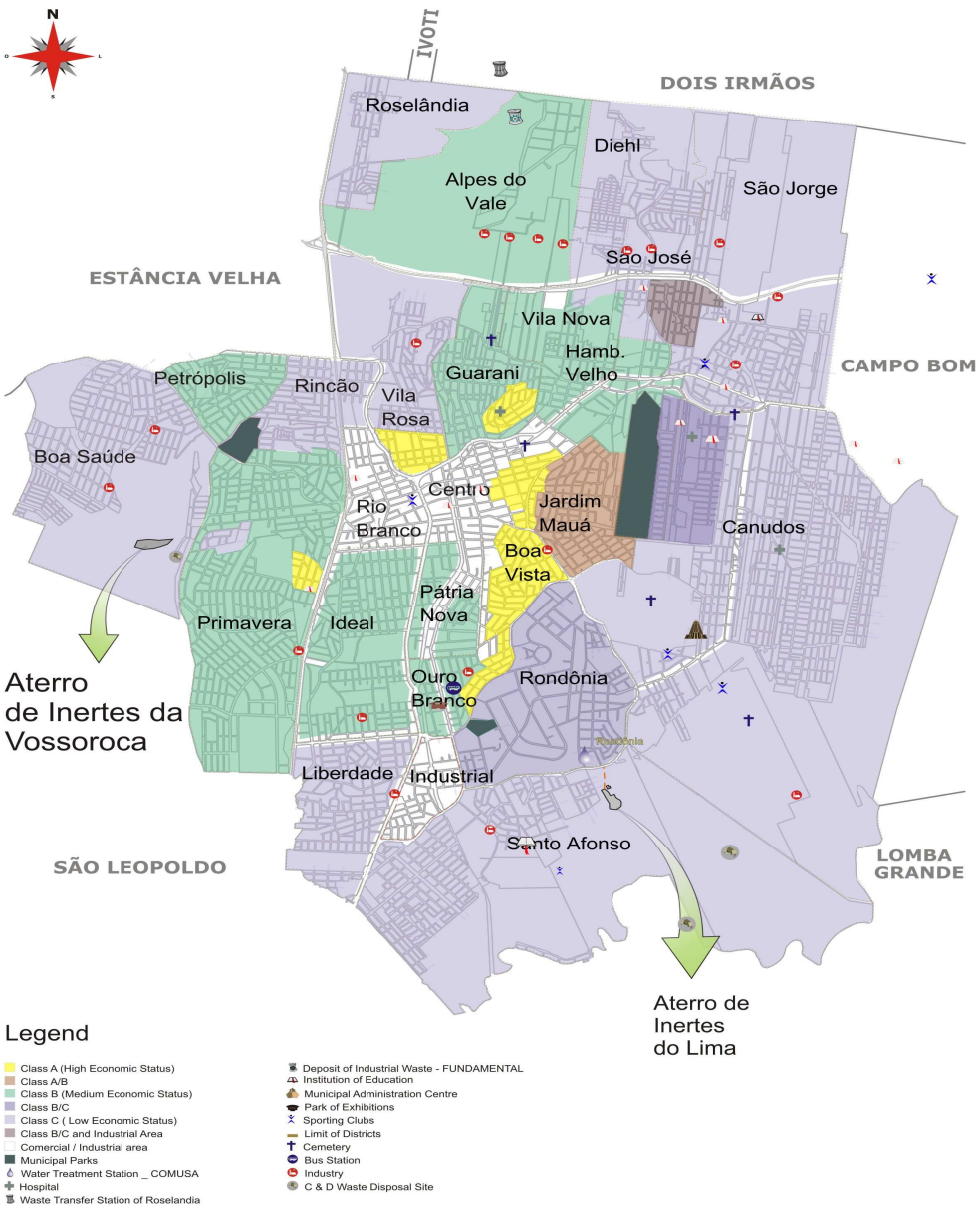


FIG. 1 – Districts searched with different socio-economic conditions

| | District | Area (km²) | Population | Building | Industries | Commerce | Service | Demografic Density |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 1 | Centro | 1,05 | 7661 | 4115 | 295 | 2321 | 3313 | 7296.19 |
| 2 | Ouro Branco | 0,7 | 3644 | 1292 | 64 | 401 | 272 | 5205.71 |
| 3 | Guarani | 1,3 | 6322 | 3010 | 69 | 131 | 384 | 4863.08 |
| 4 | Industrial | 0,8 | 3851 | 818 | 81 | 80 | 120 | 4813.75 |
| 5 | Vila Rosa | 0,44 | 2054 | 1848 | 26 | 86 | 222 | 4668.18 |
| 6 | Jardim Mauá | 1,3 | 5940 | 2008 | 38 | 110 | 299 | 4569.23 |
| 7 | Liberdade | 1,9 | 8645 | 2746 | 220 | 376 | 441 | 4550.00 |
| 8 | Diehl | 2,21 | 9845 | 2143 | 127 | 205 | 347 | 4454,75 |
| 9 | Canudos | 14,1 | 58992 | 13155 | 415 | 969 | 1146 | 4183,83 |
| 10 | Boa Vista | 0,8 | 3298 | 1220 | 41 | 87 | 284 | 4122.50 |
| 11 | Rio Branco | 1,1 | 4375 | 2062 | 147 | 1017 | 1066 | 3977.27 |
| 12 | Rincão | 1,6 | 6316 | 1556 | 115 | 214 | 360 | 3947.50 |
| 13 | Rondônia | 2,79 | 10941 | 3436 | 169 | 257 | 489 | 3921.51 |
| 14 | Petrópolis | 1,19 | 3954 | 1185 | 39 | 52 | 116 | 3322.69 |
| 15 | Pátria Nova | 1,28 | 4245 | 2086 | 70 | 215 | 383 | 3316.41 |
| 16 | Vila Nova | 1,62 | 5083 | 2399 | 89 | 127 | 302 | 3137.65 |
| 17 | São Jorge | 4,62 | 12570 | 3120 | 127 | 205 | 347 | 2720.78 |
| 18 | Santo Afonso | 8,6 | 23269 | 4298 | 127 | 238 | 326 | 2705.70 |
| 19 | São José | 2,4 | 5119 | 1443 | 62 | 153 | 144 | 2132.92 |
| 20 | Operário | 2,1 | 4354 | 1926 | 45 | 17 | 245 | 2073.33 |
| 21 | Boa Saúde | 6,9 | 11104 | 2581 | 24 | 70 | 64 | 1609.28 |
| 22 | Hamburgo Velho | 1,3 | 2003 | 1002 | 137 | 378 | 551 | 1540,77 |
| 23 | Ideal | 2,43 | 3644 | 1292 | 241 | 401 | 780 | 1499.59 |
| 24 | Primavera | 6,69 | 7992 | 2194 | 114 | 211 | 309 | 1194.62 |
| 25 | Roselândia | 5,92 | 6220 | 1470 | 16 | 55 | 60 | 1050.68 |
| 26 | Lomba Grande | 156,31 | 5496 | 827 | 44 | 152 | 142 | 35.16 |
| 27 | Alpes do Vale | - | - | - | - | - | - | - |

Table 02 - Official list of Districts of Novo Hamburgo from Municipal Administration.

Step 2-Sampling for quantification and characterization of waste

The sampling was done as follows:

**a)** collecting door to door in single family units in the socio economic classes A, B and C;

**b)** collecting door to door in multi-family units in socio-economic classes A, B and C.

All samples were analyzed for waste quantity and composition Since the weekend waste has specific characteristics due to regional culture, sampling was carried on Wednesdays and Thursdays.

### a) Sampling in Single Family Units

For the single family units, a total of 30 samples were collected, 10 in each socio-economic class (A, B and C). With the help of a quick questionnaire the number of residents of the unit and range of the same family income was ascertained. This enabled determination of the per capita income of the unit visited, and thus the socio-economic class to which the unit belonged.

### b) Sampling in Multi-family Units

For multi-family units waste were collected from two apartments of each unit for every socio-economic class, taking into account also the number of residents in each unit surveyed.

Observations and analysis:

The data collected through collection and analysis of samples is summarized below in table 03 (quantity of waste generated by residents belonging to different socio-economic class and for single/multifamily units) and table 04 (composition of waste generated by residents belonging to different socio-economic class and for single/multifamily units).

| | | PROFILE OF RSW GENERATION FROM NOVO HAMBURGO | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **A CLASS** | **B CLASS** | **C CLASS** | **Total of Inhabitants** | **Total in Tons** |
| | | | | | | | |
| | **Total Population and percentage of its classes (IBGE 2008 / FGV)** | 255,945 | 15.52% | 51.89% | 32.59% | 100.00% | |
| | **Number of Inhabitants by Socio Economic Class in multi-family units** | | 39,722 | 132,810 | 83,413 | 255,945.00 | |
| | | | | | | | |
| | **Total number of condominiums (PMNH 2009)** | 600 | | | | | |
| | **Average of Units / Building (PMNH 2009)** | 16 | | | | | |
| **MULTI-** | **Total Number of Apartments:** | 9,600 | 1,489.92 | 4,981.44 | 3,128.64 | 9,600 | |
| | **Average number of inhabitants per** | | 3.50 | 3.00 | 3.50 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **apartment by class** | | | | | | |
| | **Total inhabitants of multi-family units by class** | | 5,214.72 | 14,944.32 | 10,950.24 | 31,109.28 | |
| | **Average MSW generation per capita/day in multi-family units** | | 0.67563 | 0.48883 | 0.79083 | | |
| | **Daily MSW generation per class in multi-family units (kg)** | | 3,523.22 | 7,305.23 | 8,659.78 | | **19.4882** |
| | **Monthly generation per class in multi-family units (kg)** | | 105,696.64 | 219,156.96 | 259,793.35 | | 547.5336 |
| | **Annual generation per class in multi-family units (kg)** | | 1,268,359.66 | 2,629,883.50 | 3,117,520.19 | | 6,570.4033 |
| | | | | | | | |
| **SINGLE FAMILY** | **Average number of residents per single family unit / class** | | 2.38 | 3.86 | 4.11 | | |
| | **Number of residents of single family units per class** | | 34,507 | 117,866 | 72,463 | 224,835.72 | |
| | **Average MSW generation per capita/day - single family (kg/day)** | | 1.24667 | 0.70444 | 0.43395 | | |
| | **Daily MSW generation per class in single family units (kg)** | | 43,019.19 | 83,029.30 | 31,445.21 | | **157.4937** |
| | **Monthly generation per class in single units (kg)** | | 1,290,575.72 | 2,490,878.99 | 943,356.44 | | 4,745.1763 |
| | | | 15,486,908.67 | 29,890,547.86 | 11,320,277.29 | | 56,942.1150 |
| | | | | | | | |
| **TOTALS** | **Total of MSW generated daily in NH** | | | | | | **176.9819** |
| | **Total of MSW generated monthly in NH** | | | | | | 5,292.7099 |
| | **Total of MSW generated annual in NH** | | | | | | 63,512.5183 |

Table 03 - Quantity of Waste generated by different socio-economic classes

| | **SINGLE FAMILY GENERATION** | | | | | | | **MULTI-FAMILY GENERATION** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Metal** | **Paper** | **Plastic** | **Glass** | **Organic** | **Mixed** | Total/day (ton) | **Metal** | **Paper** | **Plastic** | **Glass** | **Organic** | **Mixed** | Total/day (ton) |
| **A Class** | | | | | | | | | | | | | | |
| **Percentual composition (%)** | 3.94 | 14.53 | 13.35 | 6.83 | 52.68 | 8.67 | | 3.48 | 20.64 | 11.05 | 8.01 | 42.8 | 14.03 | |
| **Weight composition (ton)** | 1.6947 | 6.2497 | 5.7421 | 2.9377 | 22.6589 | 3.7292 | 43.0123 | 0.1226 | 0.7272 | 0.3893 | 0.2822 | 1.5079 | 0.4943 | 3.5236 |
| **B Class** | | | | | | | | | | | | | | |
| **Percentual composition (%)** | 1.28 | 9.13 | 10.32 | 2.31 | 63.14 | 13.82 | | 0.77 | 32.97 | 10.29 | 0 | 49.94 | 6.02 | |
| **Weight composition (ton)** | 1.0628 | 7.5806 | 8.5686 | 1.9180 | 52.4247 | 11.4746 | 83.0293 | 0.0562 | 2.4061 | 0.7509 | 0.0000 | 3.6445 | 0.4393 | 7.2971 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C Class** | | | | | | | | | | | | | | |
| **Percentual composition (%)** | 4.27 | 12.74 | 18.05 | 1.47 | 45.31 | 18.16 | | 3.07 | 2.63 | 5.02 | 6.46 | 68.01 | 14.8 | |
| **Weight composition (ton)** | 1.3430 | 4.0070 | 5.6771 | 0.4623 | 14.2509 | 5.7117 | 31.4520 | 0.2659 | 0.2278 | 0.4347 | 0.5594 | 5.8895 | 1.2817 | 8.6589 |
| | | | | | | | | | | | | | | |
| **Total daily waste generation/ class** | 4.1005 | 17.8372 | 19.9879 | 5.3181 | 89.3345 | 20.9155 | **157.4936** | 0.4447 | 3.3610 | 1.5750 | 0.8416 | 11.0420 | 2.2153 | **19.4796** |
| | | | | | | | | | | | | | | |
| **Monthly generation (ton)** | 123.01 | 535.12 | 599.64 | 159.54 | 2680.03 | 627.46 | **4724.81** | 13.34 | 100.83 | 47.25 | 25.25 | 331.26 | 66.46 | **584.39** |
| **Annual generation (ton)** | 1476.17 | 6421.41 | 7195.63 | 1914.50 | 32160.41 | 7529.58 | **56697.70** | 160.08 | 1209.97 | 566.99 | 302.99 | 3975.12 | 797.50 | **7012.65** |

Table 04 - Composition of Waste generated by different socio-economic classes

Comparison waste quantity and composition data between single and multifamily units for different socio-economic class is given in table 05.

| **COMPARATIVE BETWEEN SINGLE FAMILY AND MULTI-FAMILY UNITS** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Number of Units in the building** | **Average number of residents** | **Average generation per capita (g)** | **Average generation per capita per class (g) - weighted average** | **% Metal** | **Plastic (%)** | **Organic (%)** | **Paper (%)** | **Glass (%)** | **Mixed residue (%)** | **Total (%)** |
| **A CLASS** | | | | | | | | | | | |
| **Single family units** | | 2.5 | 1,246.67 | **913.56** | 2.81 | 12.15 | 53.82 | 16.17 | 7.5 | 7.55 | 100 |
| **Multi-family units** | 26 | 3.5 | 675.63 | | 3.58 | 8.96 | 50.15 | 15.35 | 5.12 | 16.84 | 100 |
| **B CLASS** | | | | | | | | | | | |
| **Single family units** | | 3.81 | 704.44 | **609.45** | 1.28 | 10.32 | 63.14 | 9.13 | 2.31 | 13.82 | 100 |
| **Multi-family units** | 6 | 3 | 488.83 | | 0.77 | 10.58 | 52.05 | 30.72 | 0.00 | 5.88 | 100 |
| **C CLASS** | | | | | | | | | | | |
| **Single family units** | | 4.11 | 433.95 | **598.08** | 4.27 | 18.05 | 45.31 | 12.74 | 1.47 | 18.16 | 100 |
| **Multi-family units** | 34 | 3.5 | 790.83 | | 3.16 | 4.43 | 70.07 | 2.63 | 5.27 | 14.44 | 100 |

Table 05 - Comparison between single and multi-family.

From the above data, the following inferences can be drawn:

1. The classes B and C produce, basically, the same type of wastes, with substantial difference in the quantity (704.44g/d and 433.95g/d respectively). In the Class A we find a difference still more accented in the quantity – 1,246.67g/d (refer Table 05)
2. The comparison between single family units of different socio-economic classes shows results as expected – the per capita waste generation is highest in Class A (1246.67 gm/cap) and lowest for Class C (433.95 gm/cap). However in case of multi-family units the results are different from expected trend – the lowest per capita generation is from Class B. The reason may be that many family members in this Class are working outside and, consequently, do not have the main meal (lunch) at home, and when there are small children they are in daycare. As for class C, the family members make their meals at home and remain there longer, may be due to economic constraints for leisure outside the home, or because of unemployment.
3. With regards to composition (especially percentage of organic constituents) again for multifamily units the data follows the expected trend i.e. the organic constituent is lowest in case of Class A (50.15%) and highest in Class C (70.07%). However, in case of single family units the results are different from expected trend – the Class C has the lowest proportion of organic waste (45.31%) while Class B is highest (63.14%). The reason may be that class C makes better use of food as these are purchased in minimum quantities due to lack of financial resources and in case of availability of garden, they plant their own vegetables there. During the survey it was found that the persons living there were not employed, and they were living with the help of

friends and relatives and/or social plans of the Federal Government.

4. Through the application of questionnaires, we could infer that residents of apartment go out more often because they have less room for leisure, than the residents of the house hence the per capita waste generation from apartments is less than that from houses.
5. In relation to plastic, class C shows a different result than expected, which may be due to the action of scavengers within the family who use their own trash home to dispose plastic materials of little value in the recycling market.
6. In class B, for multifamily units, paper appears as the highest proportion (30.72%), mostly from packaging – pizzas, appliances, electronics, etc.

The average daily waste generation from single and multifamily units in all the three classes is summarized in Table 06 below.

| SUMMARY | SINGLE FAMILY UNITS | MULTI-FAMILY UNITS | TOTAL |
|---|---|---|---|
| **Daily MSW A Class** | 43.012 | 3.523 | 46.536 |
| **Daily MSW B Class** | 83.029 | 7.298 | 90.327 |
| **Daily MSW C Class** | 31.452 | 8.660 | 40.112 |
| **Total Daily MSW (ton)** | 157.494 | 19.481 | **176.975** |

Table 06 - Summary of daily waste generation by classes

Considering the average generation of waste by socio-economic class, the stratification of the population in classes A, B and C and the overall average between single family and multi-family units sampled, the overall generation of RSW is worked out to be 176.975 tons/day.

### 1.1.2 Commercial Waste

*From Generator*

The data collection on commercial solid waste characterization and quantification was carried out in the following steps:

Step 1-Defining the categories of commercial enterprises:

For selection of the samples was used the official list of categories of commercial and services enterprises from Municipal Administration. From there were chosen 6 commerce categories - wood store, bakery, fast food, restaurants, butchery, small grocery store - and 10 service categories - hotel, gym, car washing, office, laundry, printer, pet beauty shop, school, air service maintenance, electronic repair.

Step 2-Sampling for quantification and characterization of waste

For sampling, first, was used the criterion of reduction of 1/50, and then, a second reduction of 1/50 was done. Randomly, it was collected samples in 51 establishments. In this sampling, 49% correspond to the service and 51% to the commercial categories. Due the high volume of organic waste generated by the production process of bakeries, butchery and restaurants, the data collected for this work was kept into the two business categories, as showed on table below.

| Business Categories | Commercial* | Service** |
|---|---|---|
| **Employees /clients** | 562 | 123 |
| **Quantity (Kg/day)** | 917.24 | 89.90 |
| **Per capta generation (Kg)** | 1.63 | 0.73 |
| **Organic (%)** | 62 | 9 |
| **Plastic (%)** | 8 | 13 |
| **Metal (%)** | 2 | 1 |
| **Glass (%)** | 1 | 20 |
| **Paper (%)** | 15 | 28 |
| **Mixed residue (%)** | 12 | 29 |

Table 07 - Quantities and quality of the waste generated daily from commercial and service categories.
* wood store, bakery, fast food, restaurants, butchery, small grocery store.
** hotel, gym, car washing, office, laundry, printer, pet beauty shop, school, air service maintenance, electronic repair.

From the above data, the following inferences can be drawn:

1. During the quantification and characterization, it was found that bakeries, butcheries and restaurants, were responsible for the disproportional waste generation of the two categories, especially with regard to organic waste.
2. It was observed that the amount of waste generated by wastage from the production process of these establishments is the same observed in the industrial sector.
3. Given this observation, it is clear the need to address the business of processing food like bakeries, butcheries, restaurants, etc. in a different manner. May even be implemented in partnership with their unions, a program of cleaner production within the ISWM Plan.
4. The most recyclable material from commercial and service activities are collected by informal pickers or sold by generator for recycling businesses.
5. Considering that in the city of Novo Hamburgo there are aproximately 8,528 commercial and 12,512 service businesses categories, as a superficial simulation, we may extrapolated the waste generation in NH to 13.917 tons/day for commercial and 9.133 tons/day for service.

Bellow in table 08, just an arithmetic average to give us an idea of the quality of waste generated daily from the two sub-categories of business activities.

| Organic (%) | Recyclable (%) | Mixed Residue (%) |
|---|---|---|
| **35.5** | 44.0 | 20.5 |

Table 08 - Quantities and quality of the waste generated daily from Commercial and Service Activities

*From Vehicles*

The classification and quantification of the wastes were carried out in the following steps:

Step 1-Selecting the collector vehicles from districts:

Taking the same socio-economic groups defined for characterization and quantification from generator: A (high class), B (middle class), C (low class), and including a representative commercial district (downtown), at the transfer station of Roselândia, a collector vehicle of $15m^3$, type compactor that came from a daily collection of Centro, Boa Vista/Jardim Mauá, Primavera e Vila Kreamer districts, was directed to a place previously reserved for the characterization and quantification.

Step 2-Sampling for quantification and characterization of waste:

From the load of each vehicle selected, there were collected four samples of wastes and, after the manual mixture of the material contained into the plastic bags, it was taken and weighed 200 liters of each sample, according to proceeding indicated by the method "divided by four" (Set of Guidelines for Practitioners- UNEP, 2007). The samples were separated and classified according to the recycling groups (plastics, glasses, metal, paper), organic and mixed residue. The plastics were segregated and described in 7 groups known by the legislation (NBR 13230, 1994) and the weighing was done in more precise scale. The same proceeding was carried out for the paper, metal, glass and other identified wastes.

In the analysis performed was found the composition is following:

- **Centro District (Downtown)**
  District with Features predominantly commercial:

| District | Glass (%) | Metal (%) | Paper (%) | Tetra Pak (%) | Plastic (%) | Organic (%) | Mixed (%) |
|---|---|---|---|---|---|---|---|
| Centro | 5.85 | 3.99 | 20.21 | 1.60 | 29.79 | 18.62 | 19.94 |

Table 09 - Qualitative and quantitative characterization of the samples from vehicle at the transfer station of *Roselândia.*

The amounts of different types of plastics founded in the samples:

| PEBD (Plastic bags) % | PET % | PEAD % | Acrylic % | Styrofoam % | PVC % |
|---|---|---|---|---|---|
| 64.29 | 8.93 | 8.93 | 10.71 | 2.68 | 4.46 |

Table10 - Amounts of different types of plastics founded in the samples from vehicle at the transfer station of *Roselândia.*

For paper was verified the following composition:

| Cardboard % | White Paper % | Mixed Paper % | Newspaper % |
|---|---|---|---|
| 39.80 | 9.18 | 27.55 | 23.47 |

Table 11 - Amounts of different types of paper founded in the samples from vehicle at the transfer station of *Roselândia.*

Here was considered cardboard packaging paper and corrugated paper for packaging of electronics. Mixed paper was considered advertising brochures and newspapers insert with 100% coverage of printing.

For the mixed residue was verified the following components:

| Toilet Paper % | Others* % |
|---|---|
| 30.56 | 69.44 |

Table 12 - Distribution of mixed residue for *Centro*
*Construction debris (plaster), soil, rocks, diapers, absorbent, aluminum packaging, candy and chewing gum wrap.

- ***Jardim Mauá* and *Boa Vista* Districts**

Districts with characteristics of residential neighborhoods and socio-economic class A/B.

| Glass % | Metal % | Paper % | Tetra Pak % | Plastic % | Organic % | Mixed Residue % |
|---|---|---|---|---|---|---|
| 5.85 | 3.99 | 20.21 | 1.60 | 29.79 | 18.62 | 19.15 |

Table 13 - Distribution of various waste streams from J.M/B.V Districts

The amounts of different types of plastics founded in the samples:

| PEBD % | PET % | PEAD % | PP % | Styrofoam % | PVC % |
|---|---|---|---|---|---|
| 31.82 | 13.64 | 25.00 | 20.45 | 2.27 | 6.82 |

Table 14 - Distribution of the types of plastics for J.M/B.V

For paper was verified the following composition:

| Cardboard (%) | White Paper (%) | Mixed Paper (%) | Newspaper (%) |
|---|---|---|---|
| 32.2 | 18.64 | 32.2 | 16.95 |

Table 15 - Distribution of the types of paper for J.M./BV.

For mixed residue /reject was verified the following components:

| Toilet Paper (%) | Others* (%) |
|---|---|
| 12.20 | 87.80 |

Table 16 - Distribution of the types of paper for J.M./BV

* Presence of remnants of textile, stone, soil, absorbent, diapers, and cigarette stump.

- ***Primavera* District**

District with characteristics of residential neighborhoods and socio-economic class B.

| District | Glass (%) | Metal (%) | Paper (%) | Tetra Pak (%) | Plastic (%) | Organic (%) | Mixed* (%) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| T Primavera | 1.22 | 1.43 | 10.28 | 0.00 | 11.21 | 38.19 | 37.67 |

Table 17 - Distribution of various waste streams from *Primavera* district.

* remains of leather, textile, diapers, rubber and ceramic pieces. In the samples examined, the diapers corresponded to 33.57%.

The amounts of different types of plastics founded in the samples:

| PET % | PEAD % | PEBD % | PP % | P S % |
|---|---|---|---|---|
| 5.38 | 13.36 | 78.30 | 2.06 | 0.90 |

Table 18 - Distribution of the types of plastics for *Primavera* District

For "Paper" was verified the following composition:

| Magazines % | Newspaper % | White Paper % | Corrugated % | Paper Bags % | Kraft % | Mixed % | Cardboard % | Colored % |
|---|---|---|---|---|---|---|---|---|
| 2.83 | 51.22 | 2.93 | 0.69 | 10.36 | 14.96 | 6.83 | 7.43 | 2.74 |

Table 19 - Distribution of the types of paper for *Primavera* District.

- **Vila Kreamer District**

District with characteristics of residential village neighborhoods, and socio-economic class C to lower.

| District | Glass (%) | Metal (%) | Paper (%) | Tetra Pak (%) | Plastic (%) | Organic (%) | Mixed (%) | Total (%) |
|---|---|---|---|---|---|---|---|---|
| **Vila Kreamer** | 0.98 | 0.25 | 11.79 | 0.00 | 23.59 | 39.31 | 24.08 | 100.00 |

Table 20 - Distribution of Vila Kreamer District

The amounts of different types of lastics founded in the samples:

| PET | PEAD | PEBD | PP | P S | OUTROS |
|---|---|---|---|---|---|
| 12.58 | 19.11 | 61.90 | 5.20 | 1.09 | 0.12 |

Table 21 - Distribution of the types of plastic for *Primavera* District

For paper was verified the following composition:

| Newspaper % | White % | Paper Bags % | Kraft % | Mixed % | Cardboard % |
|---|---|---|---|---|---|
| 40.13 | 0.66 | 23.03 | 2.85 | 19.08 | 14.25 |

Table 22 - Distribution of the types of paper for *Vila Kreamer* District.

Analyzing the composition of RSW of the districts of J.Mauá/Boa Vista (socio economic class A), Centro (Commercial), Primavera (socio economic class B/A) and Vila Kreamer (socio economic class C)

we find the clear increase in recyclable waste in the high and middle classes and increasing fraction of organic waste in the higher class, as can be seen in the table below.

| | Waste Composition for All Sampled District (%) | | | |
|---|---|---|---|---|
| | District | | | |
| **Waste** | Centro | Jardim Mauá /Boa Vista | Primavera | Vila Kreamer |
| | | | | |
| **Reciclables** | 61.44 | 41.94 | 24.14 | 36.61 |
| **Organic** | 18.62 | 40.47 | 38.19 | 39.31 |
| **Mixed Residue** | 19.94 | 17.59 | 37.67 | 24.08 |
| **Total (%)** | 100 | 100 | 100 | 100 |

Table 23 - Waste composition for all sampled districts

The organic and the paper from Primavera district are within the average of other districts (except Centro). Regarding to plastic, its lowest percentage can be credited to action of scavengers and less waste generation in the neighborhood. Comparing items "glass", "metal" and "plastic" with the Boa Vista/Jardim Mauá districts, we see that the variation of these three items in the Primavera district is 40% to 70% lower.

| COMPARATIVE TABLE FOR THE DISTRICTS SAMPLED | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Districts** | **Glass (%)** | **Metal (%)** | **Paper (%)** | **Tetra Pak (%)** | **Organic (%)** | **Plastic (%)** | **Mixed (%)** |
| | | | | | | | |
| Centro | 5.85 | 3.99 | 20.21 | 1.60 | 18.62 | 29.79 | 19.94 |
| Jardim Mauá / Boa Vista | 3.83 | 4.93 | 12.63 | 1.71 | 40.47 | 18.84 | 17.59 |
| Primavera | 1.22 | 1.43 | 10.28 | 0.00 | 38.19 | 11.21 | 37.67 |
| Vila Kreamer | 0.98 | 0.25 | 11.79 | 0.00 | 39.31 | 23.59 | 24.08 |

Table 24 - Comparative table for the district sampled

Vila Kreamer as a lower class neighborhood, many scavengers live there who collect before the collection truck and take much of the waste separately as metal, glass, and other materials to be selected in the backyard of their home. Moreover, we note that the item "plastic" has a high percentage. This is due to the fact that many plastic wastes without commercial value on the recycling market are

discarded in the community collection points by these scavengers and thus collected by the municipal collection trucks.

| DISTRICT | | CENTRO | | BOA VISTA / JARDIM MAUÁ | | PRIMAVERA | | VILA KREAMER | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| **Metal** | | | **3.99** | | **4.93** | | **1.43** | | **0.25** |
| **Paper** | Magazines | 0.00 | **20.21** | 0.00 | **12.63** | 0.29 | **10.28** | 0.00 | **11.79** |
| | Newspapers | 4.74 | | 2.14 | | 5.27 | | 4.73 | |
| | White | 1.86 | | 2.35 | | 0.30 | | 0.08 | |
| | Mix | 5.57 | | 4.07 | | 0.70 | | 2.25 | |
| | Corrugated | 0.00 | | 0.00 | | 0.07 | | 0.00 | |
| | Carton | 0.00 | | 0.00 | | 1.07 | | 2.72 | |
| | Cardboard | 8.04 | | 4.07 | | 0.76 | | 1.68 | |
| | Kraft | 0.00 | | 0.00 | | 1.54 | | 0.34 | |
| | Printing | 0.00 | | 0.00 | | 0.28 | | 0.00 | |
| | | | | | | | | | |
| **Plastic** | PET | 2.66 | **29.79** | 2.57 | **18.84** | 0.60 | **11.21** | 2.97 | **23.59** |
| | PEAD | 2.66 | | 4.71 | | 1.50 | | 4.51 | |
| | PVC | 1.33 | | 1.28 | | 0.00 | | 0.00 | |
| | PEBD | 19.15 | | 5.99 | | 8.78 | | 14.60 | |
| | PP | 0.00 | | 3.85 | | 0.23 | | 1.23 | |
| | P S | 0.00 | | 0.00 | | 0.10 | | 0.26 | |
| | Polystyrene | 0.80 | | 0.43 | | 0.00 | | 0.02 | |
| | Acrylic | 3.19 | | 0.00 | | 0.00 | | 0.01 | |
| | | | | | | | | | |
| **Glass** | | | **5.85** | | **3.83** | | **1.22** | | **0.98** |
| **Tetra Pak** | | | **1.60** | | **1.71** | | **0.00** | | **0.00** |
| **Organic** | | | **18.62** | | **40.47** | | **38.19** | | **39.31** |
| **Mixed** | Toillet Paper | 6.09 | **19.94** | 2.14 | **17.59** | | **37.67** | 13.76 | **24.08** |
| | Disposable Daipers | | | | | 33.57 | | | |
| | Others | 13.84 | | 15.44 | | 4.3 | | 10.32 | |
| Total | | | 100 | | 100 | | 100 | | 100 |

Table 25 - Waste characterization for the districts sampled

The triangular graph shows clearly that the wastes from the Vila Kreamer are more attractive for recycling that from Primavera, although this district, on average, has higher economic and social conditions. The cause of this can be given to action of the pickers in

the district, and the time of collection. The proximity of the *Boa Saúde* district, local of many scavengers, eventually favoring the movement of them early in the Primavera district. This assumption can be confirmed comparing the data obtained by collect door to door, as follows:

| Primavera District | Recyclable | Organic | Mixed | Total |
|---|---|---|---|---|
| | 38.17 | 56.06 | 5.77 | 100.00 |
| | 71.58 | 1.05 | 27.37 | 100.00 |
| | 23.18 | 67.6 | 9.22 | 100.00 |
| | 43.42 | 52.63 | 3.95 | 100.00 |
| | 30.27 | 64.43 | 5.3 | 100.00 |
| **Average Generation** | **41.33** | **48.354** | **10.322** | 100.00 |

Table 26 - Data from Primavera district (from generator)

The comparison between data collected from generator and from the vehicle show a substantial reduction of recyclable (-41.5%), while the organic is reduced by (-21.0%). This seems to show that, apart from dilution of the data due to a broader sampling (collection truck), there is an intense action on the recyclable by scavengers in the neighborhood.

Vila Kreamer is residence of many pickers that, for small and without attractive economic value wastes are discarded at the municipal collection points, and then collected by the collection trucks.

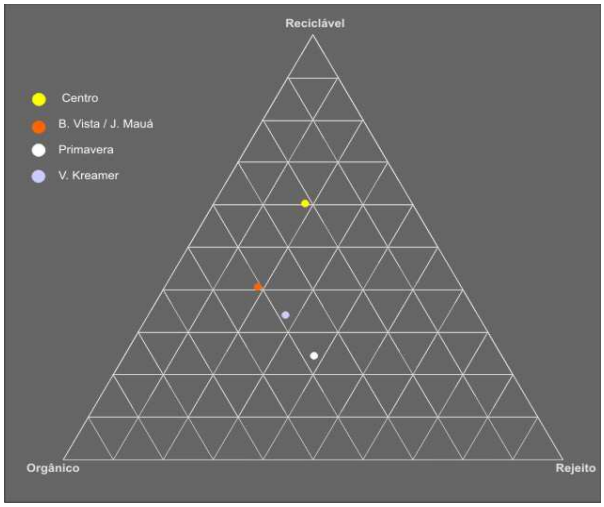


FIG. 02 - Waste composition for all sampled districts by a Triangular Graph

### 1.1.3 Seasonal Variations

Although the data collection was done in a short period of year (February/2009) it is known that school vacation causes changes in consumption habits in the local population. And these changes in habits involve quality and quantity of MSW over the year.

To characterize the variations in the amount of waste generated, data were obtained from the collection of MSW in the final disposal at landfill, through SIL - Environmental Solutions.

Through these data, as can be seen in the table below, we note that the USW produced in the city of Novo Hamburgo behaves in a regular way, related to quantity generated, showing some growth in the month of December and January, probably by influence of holydays and on March, due to return from school vacation.

| Tons of Waste Sent to Landfill | | |
|---|---|---|
| **Month** | **Year 2007** | **Year 2008** |
| March | 5252 | 3972 |
| April | 4164 | 3921 |
| May | 3709 | 3885 |
| June | 3540 | 3735 |
| July | 4110 | 4178 |
| August | 3533 | 3958 |
| September | 4490 | 3721 |
| October | 4547 | 4244 |
| November | 3907 | 3730 |
| December | 3653 | 4462 |
| **Min** | **3533** | **3721** |
| **Max** | **5252** | **4462** |
| **Average** | **4090.5** | **3980.6** |

Table 27 - Tons of waste sent to landfill.

The data for January and February 2008 have been disregarded in this analysis due to the accumulated waste at transfer station from the previous period that was sent to landfill in these particular months.

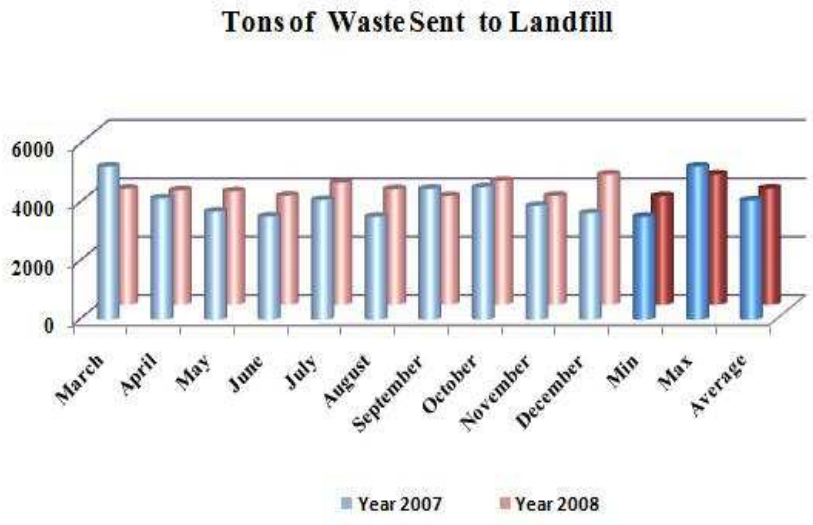


FIG. 03 - Tons of waste sent to landfill.

## 1.2 Industrial Solid Waste

According to the Report on the generation of industrial solid wastes in the state of Rio Grande do Sul (FEPAM, 2003), the leather industry is responsible for generating over 62% of hazardous industrial waste and that the main destination of the sector is up in landfills and central deposits, to which the sector of leather industries send more than 82% of its hazardous waste, reused and/or recycled only about 3%. For this outstanding participation and given the importance of allocation of hazardous waste, for this work, we sought to characterize and quantify the waste generators of the referred sector.

According to UTRESA and FUNDAMENTAL, who receive industrial hazardous and non inert material (class I and II), the volumes monthly deposited by industries from Novo Hamburgo are listed below:

| WASTE GENERATION FROM NOVO HAMBURGO<br>Jan/2008 to Feb/2009 - UTRESA | | |
|---|---|---|
| **Waste** | **Quantity m³** | **Month Avg. m³** |
| | | |
| Waste generated off production process (package / office) | 33.00 | 2.54 |
| Non-hazardous street sweepings | 884.67 | 68.05 |
| Iron scraps | 44.80 | 3.45 |
| Metalic package (non-contaminated empty tin cans) | 8.25 | 0.63 |
| Non-iron scraps (brass, etc.) | 0.50 | 0.04 |
| Iron waste (metal barrel) | 2.50 | 0.19 |
| Paper, cardboard waste | 489.89 | 37.68 |
| Plastic waste (plastic barrel, plastic drums) | 181.84 | 13.99 |
| Plastic waste (films, small containers) | 555.17 | 42.71 |
| Rubber waste | 1158.52 | 89.12 |
| EVA waste | 1627.6 | 125.2 |
| PU waste | 831.58 | 63.97 |
| Plastic foam waste | 180.74 | 13.9 |
| Fiber glass waste | 162.80 | 12.52 |
| Wood waste (packaging scrap, pallets, etc...) | 68.05 | 5.23 |
| Salted leather scraps | 6.00 | 0.46 |
| Textile waste (woven fabric, clothes, non-contaminated) | 912.17 | 70.17 |
| Burners (kettles) ashes | 35.60 | 2.74 |
| Casting dross (except from Carbon steel) | 4.00 | 0.31 |
| Casting sand (molding sand, non phenolic) | 153.56 | 11.81 |
| Refractory waste and non-ceramic items | 38.30 | 2.95 |
| Glass waste | 8.03 | 0.62 |
| Non-toxic iron scrap waste | 4.20 | 0.32 |
| Non-hazardous other waste | 174.67 | 13.44 |
| Organic tanning leather scraps and small cuts | 65.51 | 5.04 |
| Organic waste from tanning process (bones, blood, grease) | 1.10 | 0.08 |
| Small particles from organic tanning leather (powder, bran) | 27.70 | 2.13 |
| Hazardous mud from Effluent Treatment Station | 295.80 | 22.75 |
| Mud from ETS, with chromium | 1080.90 | 83.15 |
| Chromium tanning leather scraps and small cuts | 3139.09 | 241.47 |
| Small particles from chromium tanning leather (powder, bran) | 3593.79 | 276.45 |
| Hazardous street sweepings | 457.23 | 35.17 |
| Mud from ETS, from galvanization | 213.2 | 16.40 |
| Miscellaneous items contaminated with oil | 3.50 | 0.27 |
| Textile waste (woven fabric, clothes, contaminated) | 286.58 | 22.04 |
| Hazardous other waste, from production process | 468.21 | 36.02 |
| Stainless steel dross | 2.90 | 0.22 |
| Metalic dust and residues | 11.47 | 0.88 |
| Mud from ETS, from paint production | 7.00 | 0.54 |
| Chemical items waste from industrial labs | 7.15 | 0.55 |
| Empty containers (packing) contaminated | 69.39 | 5.34 |
| Paint and pigment waste | 61.67 | 4.74 |
| Paint and mud from painting cabin operation | 147.25 | 11.33 |
| Waste of leather processing, with chromium | 1.00 | 0.08 |
| Brick waste | 5.00 | 0.38 |
| Filters waste | 10.50 | 0.81 |
| Braking pads (broken , dust) | 4.55 | 0.35 |
| Sand Paper, class II | 17.83 | 1.37 |
| Overdue food | 33.52 | 2.58 |
| Personal safety equipment | 3.00 | 0.23 |
| Printing cartridge | 1.20 | 0.09 |
| Expanded/extruded Polystyrene (EPS) | 4.50 | 0.35 |
| Cutting material (from cutting machines) | 1.00 | 0.08 |
| Paper, cardboard waste. Contaminated | 204.60 | 15.74 |
| Casting sand, class I | 1.50 | 0.12 |
| Contaminated soil with Chemical products | 64.00 | 4.92 |
| Furnace soot, class I | 25.00 | 1.92 |
| Plastic waste, contaminated | 139.24 | 10.71 |
| Safety personal equipment, contaminated | 6.15 | 0.47 |
| Class I sand-paper (phenolic resin in formulation) | 7.69 | 0.59 |
| Sand and soil from Car washing service station | 39.28 | 3.02 |
| Toilet paper, tissue paper | 2.4 | 0.18 |
| Synthetic sheet scraps | 316.16 | 24.32 |
| **TOTAL** | **18394.00** | **1414.92** |

Table 28 - Total annual volumes of waste sent to industrial landfill - UTRESA.

| WASTE GENERATION FROM NOVO HAMBURGO<br>Jun/2008 to Dec/2008 | | |
|---|---|---|
| **Waste** | **Quantity m3** | **Month (average) m3** |
| Mud from ETS, with chromium | 5436.20 | 776.60 |
| Small particles from chromium tanning leather (powder, bran) | 1968.43 | 281.20 |
| Leather scraps and small cuts | 1.757,16 | 251.02 |
| Rubber waste | 395.98 | 56.57 |
| PU waste | 779.4 | 111.34 |
| Textile waste (woven fabric, clothes, contaminated) | 303.63 | 43.38 |
| Paper, cardboard waste | 244.57 | 34.94 |
| **TOTAL** | **10885.36** | **1555.05** |

Table 29 - Volumes of waste sent to industrial landfill – FUNDAMENTAL.

Both tables above are very actual and updated. Thus we are able to project total waste received in each landfill and total, as follows:

| Waste Received | Month (average) $m^3$ | Year Proj $m^3$ |
|---|---|---|
| Utresa | 1414.92 | 16979.04 |
| Fundamental | 1555.05 | 18660.6 |
| **TOTAL** | **2969.97** | **35639.64** |

Table 30 - Total waste received in each landfill.

*From Generators*

It was investigated two major footwear companies in the sector - an industry of footwear and components for footwear industry during the period of a month. For this work was applied the methodology for assessing CNTL/UNIDO which permits evaluation of the efficiency of consumption and cost of raw materials relating them to the waste generated.

We can check that the volume of waste generated relating to the cost of maintenance of landfills is very expressive. Moreover,

there is waste in raw materials that could provide better quality, materials that could be better used and which could have a different destination than the landfill.

**SAMPLE 1: Shoe Manufacturer**

| ITEMS | Quantity | | Raw Material Waste Cost average | Disposing Cost | TOTAL COST | |
|---|---|---|---|---|---|---|
| | kg | % | R$ | R$ | R$ | % |
| Leather | 10852.50 | 33.28 | 238755.00 | 813.94 | 239568.94 | 80.62 |
| Waste from splitting leather | 4559.50 | 13.98 | 4559.5 | 341.96 | 4901.46 | 1.65 |
| Humid leather dust | 4173.80 | 12.8 | 4173.8 | 313.04 | 4486.84 | 1.51 |
| Rubber | 2431.78 | 7.46 | 8000.56 | 182.38 | 8182.94 | 2.75 |
| Remade leather | 1451.4 | 4.45 | 9201.88 | 108.86 | 9310.73 | 3.13 |
| Heel support (resin) | 1227.5 | 3.76 | 4419.00 | 92.06 | 4511.06 | 1.52 |
| Synthetic linning | 1048.87 | 3.22 | 1258.64 | 78.67 | 1337.31 | 0.45 |
| Humid outsole powder (synt) | 1027.00 | 3.15 | 1027.00 | 77.03 | 1104.03 | 0.37 |
| Wood and sawdust | 971.4 | 2.98 | 971.40 | 72.86 | 1044.26 | 0.35 |
| Dry sawdust, from collector | 812.7 | 2.49 | 812.70 | 60.95 | 873.65 | 0.29 |
| EVA | 791.2 | 2.43 | 854.50 | 59.34 | 913.84 | 0.31 |
| Sinthetic Rubber | 512.9 | 1.57 | 5595.74 | 38.47 | 5634.21 | 1.90 |
| Textile | 388.1 | 1.19 | 3686.95 | 29.11 | 3716.06 | 1.25 |
| Glue (adhesive) | 246.1 | 0.75 | 662.01 | 18.46 | 680.47 | 0.23 |
| Mixed waste | 224.4 | 0.69 | 224.4 | 16.83 | 241.23 | 0.08 |
| Retort waste | 186.2 | 0.57 | 186.2 | 13.97 | 200.17 | 0.07 |
| Painting | 183.1 | 0.56 | 1741.28 | 13.73 | 1755.01 | 0.59 |
| Cloth | 177.5 | 0.54 | 53.25 | 13.31 | 66.56 | 0.02 |
| SHOEFIX | 163.5 | 0.50 | 29.43 | 12.26 | 41.69 | 0.01 |
| Cork waste | 158.9 | 0.49 | 370.24 | 11.92 | 382.15 | 0.13 |
| Miscellaneous | 1017.42 | 3.12 | 8137.94 | 76.31 | 8214.25 | 2.76 |
| **TOTAL** | **32605.77** | **100** | **294721.41** | **2445.43** | **297166.84** | **100** |

Table 31 - Raw material and parts waste quantities.

This example shows the importance of working on leather waste (even not having value added to the chart), due to market buying price and, specially, to the fact that it carries some chemicals to landfill. At the moment, the best alternative seems to be given it away for social purposes, to artisans who will make it worth again. As new technologies are coming into the region of NH, in the near future, better solutions can be found.

| SOLD ITEMS | Quantity | | Raw Material Waste Cost average | | Selling Price | TOTAL SALE Revenue |
|---|---|---|---|---|---|---|
| | kg | % | R$ | % | R$ | R$ |
| Rubber Waste | 15850.00 | 72.46 | 52146.50 | 84.84 | 0.04 | 634.00 |
| Paper Waste | 3601.90 | 16.47 | 3601.90 | 5.86 | 0.04 | 144.08 |
| Plastic Waste | 815.30 | 3.73 | 815.28 | 1.33 | 0.12 | 97.83 |
| Brown Cardboard | 755.40 | 3.45 | 657.20 | 1.07 | 0.04 | 30.22 |
| Iron Waste | 411.10 | 1.88 | 411.10 | 0.67 | 0.04 | 16.44 |
| Filling Cardboard | 161.30 | 0.74 | 306.,47 | 0.50 | 0.04 | 6.45 |
| Copper Waste | 62.10 | 0.28 | 62.10 | 0.10 | 0.04 | 2.48 |
| Aluminium Waste | 51.30 | 0.23 | 2631.69 | 4.28 | 0.04 | 2.05 |
| Zinc | 37.4 | 0.17 | 56.10 | 0.09 | 0.04 | 1.50 |
| Cutting Knives | 35.20 | 0.16 | 123.20 | 0.20 | 0.04 | 1.41 |
| Texon Cardboard | 27.20 | 0.12 | 27.20 | 0.04 | 1.17 | 31.82 |
| Filling Paper | 24.80 | 0.11 | 238.08 | 0.39 | 0.04 | 0.99 |
| Drawing Paper | 10.00 | 0.05 | 23.90 | 0.04 | 0.04 | 0.4 |
| Clips | 8.00 | 0.04 | 8.00 | 0.01 | 0.04 | 0.32 |
| Special Cutt. Knife | 7.80 | 0.04 | 327.21 | 0.53 | 0.04 | 0.31 |
| Plastic Bag | 4.90 | 0.02 | 4.90 | 0.01 | 0.12 | 0.59 |
| Steel Brush | 4.10 | 0.02 | 3.08 | 0.01 | 0.04 | 0.16 |
| Wrapping Paper | 3.50 | 0.02 | 2.49 | 0.00 | 0.04 | 0.14 |
| Steel Waste | 2.90 | 0.01 | 8.41 | 0.01 | 0.04 | 0.12 |
| Splitting Knives | 0.70 | 0.00 | 12.68 | 0.02 | 0.04 | 0.03 |
| **TOTAL** | **21874.90** | **100** | **61467.48** | **100** | - | **971.35** |

Table 32 - Quantities of waste sold for recycling business.

| SOLD ITEMS | QUANTITY | |
|---|---|---|
| | Kg | % |
| Rubber Waste | 15850.00 | 72.45 |
| Paper | 4584.20 | 20.96 |
| Plastic | 820.10 | 3.75 |
| Metal | 620.60 | 2.84 |
| **TOTAL** | **21.874,90** | **100** |

Table 33 - Summary by category of waste sold.

By reading this chart we figure that Rubber waste (72%) is a major player in this category. It seems that a deeper analysis is necessary to find a way of categorizing this item and look for recycling it. Also paper waste deserves attention with 21% participation.

| INDUSTRIAL MUNICIPAL WASTE | | |
|---|---|---|
| ITEM | QUANTITY | |
| | kg | % |
| Paper Tissue | 308.50 | 43.99 |
| Sweeping Waste | 189.10 | 26.96 |
| Organic Waste | 168.70 | 24.06 |
| Paper | 35.00 | 4.99 |
| **TOTAL** | **701.30** | **100** |

Table 34 - Industrial municipal waste from Shoe Manufacturer.

**SAMPLE 2: Shoe Components Manufacturing**

Synthetic Outsole does not have an important value in the waste material market. Not even raw material coming from the factory is carrying expressive value. Anyway a closer look at the item, due to quantity dispose could be of importance.

| ITEM | Total kg | Total % |
|---|---|---|
| Synthetic Outsole1 | 11978.50 | 26.39 |
| Reinforcement | 6219.30 | 13.70 |
| Metal | 5200.90 | 11.46 |
| Leather | 4139.00 | 9.12 |
| Remade Leather | 3783.00 | 8.34 |
| Leatherdust Waste | 2930.80 | 6.46 |
| Synthetic Outsole2 | 2046.00 | 4.51 |
| Leather Dust | 1691.00 | 3.73 |
| Residuo Quina | 1627.50 | 3.59 |
| Synt. Heel Waste | 896.00 | 1.97 |
| Packing Bubble | 848.00 | 1.87 |
| Adhesive | 576.62 | 1.27 |
| Paper | 378.37 | 0.83 |
| Synthetic Small Cuts (scrap) | 346.90 | 0.76 |
| Eva | 324.00 | 0.71 |
| Threads | 322.00 | 0.71 |
| Machine Parts | 268.00 | 0.59 |
| Sewing Waste | 208.50 | 0.46 |
| Miscellaneous | 207.00 | 0.46 |
| General Waste | 206.40 | 0.45 |
| Dust Fr. Col. | 204.60 | 0.45 |
| Burnt Components | 188.00 | 0.41 |
| Sandpaper | 169.00 | 0.37 |
| Plastic | 113.56 | 0.25 |
| Synthetic Belt. | 98.00 | 0.22 |
| Shaving Leat. | 76.00 | 0.17 |
| Modelling Material | 72.00 | 0.16 |
| Reinforcement Parts, Broken | 60.00 | 0.13 |
| Defective Angled Cut Parts | 49.00 | 0.11 |
| Printing Board | 31.00 | 0.07 |
| Counter-Weight | 29.00 | 0.06 |
| Waste from Production Inspection | 22.00 | 0.05 |
| Textile | 16.00 | 0.04 |
| Shaven Synth.. | 14.00 | 0.03 |
| Now. Waste | 13.80 | 0.03 |
| Painting | 11.00 | 0.02 |
| Cleaning Cloth | 8.63 | 0.02 |
| Metal residue | 5.70 | 0.01 |
| Sponge | 2.50 | 0.01 |
| Sweeping Waste | 0.76 | 0.00 |
| **TOTAL** | **45.382,34** | **100.00** |

Table 35 - Waste quantities from Shoe Components Manufacturing.

| ITEM | Total % |
|---|---|
| Synthetic Outsole | 26.39 |
| Reinforcement Leather Parts | 13.70 |
| Metal Pt Waste | 11.46 |
| Leather | 9.12 |
| Remade Leather | 8.34 |
| Leatherdust Waste | 6.46 |
| Leather Outsole | 4.51 |
| Leather Dust | 3.73 |
| Residue Quina | 3.59 |
| Miscellaneous | 12.71 |

Table 36 - Summary by categories of waste.

Shoe component manufacturers do not use a lot of leather. They make their products (shoes outsoles, among them) with synthetic material. This is why we find this amount of synthetic outsole disposed on this sample. Its market value cannot be compared to leather scraps value. Depending on technology synthetic outsole waste could be used to make something else. It appears that cost x benefit is not so good in this case.

## 1.3 Healthcare Solid Waste

The National Survey of Basic Sanitation (PNSB 2000), by IBGE, shows that the South held collection of solid waste of health for a total of 195ton/day. Today, one of the main issues related to the environment relate to the safety destination of urban solid waste. In the last ten years, the population grew 16.8%, while the generation of waste has grown 48% (source IBGE, 1989/2000). In this context, the healthcare wastes are an important part of the total municipal solid waste, not the quantity generated, about 1% to 3%, but the potential risk they represent.

The Resolutions ANVISA No 306/04 and CONAMA 358/05 classify the Healthcare Wastes according to group of risk that require specific forms of management.

| GROUPS | TYPE OF RESIDUE |
|---|---|
| **A** | Waste with the possible presence of biological agents that, by their characteristics, may present risks of infection;<br>**A1**<br>- Cultures and stocks of microorganisms, production of waste products, except the blood, dispose of vaccines of attenuated live organisms, culture media and instruments used to transfer, or inoculation of mixed cultures, waste from laboratories in genetic manipulation.<br>- Waste from health care to individuals or animals with suspected or certain contamination by biological agents of risk class 4, micro-relevant epidemiological and risk of spreading or causing emerging disease to become epidemiologically important or the mechanism of transmission is unknown.<br>- Bags blood transfusion with blood or rejected by contamination or by poor storage, or shelf-life expired and those from incomplete collection.<br>- About of the laboratory samples containing blood or body fluids, containers and materials resulting from the process of health care, including blood or body fluids on their free forms.<br>**A2**<br>- Carcasses, anatomical parts, offal and other waste from animals undergo the process of experimentation with inoculation of microorganisms and their cover and the carcasses of animals suspected of being carriers of microorganisms of relevance to epidemiology and risk of the spread, which were submitted or not to study or anatomo-pathological diagnostic confirmation.<br>**A3**<br>- Anatomical parts (members) of the human being; product of fertilization without vital signs, weighing less than 500 grams or less than 25 cm height or gestational age less than 20 weeks, not having legal or scientific value and there was no request for patient or family.<br>**A4**<br>- Kits for arterial lines, intravenous lines Kits arterial, intravenous and dialysis, when discarded.<br>- Filters for air and gases aspirated from contaminated area; membrane filter-hospital medical equipment and research, among others.<br>- About of the laboratory samples and their containers containing feces, urine and secretions from patients that do not contain, nor are suspected to contain agents Risk Class 4, and not have epidemiological significance and risk of the spread, or emerging disease causing organism that it is epidemiologically important or the mechanism of transmission is unknown or suspected of contamination with prions.<br>**A5**<br>- Organs, tissues, body fluids, perforating or scarificants materials and other materials from the health care of individuals or animals with suspected or certain contaminated with prions. |
| **B** | <u>chemical waste</u><br>- Products hormonal and antimicrobial products; cytostatic, anticancer, |

| | |
|---|---|
| | immunosuppressant, digitalis, immunomodulatory, anti-retrovirals, where discarded for health services, pharmacies, drugstores and distributors of medicines or seized and waste of medicines and pharmaceutical raw materials controlled by Act MS 344 / 98 and its updates.<br>- Waste sanitizing, disinfectant, desinfestant; waste containing heavy metals, laboratory reagents, including containers contaminated by them.<br>- Wastewater from the image processor (developers and fixers).<br>- Effluents of automated equipment used in clinical testing.<br>- Other products considered hazardous, as classification of the NBR 10004 of ABNT (toxic, corrosive, flammable and reactive). |
| **C** | radioactive waste<br>- Fall within this group the radioactive tailings or contaminated with radionuclides from clinical laboratory testing services, nuclear medicine and radiotherapy, according to the resolution CNEN-6.05. |
| **D** | common waste<br>- disposable diapers and sanitary paper, sanitary napkin, disposable piece of clothing, food from other patients, material used in hemostasis and anti-sepsis of venoclysis, team<br>of serum and other similar non-classified as A1;<br>- Leftover and the preparation of food;<br>- Rest of cafeteria food;<br>- Waste from administrative areas;<br>- Sweeping waste, flowers, pruning and gardens;<br>- Waste gypsum arising from health care. |
| **E** | perforating or cutting material<br>Perforating or escarificants materials, such as: Razor blades, needles, scalp, glass ampoules, burs, endodontic files, diamond burs, scalpel blade, lancets, capillary tubes, micropipettes, and laminule blades, spatulas, and all the tools of broken glass in the laboratory (pipettes, blood collection tubes and Petri dishes) and others. |

The monthly amount of healthcare waste generated by all source in Novo Hamburgo is 577.015 tons. The three hospitals in the city are the biggest source of healthcare (biomedical) waste. As shown bellow, around 0.600 tons of hazardous healthcare waste is generated daily in addition to 2.550 tons of non hazardous waste.

| Healthcare wastes | **hazardous waste** | **non hazardous waste** |
|---|---|---|
| 483 beds | 1.244 kg | 5.186 kg |

Table 37 - Average wastes generation per bed-day for the three hospitals.

Table 37 shows the quantification of the healthcare waste in Novo Hamburgo, generated by generating source, according to the classification of ANVISA.

| Generation Source | Number of the establishments | Classes | Quantity kg/unid/day | | Quantity kg/unid/month | Total/ month kg |
|---|---|---|---|---|---|---|
| Pharmacy | 132 | | | | | |
| | | A | | 3.18 | 95.40 | 12592.8 |
| | | B | | 0.63 | 18.90 | 2494.8 |
| | | C | no generation | | | |
| | | D | | 17.00 | 51.00 | 6732.00 |
| | | E | | 0.21 | 6.30 | 831.60 |
| Dental Office | 120 | | | | | |
| | | A | | 3.46 | 103.80 | 12456.00 |
| | | B | | 0.69 | 20.70 | 2484.00 |
| | | C | no generation | | | |
| | | D | | 18.50 | 555.00 | 66600.00 |
| | | E | | 0.23 | 6.90 | 828.00 |
| Doctor's Office | 249 | | | | | |
| | | A | | 1.51 | 45.30 | 11279.70 |
| | | B | | 0.30 | 9.00 | 2241.00 |
| | | C | no generation | | | |
| | | D | | 8.10 | 243.00 | 60507.00 |
| | | E | | 0.10 | 3.00 | 747.00 |
| Veterinary Clinic | 11 | | | | | |
| | | A | | 0.77 | 23.10 | 254.10 |
| | | B | | 0.15 | 4.50 | 49.50 |
| | | C | no generation | | | |
| | | D | | 4.15 | 124.50 | 139.50 |
| | | E | | 0.05 | 1.50 | 16.50 |
| Hospital | 4 | | | | | |
| | | A | | 157.00 | 4710.00 | 18840.00 |
| | | B | | 31.00 | 930.00 | 3720.00 |
| | | C | | 1.80 | 54.00 | 216.00 |
| | | D | | 835.00 | 25050.00 | 100200.00 |
| | | E | | 10.50 | 315.00 | 1260.00 |
| Legal Medical Institute | 1 | | | | | |
| | | A | | 20.00 | 600.00 | 600.00 |
| | | B | | 3.90 | 117.00 | 117.00 |
| | | C | no generation | | | |
| | | D | | 107.00 | 3210.00 | 3210.00 |
| | | E | | 1.30 | 39.00 | 39.00 |
| Medical Clinic | 2 | | | | | |
| | | A | | 13.12 | 393.60 | 787.20 |
| | | B | | 2.62 | 78.60 | 157.20 |
| | | C | no generation | | | |
| | | D | | 70.00 | 2100.00 | 4200.00 |
| | | E | | 0.87 | 26.10 | 52.20 |
| Laboratory | 4 | | | | | |
| | | A | | 0.78 | 23.4 | 93.60 |
| | | B | no generation | | | |
| | | C | no generation | | | |
| | | D | | 4.16 | 124.80 | 499.20 |
| | | E | | 0.05 | 1.50 | 6.00 |
| Health Center | 21 | | | | | |
| | | A | | 44.61 | 1338.30 | 28104.30 |
| | | B | | 8.90 | 267.00 | 5607.00 |
| | | C | no generation | | | |
| | | D | | 237.92 | 7137.76 | 149892.96 |
| | | E | | 19.60 | 588.00 | 12348.00 |
| **Total** | **544** | | | | | |
| | | **A** | | | **2388.59** | **85001.70** |
| | | **B** | | | **562.35** | **16870.5** |
| | | **C** | | | **7.80** | **216.00** |
| | | **D** | | | **15293.28** | **458798.66** |
| | | **E** | | | **537.61** | **16128.30** |
| | **Total/month (kg)** | | | | | **577015.16** |

Table 38 - Quantification of the healthcare waste in Novo Hamburgo.

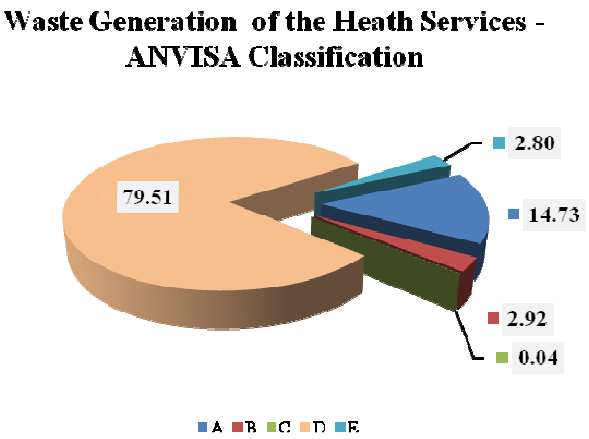


FIG. 04 - Waste generation of health services in Novo Hamburgo in 2008.

## 1.4 Construction and Demolition Solid Waste

### 1.4.1 New Constructions

The conference of the ten graphics sent by municipal authorities in order to prepare the database for future projections, indicated a real close to the licensed works, as the construction of solid waste is the largest item of generation volume in Brazil. When it comes to numbers in Novo Hamburgo its importance is seen, even more for not having a licensed site for disposal of C&D waste.


FIG. 05 - Average quantities of the period from 2004 to 2008 = 53000 ton/year. (Estimated by Lovato 2007: 1m³ = 150kg)

*The wastes C&D are classified in accordance with the Resolution CONAMA No. 307, in 4 classes:*

***Class A**: aggregated wastes that can be re-used or recycled, such as:*

*a) of construction, demolition, reforms and repairs of paving and of other works of infrastructure, including originating grounds of leveling of the ground;*

*b) of construction, demolition, reforms and repairs of constructions: ceramic components (bricks, blocks, tiles, etc.), cements plates of revetment and concrete; and*

*c) of process of manufacture and/or demolition of precast pieces in concrete (blocks, tubes, kerbs, etc.) produced in the flowerbeds of works.]*

***Class B**: recyclable wastes for other destinations, such as plastic, paper, cardboard, metal, glass, wood and others.*

***Class C**: wastes for which were not developed technologies or economically viable applications that allow their recuperation, such as products originating from the plaster.*

***Class D**: hazardous wastes originating from the process of construction, such as paints, solvents, oils and others, or those contaminated originating from demolitions, reforms, repairs of clinic radiological, industrial installations and others.*

Considering only licensed works in Novo Hamburgo, then the percentage of aggregated wastes that can be re-used or recycled (Class A) is shown below:

| | |
|---|---|
| Mortar % | 34.20 |
| White and red ceramics % | 22.90 |
| Concrete % | 26.80 |
| Pebble % | 14.01 |
| Others (metalic plate, organics, paint, Plastics) % | 2.10 |

Table 39 - Percentage of aggregated wastes.

### 1.4.2 Debris of Demolition and Reforms

Quantity of C&D waste from small generators collected by Private Enterprises in Novo Hamburgo is shown bellow.

| ENTERPRISES | QUANTITY (M3/DAY) | QUANTITY (M3/YEAR) |
|---|---|---|
| **BIFRAN** | 35 | 9.000 |
| **APOLO** | 164 | 53.040 |
| **VITEC** | 30 | 7.200 |
| **MAKYSINOS KAISER** | 48 | 12.672 |
| **TOTAL** | 277 | **81.912** |

Table 40 - Quantity of C&D waste from small generators.

Materials found among the C&D waste in Apollo Private Collector in NH, separated by class according to CONAMA Resolution No. 307/02, as shown in the table below:

| Materials | Class | Materials | Class |
|---|---|---|---|
| Sand | A | PVC pipe | B |
| Mortar | A | Ferrous | B |
| Stone | A | Wood | B |
| Cement pipe | A | Plastic | B |
| Ceramics | A | Rubber | Others |
| Concrete | A | Toilet bowl | A |
| Agegated from demolition | A | Container from chemical substances | D |
| Yard/Garden | Others | Asbesto tile | D |
| Tiles | A | Textile | Others |
| Soil | A | Furniture | Others |

Table 41 - Different materials found among C&D waste.

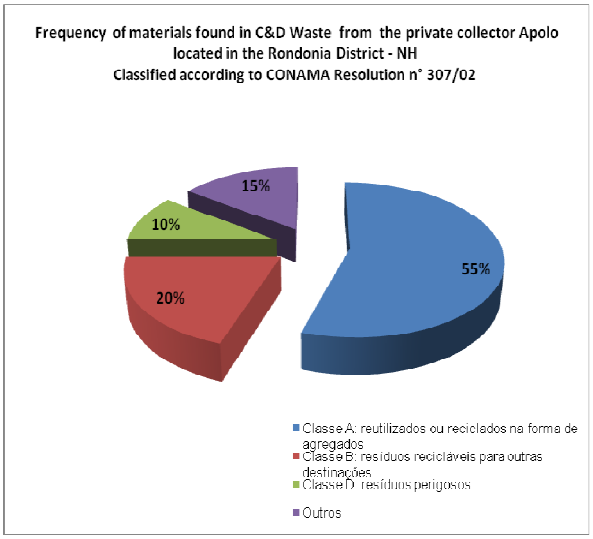


FIG. 06 - Frequency of materials found in C&D waste.

The results shown in the figure above are 55% Class A: aggregated wastes that can be re-used or recycled, 20% Class B: recyclable wastes for other destinations, 10% Class D: hazardous wastes originating from the process of construction, and 15% Others: such as furniture, textiles, rubber, vegetation.

## 1.5 Trends, Projections and Considerations

### 1.5.1 Residential Waste

The population growth rate of Novo Hamburgo showed a decreasing trend from 1.90% in 1996 to 1.22% for 2000 and 1.02% in 2007. For the year 2008 there was a small increase in the population growth rate of around 1.14%, which if remains constant, it will increase the population of Novo Hamburgo to approximately 293,000 inhabitants in 2020.

| Population of Novo Hamburgo | | | | | | | Projection of Population Growth | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Change in Population Growth | | | | | | | | | | | | | | |
| Year | 1991 | 1996 | 2000 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2020 |
| Population | 205668 | 225245 | 236193 | 253067 | 255945 | 258862 | 261813 | 264798 | 267817 | 270870 | 273958 | 277081 | 280240 | 293239 |
| Growth Rate | | 9.52 | 4.86 | 7.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 4.64 |
| Growth Rate(year) | | 1.90 | 1.22 | 1.02 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 | 1.14 |

Table 42 - Projection of Population Growth

| Year | GDP per capita |
|---|---|
| 1999 | 7919.48 |
| 2000 | 9701.83 |
| 2001 | 10051.89 |
| 2002 | 12065 |
| 2003 | 12727 |
| 2004 | 14816 |
| 2005 | 15035 |
| 2006 | 15062 |
| 2008 | 13635 |

Table 43 - Evolution of GDP per capita in NH between 1999 and 2008.

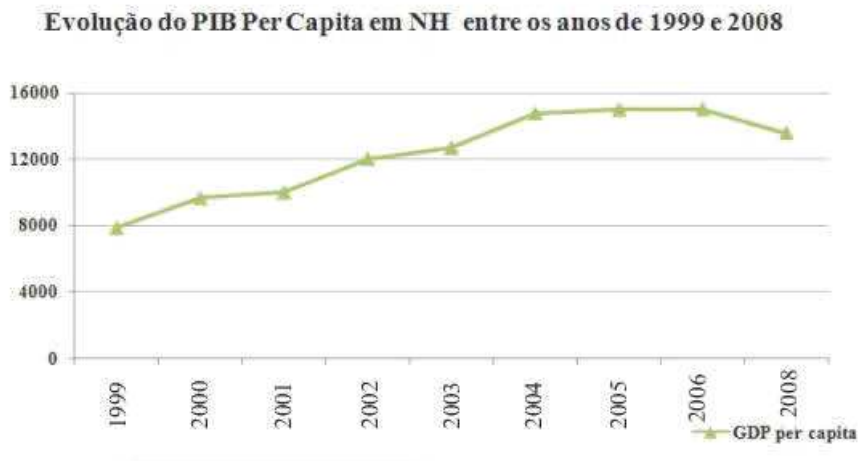


FIG. 07 - Evolution of GDP per capita in NH between 1999 and 2008.

In contrast to population growth, we still have a substantial reduction in GDP per capita between the years 2006 and 2008, with consequent reduction in the generation of MSW in the city

Observing the table 27, we can observe that the quantity of MSW sent to landfill to recreation in *Minas do Leão*, considering the normal seasonal variations within each year, has remained relatively stable since 2007.

According to the data for population growth and per capita GDP, we project that the generation of MSW, despite population growth, should not increase in proportion.

Based on all data collected the projection of Municipal Waste Generation is as follow:

**PROJECTION OF POPULATION GROWTH X GENERATION OF WASTE**

| Year | Population RS (FEE RS) | Population NH (FEE RS) | Population growth rate RS (%) | Population growth rate NH (%) | % Pop. NH / RS | Daily waste Generation per inhabitant (0,69143 kg ) | Recyclable - Kg (29,84%) | Organic - Kg (56,77%) | Mixed - Kg (22,492%) |
|---|---|---|---|---|---|---|---|---|---|
| 1996 | 9,634,688 | 226,070 | | | 2.35 | | | | |
| 2000 | 10,187,798 | 236,193 | 5.7408 | 4.4778 | 2.32 | | | | |
| 2001 | 10,254,954 | 238,618 | 0.6592 | 1.0267 | 2.33 | | | | |
| 2002 | 10,317,984 | 241,032 | 0,6146 | 1.0117 | 2.34 | | | | |
| 2003 | 10,377,446 | 243,442 | 0.5763 | 0.9999 | 2.35 | | | | |
| 2004 | 10,433,449 | 245,832 | 0.5397 | 0.9818 | 2.36 | | | | |
| 2005 | 10,486,207 | 248,219 | 0.5057 | 0.9710 | 2.37 | | | | |
| 2006 | 10,536,009 | 250,636 | 0.4749 | 0.9737 | 2.38 | | | | |
| 2007 | 10,582,877 | 253,067 | 0.4448 | 0.9699 | 2.39 | | | | |
| **2008** | 10,727,937 | 255,945 | 1.8216 | 1.1372 | 2.40 | **176,968.05** | **52,807.27** | **100,464.76** | **39,803.65** |
| 2009 | 10,812,339 | 256,398 | 0.7867 | 0.1769 | 2.39 | 177,281.06 | 52,900.67 | 100,642.46 | 39,874.06 |
| 2010 | 10,897,309 | 257,334 | 0.7859 | 0.3650 | 2.38 | 177,928.22 | 53,093.78 | 101,009.85 | 40,019.61 |
| **2015** | 11,274,465 | 259,356 | | | 2.38 | **179,326.49** | **53,511.02** | **101,803.65** | **40,334.11** |
| 2020 | 11,605,196 | 273,969 | | | 2.43 | 189,430.73 | 56,526.13 | 107,539.83 | 42,606.76 |
| 2025 | 11,870,400 | 287,809 | | | 2.48 | 198,999.68 | 59,381.50 | 112,972.12 | 44,759.01 |
| **2030** | 12,054,977 | 299,134 | | | 2.52 | **206,830.28** | **61,718.15** | **117,417.55** | **46,520.27** |

Source: FEERS/ CIE / NPE / IBGE

Table 44 **-** The projection of Municipal Waste Generation.

### 1.5.2 Construction and Demolition Waste

There is no a direct relationship between population size and rate of construction and demolition waste generation, as this generation is a function of different variables such as population, economic matrix of the city, cultural habits, topography, among others.

The following calculation was based on the references used for the characterization and quantification phase, whose generation projection of C&DW is related to population growth.

| Year | Population (inh) | C&DW Generation (t/year) |
|---|---|---|
| **2007** | 253,067 | 63,014 |
| **2008** | 255,676 | 63,663 |
| **2009** | 258,311 | 64,319 |
| **2010** | 260,974 | 64,983 |
| **2011** | 263,664 | 65,652 |
| **2012** | 266,382 | 66,329 |
| **2013** | 269,128 | 67,013 |
| **2014** | 271,902 | 67,704 |
| **2015** | 274,705 | 68,402 |
| **2016** | 277,357 | 69,107 |
| **2017** | 280,398 | 69,819 |
| **2018** | 283,288 | 70,539 |
| | **Total** | **800,543 t** |

Table 45 - The projection of C&D Waste Generation.

# 2. ASSESSMENT OF CURRENT SOLID WASTE MANAGEMENT

## 2.1 Administrative Aspects

### 2.1.1 Municipal Solid Waste

The collection, transportation and final disposal of Residential and Commercial Solid Waste in Novo Hamburgo are the responsibility of the Municipality, which through bidding process outsource such activities, by contract. There is no licensed landfill in Novo Hamburgo. The three sites used as landfills in the city had their activities ceased by judicial determination in the beginning of 2008. The cost to the Municipal Treasury with a small part of the environmental liabilities of these areas, only in 2008 it was 5,608,182.74 (Public auction/Contract 31/2008).

The Municipality charges for house/apartment an annual fee for the garbage collection service. Since the rate now appears insufficient

to cover all expenses generated by this service, the City is forced to inject resources from its "*Caixa Único*" (type of Single Account, composed of other sources of revenue: IPTU, ICMS returned, CIDE, various rates, etc.). The table below shows this scenario in 2008.

| Services | Total 2008 (in Reais) |
|---|---|
| Residential Solid Waste Collection | R$3,908,327.81 |
| Residential Solid Waste Transportation | R$1,172,255.40 |
| Residential Solid Waste Final Destination | R$1,651,814.40 |
| Collection, Treatment and Final Destination of Municipal Healthcare Waste | R$323,521.00 |
| Implementation, Operation and Maintenance of Ecopoints | R$287,931.80 |
| Manual Sweeping of Roads and Streets | R$1,219,305.44 |
| Manual and Mechanical Weeding and Clearing of Public Vias | R$3,545,555.30 |
| Painting of Curbs | R$693,379.00 |
| Supply of Team for Diverse Services | R$838,270.60 |
| **Total expenditure Cleaning Service** | **R$13,640,360.75** |
| **Total Revenue of Fee Garbage Collection** | **R$5,983,955.77** |
| **Difference Revenue X Expenditure** | **R$7,656,404.98** |

Table 46 -Difference Revenue X Expenditure of Cleaning Service in NH during 2008.

At present, the private company VEGA Environmental Engineering, carries out for collection system, equipment and final disposal of RSW, monitoring by the Municipal Secretariat of Constructions and Urban Services (SEMOPSU) and Municipal Secretariat of Environmental and Urban Planning (SEMAM). VEGA uses 7 (seven) trucks – 5 (five) with 10 tons of capacity are used effectively, and 2 (two) with 14 tons of capacity stay in standby position.

**Current Administration Framework in Novo Hamburgo**

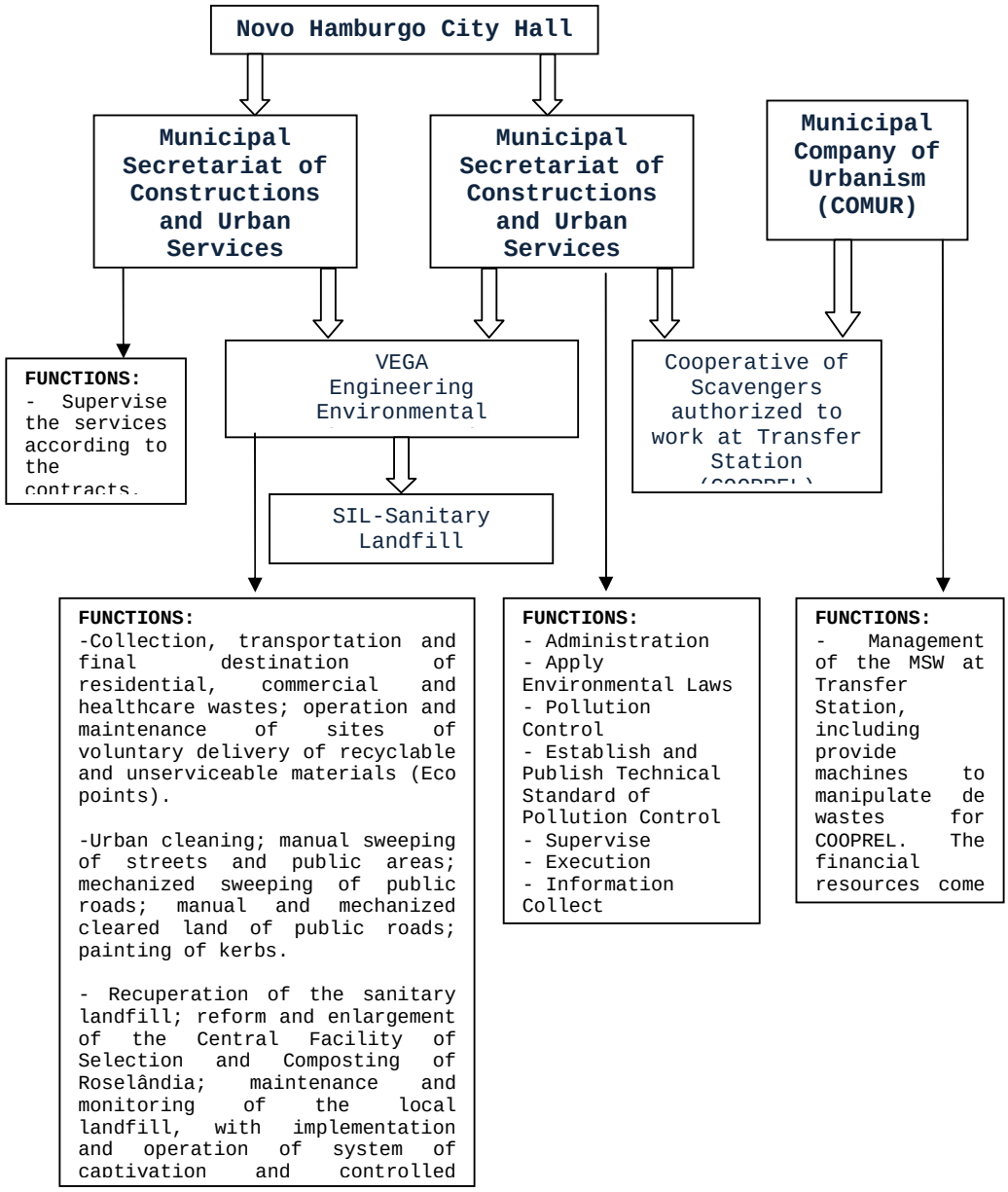


FIG. 08 - Current Administration Framework in Novo Hamburgo.

All the Residential and Comercial wastes collected in Novo Hamburgo are taken to the single Transfer Station of "Roselândia", which is operates by the Municipal Company of Urbanism (COMUR), an enterprise of mixed economy. At the transfer station the wastes are available for COOPREL (Cooperative of Scavengers) to make the manual sorting by the cooperated ones along two conveyor belt. The

work condition is rough and it is not safe enough. The residual waste of the tip of the conveyor belt and organic waste are loaded by a grader poclain model in trucks, with capacity of 40 tons each, to be transferred to an authorized private landfill in *Minas do Leão* – Sanitary Landfill of Recreation (SIL) – 130 Km away from *Novo Hamburgo*.

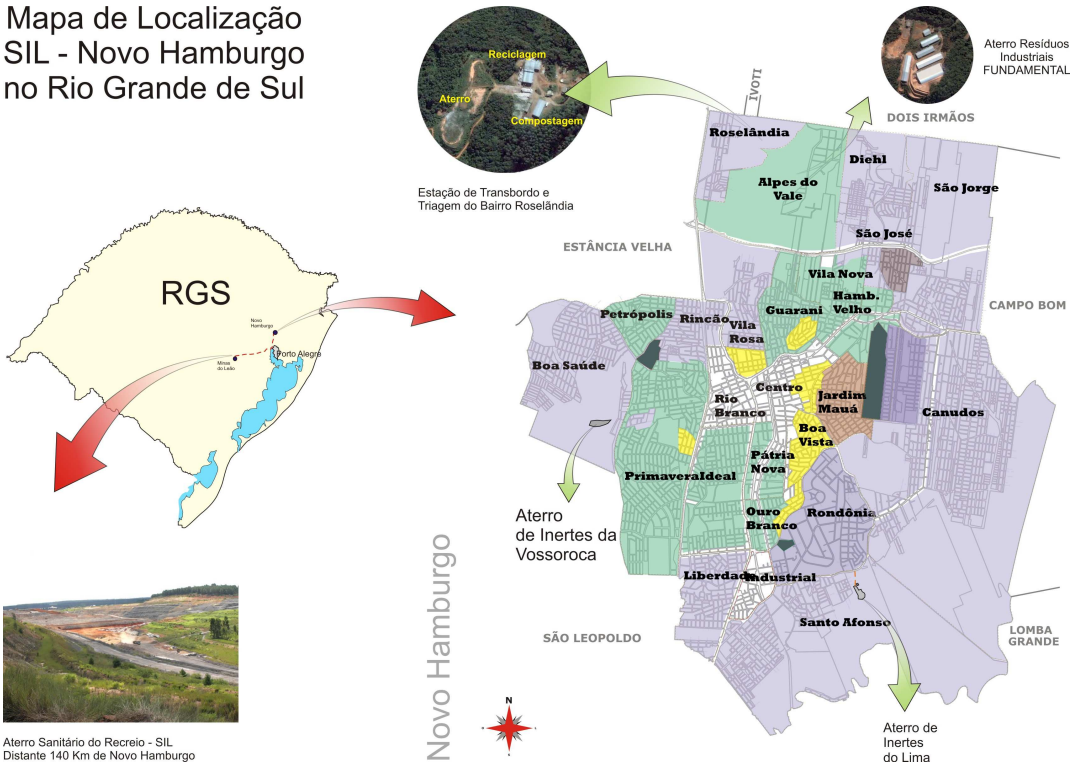


FIG. 09 - Map location of transfer station and landfills.

### 2.1.2 Industrial Waste

Waste from Industry in the city of Novo Hamburgo, are the responsibility of the generator. Therefore, the collection, transportation and final disposal of waste from industrial process is carried out by generator.

There are two major industrial hazardous waste landfills in the region that receive waste from NH industries - UTRESA and

FUNDAMENTAL. The first is located in the city of Estância Velha, 15 Km away from NH downtown and it is the largest receiver in the area. The second is located in Novo Hamburgo and receives waste normally from associates (preferred rates) or non associates. It supplies a list of the authorized companies to arrange the waste transportation. To be on the list truckers and/or companies must have all paper-work on hand and be registered with government departments. No entrance allowed without it.

However, these two plants have some limitations. ULTRESA since 2006 is under judicial intervention due a great environmental disaster in the river *Sinos*, that caused the slaughter of millions of fish and other impacts related to discharges of toxic wastes into the river, by this and other public and private companies included in the judicial proceedings. In face of that, the renewal of operating licenses of its cells is subject to remediation of the infractions identified, which limits the volume of waste received by ULTRESA till the adjustment of this situation. While FUNDAMENTAL not receive some types of hazardous industrial waste

A municipal program to encourage cleaner production in the industrial sector proves to be essential and urgent to reduce the volume of industrial waste ending up in landfills.

### 2.1.3 Healthcare Waste

Healthcare waste is responsibility of generators, which makes the initial investment in infrastructure for storage and segregation. They also pay to providers of service for the collection, transport, treatment and final disposal of waste. These costs should be passed to the price of the service. With respect to municipal administration

are expected fines in municipal law, the unfair treatment of waste, when it occurs.

According to the Resolution ANVISA n$^{o}$ 306/04, every hospital should have its waste management plan and provide training for its team conduct the correct management of such waste. However, during data collection, it was observed that in the public hospitals there was not compliance with the resolution in full, even when in the existence of the plan it was not properly followed.

The sources generating from NH outsource the service to companies in the region, because there is no one in the city. In the region of NH were identified by the project team, several private plants for transportation, proper treatment and final disposal of healthcare waste. Among the technologies used are autoclave, incinerator, microwave.

As for recycling, it was found data available only for generation of a hospital with 180 beds - Metals: 13kg/month; Plastics: 316kg/month; Paper/cardboard: 163kg/month; Glass: 747kg/month. The other generators visited have not control, discarding in garbage bins for municipal collection. Based on that, we can infer the need of a cleaner production program for the health facilities aiming a significant reduction in the generation and training on healthcare waste proper segregation.

### 2.1.4 Construction and Demolition Waste

Waste from construction and demolition in the city of Novo Hamburgo is the responsibility of the generator. Therefore, the collection, transportation and final disposal of waste from construction and demolition is not carried out by City Hall.

C&D waste generators hire the services of private companies, known as "*Papa-Entulho*". According to generator needs, the containers are placed on the streets and avenues (public roads) or on the sidewalk, from one to three days. After this period, are transported by truck, until the final destination.

As the city of Novo Hamburgo has no licensed area available for deposition of C&D Waste, so is common the population dispose demolition debris anywhere, dribbling the surveillance of public control.

The private collector sector has faced a number of difficulties regarding the collection, where there is no awareness of the population that the containers (*papa-entulho*) is proper only for collecting inert materials from construction and/or demolition process, causing a serious problem at the time of collection and final disposal of such wastes.

Also at the time of collection and disposal there is not a previous selection. This problem is not only of small generators as well as major constructors. Some waste end up leaving the city for not having an appropriate place, going to neighboring municipalities. Otherwise, the C&D solid wastes are disposal in irregular areas, modifying the landscape along of secondary roads, without concern regarding the existence of hazardous material or not.

During the collection of information, it was found a technical proposal for recuperation and sizing, layout and operation of the Central Facility of Inert Materials of the District Rondônia – "Aterro do Lima". The recuperation of this area predicts the installation of a landfill of inert waste of the construction that contemplates the

receiving and the selection of these materials as well as the temporary stock of materials like wastes of pruning, wastes of great volume, re-using materials and dead animals (Engebio-NH-MD-01, Project Contract 008-2008).

It was also found in the archives of the Secretariat of Environment, a manual of basic guidelines for the management of waste from civil construction. Although this manual is available since 2005, no program related was implemented so far. This manual was prepared jointly by the Department of Environment, Society of Architects and Civil Engineers (NH), Union of Construction Industries (NH), Regional Council of Architects and Engineers (RS) and FEEVALE University, based on municipal Law 1098/2004 and the Resolution CONAMA 307/2002.

In this context, we conclude that the first step to fulfill the Law should be involve the generators, the collectors and the secretary of the environment in order to find appropriate areas and licensing them, preventing the illegal transport, having a strict control on entry of such waste, as well as the segregation, identification and quantification of them. To ensure a reduction in waste disposal of construction and demolition in irregular areas, and also stimulate a process of reuse and recycling, a program of cleaner production and an environmental education campaign are crucial.

## 2.2 Political Aspects

During the collection of information in the prefecture of NH, we identified the absence of any environmental variable in local public policy for sustainable development of the municipality. Just as the lack of communication between the various municipal departments and integration of projects essential to the well being of the

population. From this understanding, to change this culture, some aspects should be considered:

The lack of culture of assessment and monitoring of the public policies and its continuity generates demands applicants in environmental sanitation services. To transform this "state of affairs", which causes discontent for the people of NH, in a situation of opportunity that will bring benefits to all stakeholders it must become a priority on the agenda of local government.

The lack of understanding the relationship between environmental management and the health of urban inhabitants is a issue that need to be addressed to the NH authorities. The implications of inadequate municipal waste management upon the health of the public are serious and they cannot be ignored. The combined effects of casual disposal of waste, insufficient waste collection and inadequate waste disposal facilities have always had serious, adverse implications for direct transmission of diseases and the spread of epidemics.

## 2.3 Legal Aspects

The regulatory framework related to Solid Waste Management in Novo Hamburgo can be distinguished at National, State and Municipal levels. On analysis of the framework several important Laws/Acts, Regulations/Standards and Technical Guidelines can be identified in relation to the management of Solid Waste. For a better understanding, the hierarchy for the creation of the Brazilian environmental legislation is shown below:

**1.** Federal Level

Laws: National Congress

Resolutions: CONAMA- National Council of Environment

Decrees: Presidency of the Republic

**2.** State Level

Laws: Legislative Assembly

Resolutions: CONSEMA- State Council of Environment

Decrees: State Government

**3.** Municipal Level

Laws: Municipal Government

Resolutions: CONAM- Municipal Council of Environment

Decrees: Municipal Government

The management of the solid waste at local authority is supported by the Municipal Law n°. 1098/2004 that establishes the Municipal Program of Selective Collection of Solid Urban Wastes. But, effectively, there is no current policies implementing a recycling program.

In the state of Rio Grande do Sul, the Law 9.921/93 (regulated by Decree 38.356/98) demands that the local authorities present an integrated management plan on solid wastes, privileging the processes of the waste segregation in the origin and encouraging to the activities of recycling.

The Federal Constitution of 1988, in his Article 23, Incise VI, it establishes that the protection to the environment and the combat to the pollution in any of his forms, including the contamination of the ground for solid wastes is a common competence of the Union, States, and Federal District and of the Local Authorities. In the article 24, it establishes the competence of the Union, of the States and of the Federal District in legislating contestant on "(...) protection of the environment and control of the pollution" (Incise VI) and, in the article 30, Incises I and II, it establishes that the municipality

authority has the power "to legislate on the subjects of local and supplementary to interest of the federal and state legislation and in what to fit.

The Federal Law n° 6.938, of 31/8/81, which has on the National Politics of Environment, sets up the systematic of Assessment of Environmental Impact for modifying or potentially modifying activities of the environmental quality, with the creation of the Assessment of Environmental Impact (AEI), setting up the licenses to be obtained along the existence of these activities (IPT/Cempre, 2000).

The Law 11.445/2007 establishes the general guidelines of sanitation, including in the notion of sanitation, the services, infrastructures and operational installations of the supply of drinkable water, sanitary exhaustion, urban cleaning, handling of solid wastes and drainage and handling of the pluvial urban waters.

The Law of Basic Sanitation affirms that the urban cleaning and the handling of the solid wastes must be carried out in the appropriate form to the public health and to the protection of the environment.

The plan of basic sanitation of the local authority must contain five great subjects:

1. diagnosis of the situation and its impacts in the conditions of life, pointing to the causes of the detected deficiencies;
2. objectives and targets of short, middle and long terms for the full coverage of the access to the benefits of the basic sanitation and, in fact, to the urban cleaning and to the healthy handling of the solid wastes;

3. foresee new territorial spaces for the waste final destination is a matter that demands time and accurate analysis and needs to be planned well;
4. actions for emergencies and contingencies, like strikes in the sector of garbage collection, fire in the deposits of wastes and emissions of pollutants;
5. mechanisms to assess the efficiency of the planned actions (MACHADO, 2007).

The Resolution CONAMA – 05/1993 uses the attributions of the law above in order to define concepts in its Article, item I, Solid Wastes on basis of the NBR - 10004 and in the item II, Solid Wastes Management Plan as an integrant document of the process of environmental license. In the item III regulates on the System of Treatment of Solid Wastes and in the item IV on the Final Disposal.

The set of legislation identified during the data collection is listed along this topic by sector:

### 2.3.1 Residential and Commercial Waste

*Selective collection and recycling of residential waste:*

Organic Municipal Law[2] of the Municipality of Novo Hamburgo in Article 118 establishes that *"The city will maintain an ongoing program to encourage selective collection and recycling of household waste"*.

In state legislation, the Resolution n° 17/2001, of CONSEMA[23] establishes guidelines for the preparation and submission of Plan of Integrated Management of Solid Waste.

[2] Municipal Organic Law corresponds in the Brazilian legislative system, the Constitution of the Municipality, as equivalent of the Federal Constitution and State Constitution.
[3] CONSEMA – State Council on the Environment

*Segregation of Waste at Source:*

***Educational Environmental Mechanisms to stimulate Segregation of Domestic Waste and Awareness for Recycling*** - In the first paragraph of that Article 118, the Municipal Organic Law establishes the obligation of the educational mechanisms and information on the initiative of the government for encouraging the segregation of waste generated at home for its reuse and recycling.

These mechanisms are shown in the Municipal Organic Law as the community and advertising campaigns, educational and informative lectures, emphasizing the environmental, social and economic benefits resulting from recycling:

> *§ 1st - The separation of domestic waste, to its recycling and reuse should be encouraged by the municipal authorities through community campaigns and advertising, as well as through lectures of educational and informative character in the chain of local schools, with emphasis the environmental, economic and social benefits, from the recycling of waste.*

Although the comprehensive nature of the possibilities listed in the Law, it is quite reasonable view that list does not have a character of "numerus clausus", ie is not exhaustive but illustrative.

The Municipal Law n$^{o}$ 730/2002, as amended by Laws 1099 and 1104, both of 2004, provides for the obligation of shops using plastic bags for packaging, printing of information on the separation of garbage.

***Recycling of Domestic Waste and Manual Collection Systems*** - It is a competence of the Municipality to find ways to permanently increase the amount of household waste recycled, the

improvement for manual[4] collection systems, and installation of suitable equipment at landfill[5]. The Municipal Organic Law, in paragraph 2 of art.118 establishes municipal jurisdiction:

> *§ 2nd - It´s responsibility of the Executive Power, on an ongoing basis, seek ways to increase the amount of household waste recycled in the city, enhancing and improving the system of manual collection and providing the installation of appropriate equipment for this purpose in municipal landfills.*

The Resolution NBR 12980, of ABNT[6], establishes standards for the collection, sweeping and packaging of urban solid waste.

*Segregation of Waste:*

***Mandatory Installation of Differenciated Containers -*** Besides the laws of educational character, the municipality has a Municipal Law n$^{o}$ 224/1999, which requires that the buildings have more than four apartments or over three floors located in the urban perimeter in the city of Novo Hamburgo, the installation and maintenance of a dumping ground for organic waste and another for inorganic waste.

***Selective Solid Waste Collection of Residential and Small Commercial business Responsibility of the City -*** On the site, the Municipal Law n$^{o}$ 1098 of 01/06/2004 establishes the Selective Collection Program of Municipal Solid Waste among other provisions.

[4]This suggests a concern with generating income for social layers directly involved with the sorting at transfer stations.

[5] The reference to landfill is somewhat technical and should not be construed as work in place of final disposal, but the transfer stations.

[6] ABNT – Brazilian Association of Technical Standards

The collection of commercial waste that the law gives the responsibility of the generator refers to the large quantities generated by the large establishments, since the generation of medium and small shops are similar to household waste and subject to the same system of collection.

The Municipal Law follows the plan of the State Law n$^{o}$ 9921/93, which deals with solid waste management and the State Decree No. 38356/98, which regulates the State Law and provides in its art. 8$^{th}$ that collection, transport, treatment, processing and final destination of the waste of industry, trade and services, including health are the responsibility of the generating source.

*Transportation of Waste:*

The municipal legislation makes its prediction in Municipal Law 1098/2004. The Municipal Law follows the plan of the State Law 9921/93, which deals with solid waste management and the State Decree No. 38356/98, which regulates the state law.

There are federal regulations on the subject, the ABNT, in the NBR 13221, which deals with procedures for the transport of waste.

*Criminal Law Enforcement and Administrative:*

In Brazil the power to legislate on criminal matters is exclusive of the Union, therefore the Federal sphere. There are as the main character of the criminal repression the Law No 9605/98 – of the Environmental Crimes - and Decree n$^{o}$ 3179/99, which provides for sanctions for conduct and activities harmful to the environment.

In the same Law no 9605/98, are set administrative penalties for conduct and activities harmful to the environment. In this case, there is competition between state and municipal legislation.

Also, the State Law n° 11877/2002 provides for the imposition and gradation of environmental penalty of administrative nature, among other provisions; the Resolution CONSEMA No 006/1999 discipline the application of Federal Decree n° 3179/99, which regulates the Law n° 9605/98, with regard to violations, penalties, administrative procedure and other provisions.

The city of NH uses the federal and state laws and ordinances, and also the municipal law n° 131/92 for the fines that apply based on grounds of breach of environmental legislation.

### 2.3.2 Industrial Solid waste

*Authorization to operate:*

The Organic Municipal Law of the Municipality of Novo Hamburgo establishes in its Article 146 that the estimates of both the issuing and renewal of licenses for installation and operation of establishments in industry and trade of products with potential polluter are necessarily subject to City Council on the Environment.

*Responsibility for Collection and Transport, Treatment and Final Disposal:*

At the local level, the Municipal Law n° 1098 of 01/06/2004 establishes the Municipal Selective Collection of Solid Waste Program, among other provisions.

The collection of commercial waste, which the law gives the responsibility of the generator, referred to the large quantities generated by the large establishments, since the generation of medium and small shops are similar to household waste collection being subjected to the same system of this collection.

The Municipal Law follows the plan of the Municipal State Law nº 9921/93, which deals with solid waste management and the State Decree nº 38356/98, which regulates the State Law and provides in art. 8th that collection, transport, treatment, processing and final destination of the industrial waste, trade and services, including health, are the responsibility of the generating source.

Resolution nº 73/2004, of CONSEMA[7] has on co-disposal of industrial solid wastes in municipal solid waste landfills in the State of Rio Grande do Sul.

*Hazardous Industrial Solid Waste:*

The State Ordinance No. 12/95 of SSMA[8], among other things, deals with EIA/RIMA ventures for processing and final destination of hazardous industrial solid waste.

*Destination of Industrial Solid Waste:*

At state level, the State Law nº 9921/93, which deals with solid waste management and the State Decree nº 38356/98, which regulates that State Law set guidelines.

[7] CONSEMA – State Council of Environment.
[8] SSMA – State Department of Health and Environment. At the time of publishing this Ordinance, the former Secretariat of Health and Environment accumulated tasks that are now distributed by two separate departments, one for the environment and another for health.

At federal level there are the NBR[9] dispatched by ABNT addressing the issue: NBR 13221, regulates procedures for the transport of waste; NBR 8418, regulates the presentation of Projects for Industrial Hazardous Waste Landfill and NBR 8849/95, which deals with the presentation of Projects for Controlled Landfill of municipal solid waste. The NBR is followed in the three administrative plans, federal, state and municipal, as general rules on technical content.

### 2.3.3 Construction and Demolition Waste

The Municipal Law n° 1098/2004, which provides for the Municipal Selective Collection Program for Urban Solid Waste, among other provisions, deals with the generators of construction waste in Novo Hamburgo.

*Authorization to operate:*

The entrepreneur must submit in advance a plan of management of construction waste, including its management and allocation.

***Construction Waste Management Plan for the Industry -*** Even if you deal with projects and activities covered in the legislation as not subject to environmental control, nevertheless, must be submitted to the municipal environmental agency, along with the rest of the project.

In the case of enterprise or activity subject to environmental control, the solid waste management plan shall be subjected to the environmental agency responsible according to the law. Thus, in the

[9] NBR - Brazilian Standards of the Regulations, published by ABNT - Brazilian Association of Technical Standards.

case of projects and activities of construction, in any case the management plan shall be submitted for evaluation of an environmental agency.

The Resolution CONAMA 307/2002 deals with the management of waste from construction.

*Responsibility for Collection and Transport, Treatment and Final Disposal:*

By the provisions of Municipal Law n° 1098/2004 the waste from construction cannot be disposed in household waste landfills in areas of "going out", slopes, bodies of water, vacant lots and in areas protected by law, or without the express authorization of the competent environmental agency. The management plan should establish the management and distribution of environmentally appropriate waste.

The NBR 13221 of ABNT establishes procedures for the land transport of waste. In the case of waste classified as class D, according to municipal law, its storage, transport, reuse and allocation must follow specific technical standards for hazardous waste.

The State Law n° 9921/93 and State Decree n° 38356/98 establish the management of waste, including hazardous, in the RGS and NBR 10157 of ABNT, the national criteria for the design, construction and operation of landfill of hazardous wastes. The storage of hazardous waste has its own technical standards in NBR 12235, ABNT's also.

### 2.3.4 Solid Waste of Health Services

The Municipal Law no 1098/2004 follows the plan of the State Law 9921/93, which deals with solid waste management and the State Decree n° 38356/98, which regulates the state law and provides in its art. 8th, that the collection, transport, treatment, processing and final destination of the industrial waste, trade and services, including health, are the responsibility of the generating source.

The NBR 12808 of ABNT, establish the classification of Healthcare Waste.

*Responsibility for Collection and Transport, Treatment and Final Disposal:*

In the state legislation there is the State Decree n° 23430/74 approving the Sanitary Code of the State of RGS, the State Law n° 9921/93 and State Decree n° 38356/98 have on waste management, including health, in the RGS.

Still in the state legislation there are the Laws 10099/94 and 10330/94, which have on solid waste from health services and other provisions.

The handling of healthcare waste has its procedure rules in NBR 12809/93, of ABNT, while the collection of the healthcare waste has the procedure established in NBR 12810, ABNT's also.

*Waste Disposal:*

The final destination of healthcare waste must be given in landfills designed, constructed and operated in the manner prescribed by NBR 8419/92, which deals with the presentation of projects for

landfills for municipal solid waste. Also, the Resolution CONAMA nº 358/2005 provides guidelines for the treatment and final destination of healthcare waste.

The Municipal Law nº 038/1970 establishing the practice of burning of remains and cremation of corpses.

In the state rules, the Resolution CONSEMA 009/2000 provides for the environmental licensing system for the incineration of waste of health services in the State of Rio Grande do Sul.

### 2.3.5 Hazardous Solid Waste

*Organic Law & Nuclear Materials:*

The Organic Municipal Law of the Municipality of Novo Hamburgo establishes in its article 144, section V, the duty of the government to "*prohibit the installation in the municipal territory of factories, processing plants, storage of nuclear waste, weapons and other artifacts that make use of nuclear technology, except for medical purposes*";

*Hazardous Waste Management:*

The Municipal Law nº 1098/2004 follows the plan of the State Law 9921/93, which deals with solid waste management and the State Decree nº 38356/98, which regulates the state law.

The Municipal Law no 1098/2004 provides that in case of waste from construction framed in Class D, storage, transport, reuse and allocation must follow specific technical standards for hazardous waste.

*Several other municipal laws regulate the allocation of hazardous waste in Novo Hamburgo:*

Municipal Law nº 1131/2004 - establishes the responsibility of the final destination of batteries and used batteries, and other provisions;
Municipal Law nº 1055/2004 - establishes the responsibility of the final destination of used lamps, and provides other measures;
Municipal Law nº 049/1993 – establishes the deposition, in an appropriate place, of toxic waste.

Under the State Ordinance nº 12/95 of SSMA, among other things, deals with EIA/RIMA ventures for processing and final destination of hazardous industrial solid waste.

The State Law nº 11019/97 and its Regulation in the State Decree 45554 have on the final destination and disposal of batteries containing metallic mercury, fluorescent lamps, cell phone batteries and other devices that contain heavy metals in the State of Rio Grande do Sul.

The State Law nº 9921/93 and State Decree nº 38356/98 establish the management of waste, including hazardous, in the RGS and NBR 10157 of ABNT of federal character, the national criteria for the project, construction and operation of landfills for hazardous wastes. The storage of hazardous waste has its own technical standards in NBR 12235, ABNT's also.

*Also regulated by ABNT:*

NBR 11175 - Solid Waste Incineration Hazardous - Standards of Performance;

NBR 12235 - Storage of Hazardous Waste;

NBR 11174 - Storage of Waste Class II - A: not inert and B: inert (as NBR 10004/2004);

NBR 8418 - Presentation of Projects for Industrial Hazardous Waste Landfill.

The NBR is followed in the three administrative plans, Federal, State and Municipal, as general rules of technical content.

## 2.4 **Financing Mechanisms**

### 2.4.1 Municipal Funds

In terms of remuneration for services, the urban cleaning system can be divided simply into collecting garbage, cleaning of the streets and final disposal. For the collection of garbage, the Municipality charges the population a special fee, called tax of garbage (*taxa de lixo*) that is charged in the same guide for Property Taxes (IPTU), using the same basis of calculation, which is the area of property. Such a practice is unconstitutional, being replaced by various other forms of recovery, still no consensus on how best to do it. It has tried to correlate the production of waste with consumption of water, electricity, etc. Only a tax reform that could exploit the municipalities to redress of a socially just, for cleaning services provided to urban population.

The remuneration of the urban cleaning system is not so direct, or the resources arising from payment of fees for collecting garbage can be conditioned only to the system, due to tax laws. Similarly, the city may not charge the residents a sweeping and cleaning of the street as a single service. We must therefore ensure that the city, by political means, the budget allocations to support adequately the costs and investments in the system.

Regarding the taxpayers, there are few legally possible solutions to circumvent the situation. The cuts commonly used in the supply of light or water, lack of payment of the fee cannot be applied in the collection or removal of garbage. Failure to pay the tax of garbage, for example, cannot be fought with the suspension of the service and care to delinquent taxpayers, because the garbage that has to be collected it must be collected in any manner for reasons of public health. While application of legally questionable in some cases is used for registration of the property of the debtor in debt the city. Even so this act has little power punitive, because only the debtor in threat at the possible sale of the property.

According to local authorities the rate of garbage collected from the population of Novo Hamburgo is not sufficient to cover all costs in the supply chain management of solid waste. The complementation is done through the budget of the Secretariat of Environment, which has resources from Municipal Treasury (Caixa Único).

For making investment, or the purchase of equipment for installation of units of treatment and final disposal, the city may resort to external funding sources (Federal Funds). While there is little legal clarity to guide the provision of public urban cleaning, the outsourcing by hiring private companies to run with its own resources (equipment and personnel) of the collection, cleaning of designations, treatment and final disposal is a possible solution to the municipalities that do not have resources available for investment. This was the option chosen by the city of Novo Hamburgo.

As the financial situation for the management of industrial waste, the balance and sustainability were searched within the universe of its own generators and medical centers for treatment and final disposal, also operated by the private sector. As investment for

these units are high and their licensing bodies with environmental control is a complex process, the system is not balanced.

However, the remuneration of the urban cleaning system is solved in the following equation: Cost = Salary = Features + Collection of the Municipal Treasury rate of collection (TCL) + Collection of Rates and Miscellaneous Income.

### 2.4.2 Federal Funds

The Federal Government through the Ministries of Environment, Cities and Health, finances infrastructure projects, in the area of solid waste. The resources are from the Union Budget (fiscal sphere, parliamentary amendments), or from multilateral credit agencies - FGTS, CAIXA and BNDES - by means of credit lines.

The Federal Government improvements from 2003 to 2005 was the creation of management tools, with draft policies for sanitation and waste: Creation of the Inter-ministerial Committee on Environmental Sanitation headed by the Ministry of Cities, which has rearranged existing programs, from 27 to 5 programs, namely: Urban-City Environmental Sanitation, Rural Sanitation -FUNASA, Sustainable Urban Drainage-MI; Living Semi-Arid-Cities, and Urban Solid Waste -MMA.

The ministries act as the population density of cities. Thus, the Ministry of Health is responsible for funding for municipalities of up to 30,000 inhabitants, funding actions to implement or improve systems for treatment and final disposal of MSW.

The Ministry of the Environment funding planning activities of collection, treatment and appropriate final disposal of MSW for municipalities with up to 250,000 inhabitants.

In the case of municipalities with population over 250,000 inhabitants the input of resources from the Ministry of Cities, and the same for the elaboration of projects for implementation and expansion of systems or MSW for the deployment and expansion of systems for cleaning service, packaging, collection, treatment and final disposal of MSW.

The Ministry of Cities, which requires the council requesting funding already has a Plan of Urban Solid Waste Management - PGRSU whatever the modality of the project.

Now the Ministries of Health and Environment require the existence of a prior to Urban Solid Waste Management Plan (PGRSU) some methods of design. In the "Support to Implementation, expansion, improvement of systems of Public Collection, Treatment and Final Destination for Solid Waste Prevention and Control of disease" is required by the Ministry of Health to submit USWMP (PGRSU), now the Ministry of Cities makes this requirement in the "Supporting the Development of Projects for Implementation and Expansion of Urban Solid Waste Systems."

Following presents a summary of activities financed by these ministries. In publication the Ministry of the Environment entitled "Plans for Integrated Urban Solid Waste: Assessment of the State of Art in Brazil, compared to the situation in Germany and Proposals for an appropriate methodology" published in 2005. More details on the subject can be found at
http://www.mma.gov.br/port/sqa/urbana/index.cfm?submenu=2

*Ministry of Environment*

**i.** Support the Development of Project on Environmental Management of Solid Waste in Urban Areas with population between 30,000 and 250,000 inhabitants;

**ii.** Support for Integrated Urban Solid Waste Management Project in municipalities with population between 30,000 and 250,000 inhabitants;

**iii.** Support for Projects to convert methane emissions into energy resulting from Solid waste;

**iv.** Promote the Project on Management and Disposal of waste in municipalities with populations between 30,000 and 250,000 inhabitants;

**v.** Support for Projects of Integrated Waste Management in Urban Municipalities with Population between 30,000 and 250,000 inhabitants;

**vi.** Training of staff for the Environmental Management of Urban Solid Waste;

**vii.** Information System in Environmental Management of Urban Waste.

*Ministry of Cities*

**i.** Support the Development of Projects for Implementation and Expansion of Urban Solid Waste Systems;

**ii.** Support the deployment and expansion of Cleaning Service systems, Packaging, Collection, Treatment and Final Disposal of Urban Solid Waste in Cities with populations more than 250,000 inhabitants or members of Metropolitan Regions;

**iii.** Funding for implementation and expansion of Cleaning Service systems, Packaging, Collection, Treatment and Final Disposal of Urban Solid Waste.

The actions of environmental sanitation in metropolitan areas, implemented in partnership with Ministry of Cities, are designed to promote the improvement of sanitary conditions in areas lacking in infrastructure, through increasing coverage and improving the quality of water supply, sanitation and solid waste, contributing to reduce morbidity caused by diseases associated with deprivation and disability of environmental sanitation service.

*Ministry of Health (FUNASA)*

**i.** Establishment, extension or improvement of the System of Collection, Treatment and Final Destination of Solid Waste for the Prevention and Control of Diseases in municipalities up to 30,000 inhabitants or at risk of transmission of "dengue";

**ii.** Support the deployment, expansion, improvement of system of public Collection, Treatment and Final Destination for Solid Waste, Prevention and Control of Diseases in Municipalities with population over 250,000 inhabitants or in Metropolitan Regions, together with the Ministry of Cities.

*Criteria for Conclusion of Agreements*

The criteria to be established with agreements between the ministries and the municipalities listed above can be found in "Manual for Collection of Resources", available at http://www.mma.gov.br/port/sqa/urbana/doc/manual.pdf

The main information is described, briefly, below:

**Eligibility of the municipality**

**a)** Municipalities that have joined the Garbage and Citizenship Program (eradication of Infant work in dumps);

**b)** Municipalities that have signed Terms of Adjustment of Conduct on Solid Waste with the prosecution.

**Priority Support**

**a)** Municipalities that have Human Development Index - HDI equal or less than 0.75(2000);

**b)** Cities that have had positive results in programs of withdrawing children from landfills, according to information from UNICEF;

**c)** Municipalities that have developed with the participation of Civil Society, Integrated Urban Solid Waste Management Plan;

**d)** Municipalities that have specific legislation on solid waste;

**e)** Municipalities that have in regular operation, the Municipal Council of Environment or Urbana cleaning Council;

**f)** Municipalities that have any form of recovery for costs of urban cleaning services;

**g)** Municipalities that have associated or proposals that favor some form of association;

**h)** Municipalities whose favor proposals of reduction of the generation, recycling and reuse of waste;

**i)** Municipalities that have the phases of the system, developed and applied directly by the City Hall;

**j)** Municipalities served by the Zero Hunger Program (Programa Fome Zero);

**k)** Municipalities that participate effectively in the Watershed Committee;

**l)** Municipalities members of the Project Watershed Revitalization of the "Rio São Francisco";

**m)** Municipalities located in the area of influence of Highway BR163;

**n)** Municipality classified by EMBRATUR as touristic and potentially touristic area;

**o)** Cities included in the program "MONUMENTA" of the Ministry of Culture/BID, or in the general list of the Institute of Historical and Artistic Heritage as National Historical Sites for National Urban or Urban Collections of National Monuments.

**Objects Funded**

- ✓ Implementation of works of Sanitary Landfill, including equipment for landfill operation, Health and environmental recovery of areas degraded by landfill;
- ✓ Implementation of waste treatment units, including civil works, materials and equipment;
- ✓ Implementation of the Collection System, including the purchase of vehicles and equipment for packaging (for baskets and containers for Sites or points of Volunteer Delivery (PEV)installed in public designations);
- ✓ Equipment for landfill operation;
- ✓ Facility for sorting of solid waste for the collectors/pickers of recyclable waste;
- ✓ Plan for Integrated Solid Waste Management;
- ✓ Projects of technical training in the area of municipal wastes.

*Financial Sustainability*

The release of resources of the institutions of the federal government for municipalities shall be subject the existence of legal instruments to regulate and charge for services, and as a specific

budget to cover the operation of the units deployed as way to ensure the sustainability of the system. That sustainability should be seen in a comprehensive manner involving the environmental dimensions, social, cultural, economic, political and institutional. This means involving the legislative and local communities in order to obtain the resources and ensure continuity of activities, identify technologies and appropriate solutions to the local reality.

To obtain resources from the federal government is required by "FUNASA" the presentation of documents after the approval of prior consultation. The main documents and procedures are presented in http://www.mma.gov.br/port/sqa/urbana/doc/manual.pdf

## 3. TARGETS

In developing objectives and deciding what priority should be assigned was considered the stakeholders' concerns during the data/information collection, as follow:

| | |
|---|---|
| **OBJECTIVE 1** | Through waste minimization to reduce the effects of waste and cost of waste management |
| **OBJECTIVE 2** | To protect and enhance the public health of the community |
| **OBJECTIVE 3** | To protect the environment |
| **OBJECTIVE 4** | To assist economic development through industry/business |
| **OBJECTIVE 5** | To promote social inclusion through creating employment with the organization of recycling/processing chain |
| **OBJECTIVE 6** | To educate and motivate the community on solid waste |

The targets to achieve the objectives set for NH ISWM Plan were taken back to the workshop participants for confirmation before proceeding to develop action plans.

**Short Term (2010 – 2015):**

| | **ISW** (+ healthcare) | **MSW** (service + commercial + residential) | **C&DW** |
|---|---|---|---|
| **Reduction at source** | -10% | -5% | - 10% |
| **Hazardous segregated** | 100% | 100% | 100% |
| **Organic segregated** | 80% | 50% | ----- |
| **Recyclable Segregated** | 80% | 70% | 80% |

**Long Term (2015 – 2030):**

All the targets, set for short term (by 2015), will also be applicable in 2030, except the following targets for material recovery at transfer stations and level biological treatment for resource recovery:

- ✓ 90% of inorganic wastes sorted at transfer stations for material recovery.
- ✓ 90% of organic waste is composted and biogas is recovered.
- ✓ 80% of construction and demolition waste is recovered at local facilities.

# 4. STAKEHOLDERS' ISSUES OF CONCERN

Fundamental to ISWM is that all stakeholders are involved and participate in the planning and implementation processes. It is essential to let people participate in the process and recognize an active role for communities and small and medium enterprises in the operation and management of waste systems.

Within this context, for ISWM Plan for NH preparation, the diversity of stakeholders that participated on workshop consultation can be characterized as:

Involvement and participation of all the stakeholders in the system, including communities and the informal and formal sector; public health and sanitation departments, non-governmental organizations, external funding agencies, waste scavengers, specialists from local universities, sanitary engineers, Labor Union representative, Union of Enterprises of Construction and officials from Municipality, as concerns expressed below.

*Sorting and material recovery from municipal waste:*

- It was suggested that currently there is no formal selective collection; hence this will help to increase the rate of recycling and also provide jobs and better working conditions through formal sector.
- The selective collection depends on the awareness of the population.
- There was a concern about the demand for recycling materials, and it was suggested to formulate strategies to increase the demand.
- There was a concern that sorting and material recovery cost could be more than the earnings from sale of recycling materials; therefore, a strategy should be adopted to either reduce the costs for sorting and material recovery or to increase the demand/price through price regulations for raw materials, etc.
- The sanitary engineers expressed that the used toilet tissue should go to the sewer to avoid pathogenic problems, since the worst is the handling.
- The government, in response to requests from stakeholders for infrastructure for the composting of organic, explained that

they already have financial resources available to begin expansion of the composting plant.

- Recyclers said that is possible for them to receive the 50% of the volume target to be recycled.
- The teachers expressed concern in placing those targets in strong system of continuing education.
- A general concern is the continuity of the actions of the Plan and its monitoring by the local government.

*Treatment and disposal of municipal waste:*

- The stakeholders expressed concern on the lack of infrastructure and basic conditions of hygiene, safety and health of the transfer station.
- The government, in response explained that economic efficiency, social inclusion and environmental protection are the important priorities and policies will be formulated accordingly.
- It was suggested that a study should be done to assess the technologies and feasibility for biological treatment of food waste.
- There are reports that the organic waste from restaurants was taken to rural area generating zoonosis - public health. Researchers suggest a strategic planning in the area for animal and human. Today we have over 1000 animals being fed scraps of food. The problem with composting is the glass, then it can be used for parks and gardens should not be used for agriculture.
- The manager of the landfill, which serves the municipality mentioned that current capacity of landfill is high. So it does not represent any limitation for the next 30 years.
- The director of the company that handles the collection and transportation of municipal waste, mentioned that his company can adjust for the plan' targets within 4 months, if necessary.

*Treatment and disposal of industrial and healthcare Waste:*

- The operator of hazardous waste management suggested that the cost of treatment and disposal is rising, but it is difficult to raise the price for the customers. It is also difficult to recover some waste of leather because the rigidity of law.
- It was suggested more research on the engineering of materials and identification of new technologies for use of industrial waste from footwear and furniture sectors.
- It was suggested that a study on the rural area should be done, particularly to identify areas impacted by local industries.

*Treatment and disposal of Construction and Demolition waste:*

- The volumes of waste produced by informal constructions are very high which complicates the process of collection and disposal. Important to create a political mobilization, already discussed with the previous and current mayors. There should be a policy of continuity of government programs, with the support of the Union of Construction Industries.
- 4,000 trucks per month of waste from construction illegally disposal, according to the municipal representatives. They are seeking a solution, but as places for deposit of inert in the city were closed by judicial order, the generators say they rely on licensed area to deposit their waste properly and thus depend on the help of City Hall.
- The President of the Union of Construction Industries was very concerned about the lack of political will of the municipality to establish a partnership in solving the disposal and recovery of construction and demolition wastes. Over 80% of C&DW can be recycled.

# 5. INTEGRATED SOLID WASTE MANAGEMENT (ISWM) PLAN

## 5.1 Generation, Collection and Transportation

***Waste Inventorisation***

- ✓ Develop procedural requirement inventory mechanisms for the recording of waste generated.
- ✓ Provide adequate and ongoing funding and support the inventory process.
- ✓ Develop policy and strategies aimed specifically at promoting inventories.
- ✓ Support national efforts to promote awareness of waste generation issues advise on inventory methods and practices.

### 5.1.1 Strategies for Reducing Waste

The targets listed above in the section III are set for the reduction of waste, with reference to current levels, through various policies and voluntary measures. These measures are suggested at level of waste generation. The important measures in terms of generation to reduce the disposal of waste are focus on reducing and reusing waste. Policy measures, both regulatory and fiscal, are a vital part to address all the waste generation sources, including residential sector, commercial sector, industrial sector, and hospitals. In addition to the policies, awareness raising leading to voluntary actions is a key measure to reduce and reuse waste at source.

### 5.1.2 Policies for reducing waste at source and reuse

To encourage waste reduction and reuse, the specific regulations and/or fiscal policies are needed for different sources of waste generation and waste types. A combination of following policy

measures may encourage waste generators in Novo Hamburgo to reducing waste at source:

*Municipal waste from residential areas:*

- ✓ Minimize wastes through: source reduction, through the increase in the use of locally produced goods, the use of goods with low amounts of packing, and reuse, by purchasing reusable products and adapting wastes to alternative uses.
- ✓ Develop a coordinated approach to waste minimization through improved coordination within the government sector as well as between the government and non-government sector
- ✓ Promote awareness of, and advise on, waste minimization methods and practices.
- ✓ Encourage community involvement at the local level so that they understand the principle and accept the need for waste minimization.
- ✓ Develop local business incentives to promote the sale/use of products with low amounts of, or reusable packaging.

### 5.1.3 Voluntary actions for waste reduction and reuse at source

Voluntary actions through awareness raising and capacity building are useful to achieve the targets for reduction and reuse of waste at source. These voluntary measures are also useful for the transition to implement a new regulatory or fiscal policy.

A combination of the following voluntary measures may encourage waste generators in Novo Hamburgo to segregate waste at source:

*Municipal waste from residential areas:*

Voluntary measures of waste generation at household level, on monthly basis, to develop a waste generation chart, and then chalk out voluntary measures at household level to reduce waste:

- ✓ Payback system for electronic appliances, furniture and other items, which could be recycled. This payback can be either in cash or in terms of providing handling and transportation of these items.
- ✓ Retailers of consumer goods, including electronics and furniture to take back the old items and provide discount on the new items.
- ✓ Payback on soft drink empty cans and bottles.
- ✓ Take back packaging after delivery of consumer goods.

*Municipal waste from commercial areas:*

- ✓ Similar voluntary actions, as suggested for municipal waste from residential areas.
- ✓ Voluntary measures for reduced packaging at super markets, reduced consumption of paper at offices, and efficient handling of perishable items including vegetables and fruits.
- ✓ Publicize the economic benefits of waste minimization.

*Industrial waste:*

- ✓ Similar voluntary actions, as suggested from municipal waste, from residential and commercial areas.
- ✓ Voluntary measures to improve resource efficiency and reuse to the reduction of waste generated in the production process.
- ✓ Look for the support of the *Forum Gaucho of Sustainable Production and Consumption* for implementation of Cleaner Production Programs for industry sectors.

- ✓ Promote source reductions through implementation on promotion of appropriate technologies for cleaner development.
- ✓ Introduce appropriate economic instruments.
- ✓ Encourage the adoption of regional and international agreements.

*Awareness raising and capacity building:*

- ✓ Awareness raising package for all stakeholders to raise the awareness on the need to reduce and reuse waste and to strengthen their understanding of their role to be part of strategies to reduce and reuse waste.
- ✓ Capacity building on various measures of volunteer activities and actions for residential, commercial and industrial sectors.
- ✓ Promote source reductions and reuse techniques through community education awareness programmes to adopt appropriate consumption patterns.

### 5.1.4 Strategies for segregation at source

Hazardous waste must be separated at source, as the mixing of even a small quantity of hazardous waste with non-hazardous waste may contaminate all the waste. The other approach is to segregate organic waste from the rest of the waste at source. The following regulatory and fiscal policies, voluntary actions and technological measures will help achieve these targets.

### 5.1.5 Policies for segregation at source

Based on the targets to separate hazardous and non hazardous waste at source and to separate kitchen waste (organic waste) from

other wastes, the following regulatory policies and fiscal incentives and disincentives could be introduced:

- ✓ Regulations banning the mixing of hazardous waste with non-hazardous waste.
- ✓ Regulations for the appropriate disposing kitchen waste (food) in separate bags or bins.
- ✓ Providing free collection system (bins) for hazardous waste from residential sources.
- ✓ Collection of recyclable waste (plastic, paper, etc.) from households and after selling the recyclable waste, some proportion of earnings can be handed to residents (or Association of Neighborhoods) as an incentive.
- ✓ Providing free bags (or collectors) for disposing food waste for (organic), and cost of the bags and transportation could be recovered from the compost plants - or the cost of bags can be cross-subsidy from the earning for the waste bags for other waste.
- ✓ Establishment of monitoring system by residents' committees for segregation at source.
- ✓ Reduced monthly charges from households related to practice of segregation at source by residents' committees.
- ✓ The new residential condominiums may be given a choice to be charged as big container/skip as the office of residential condominiums can collect the waste collection fee from their residents.
- ✓ The regulations and policies for segregation at source are already in place for industrial and healthcare waste. Strict enforcement of these regulations and policies would ensure that

the waste is segregated at source and hazardous waste is not mixed with non-hazardous waste. Enforcement for appropriate handling, collection and transportation is also required for industrial and healthcare waste, including hazardous waste.

- ✓ Develop, fund and promote individual/community based development of processing facilities, including: composting, methane capture, can, plastic, paper and debris recycling.

- ✓ Educate those involved in private and community based facilities with respect to basic health, hygiene, safety standards and practices.

### 5.1.6 Voluntary actions for segregation at source

Voluntary actions are useful to complement the regulations and fiscal policies. These are also useful as a transition towards implementation of regulations and fiscal policies. To promote voluntary actions, awareness raising and training are very important to motivate the stakeholders and to build their capacity for such actions. The following voluntary actions are suggested:

- ✓ Residents' committees and voluntary groups to encourage generators to segregate waste in accordance with organic waste (food and yard), mixed waste and hazardous waste.
- ✓ Holding regular meetings and informal monitoring by volunteer groups - awareness for residents' organizations.
- ✓ Volunteer groups for awareness raising.
- ✓ Identify/create outlet markets for recycled wastes.
- ✓ Promote awareness of processing and advising on appropriate methods and practices.

### 5.1.7 Technological measures for segregation at source

The segregation at source requires good bins or bags for each type of waste, including non-hazardous waste, organic waste (food and yard), mixed waste and hazardous waste. The technological measures that follow are designed for effective and efficient segregation at source:

*Municipal waste from residential areas:*

- ✓ Transparent plastic bags provided by the collection service for residents to make the separation of organic waste - special plastic bags can be made for collection of waste.
- ✓ Bins for hazardous and mixed waste provided by the collection service or residents' committees.
- ✓ Community bins/skips for the collection of segregated waste at source (hazardous, mixed and organic waste). For residential condominiums, a collector box can be provided for residents to put their bags with waste. The current waste collection points for new residential condominiums can be updated by fencing and partition for organic and non-organic waste bags. The collection points for old houses streets can be constructed at points where most of the households do not need to walk more than 100 meters to put their waste bags.
- ✓ Marked bins for hazardous waste at appropriate points.
- ✓ Big and heavy items (more than 50 cm in any dimension and/or 5 kg weight) should not be thrown with regular waste.

*Municipal waste from commercial areas:*

- ✓ Similar bags to those used for domestic waste for small commercial entities and offices - Small commercial entities can

be described as small shops and individual food and vegetables sellers on streets (excluding big market).

- ✓ Mini skips or jumbo bins of various sizes (from $2m^3$ to $5m^3$) for different types of non-hazardous wastes (for example food waste from restaurants or packing from supermarkets).
- ✓ Special marked/colored bags or containers for hazardous waste.

*Industrial waste:*

- ✓ Mini or big skips (from $2m^3$ to $30m^3$ or more) for different types of non-hazardous wastes.
- ✓ Special marked/colored containers for hazardous waste. Industrial sludge is also considered hazardous and dry sludge must be transported in special bags.

### 5.1.8 Strategies for Collection and Transportation

The collection and transportation is the most crucial stage as most of the budget for solid waste management could be spent on these activities, and deficiency in these stages could affect the effectiveness and efficiency of the whole solid waste management process. Keeping in view the targets and stakeholders' concerns, specific policies, voluntary actions and technological measures may be required:

### 5.1.9 Policies for Collection and Transportation

The policies for collection and transportation must address various issues, including frequency of collection, timing of collection, type of collection vehicle and charges for collection for different types of waste and for different sources:

*Municipal waste from residential areas:*

- ✓ Daily collection of organic waste (food) from community skips/bins from all the streets and from enclosed waste storage areas for residential condominiums.
- ✓ Weekly collection of recyclable, hazardous waste and other wastes.
- ✓ Big and heavy items can be collected based on request, with separate collection charges payable to the waste collection company.
- ✓ Waste is collected early in the morning or late in the evening to avoid congestion on the roads.
- ✓ Waste collection vehicles from residential areas to transfer station or treatment plant: rear loading commercial covered trucks.
- ✓ Collection charges to be covered from the cost of bags for other waste, earning from the sale of organic waste for composting plants and earning from sale of recyclable waste - Guidelines for cost estimation are provided as Annex C.

*Municipal waste from commercial areas:*

- ✓ Daily collection of all types of waste with separate vehicles for organic waste, recyclable waste and non-recyclable waste - Collection of waste from commercial sources is preferred after the closing time of markets and others commercial entities.
- ✓ Collection and disposal charges based on the number and size of the skips/bins for non-recyclable waste - payable directly to the collection company.

- ✓ Higher collection and disposal charges for hazardous waste - payable directly to the hazardous waste management company.
- ✓ Lower collection charge for recyclable and organic waste, according to the earning from sale of composting plant and sale of recycling waste - payable directly to the collection company.

*Industrial waste:*

- ✓ Generators of waste are responsible to arrange the services of collection and disposal for industrial waste through the waste collection and disposal companies aligned with the prevailing system.
- ✓ Government may further strengthen its regulatory and monitoring role to check illegal dumping of waste, proper handling of all types of waste in accordance with their characteristics and to continuously collect information on the quantification and characterization of the waste to promote recycling and exchange of waste - Concept of Eco District.

*Overall - for all sources and types of waste:*

- ✓ National and local standards and regulations apply for collection vehicles for transporting organic waste, recyclable waste, non recyclable waste and hazardous waste.
- ✓ National and local regulations for safety and maintenance of vehicles, including noise and air pollution, leakages and cleanliness of collection vehicles.

### 5.1.10 Voluntary Actions for collection and transportation

The collection and transportation of solid waste is a regulated activity. Nevertheless, the following voluntary actions that help to

improve its efficacy and efficiency and can minimize negative impacts on the environment:

- ✓ Voluntary groups to motivate and monitor the punctuality in putting the waste at appropriate places in the correct manner to be collected and transported.
- ✓ Respect for sanitary workers and waste collectors to motivate them to work efficiently.
- ✓ Avoid creating congestion for waste collection vehicles.

### 5.1.11 Technological measures for collection and transportation

The selection of appropriate collection equipment, including types of vehicles is important for better efficiency and lower environmental impacts from the activities of transporting waste. The types of vehicles may vary according to type of waste (organic, recyclable, non recyclable and hazardous waste) and quantity of waste, which needs to be correlated with the frequency of collection.

*Residential waste:*

- ✓ Vehicles for collection of recyclable waste from residential areas to transfer station or treatment plant: rear/side-loading commercial covered trucks.
- ✓ Vehicles for collection of non recyclable waste from residential areas to transfer station or treatment plant: compactor trucks.
- ✓ Vehicles for collection of organic waste from residential areas to transfer station or treatment plant:
- ✓ If one type of waste is not substantial in quantity, then the collection vehicle with two compartments will be used.
- ✓ Identify and assist in the introduction of technologies which are suited to individual circumstances and needs.

- ✓ Support national efforts to advice on collection methods and best practices.
- ✓ Provide adequate centralized collection points to facilitate collection and handling where community collection exists.

*Municipal waste from commercial areas:*

- ✓ Vehicles for collection of recyclable waste from commercial areas to transfer station or treatment plant: rear or side loading commercial covered trucks or recycling hauler.
- ✓ Vehicles for collection of non recyclable waste from commercial areas to transfer station: rear or front loading compactor trucks.
- ✓ Vehicles for collection of organic waste from commercial areas to transfer station or treatment plant: compactor trucks with leakage proof system.
- ✓ Provide adequate centralized collection points to facilitate collection and handling where community collection exists.

*Industrial waste:*

- ✓ Vehicles for collection of recyclable waste from industrial areas to transfer station or treatment plant: rear or side loading commercial covered trucks or recycling hauler.
- ✓ Vehicles for collection of non recyclable waste from industrial areas to transfer station or treatment plant: rear or front loading compactor trucks.
- ✓ Vehicles for collection of organic waste from industrial areas to transfer station or treatment plant: compactor trucks with leakage proof system.
- ✓ Identify and assist in the introduction of technologies which are suited to individual circumstances and needs.

### 5.1.12 Operational Plan for collection and transportation

The Operational Plan for collection and transportation from generation point to transfer station or treatment plant is determined based on decisions on what is to be done with the collected waste and how much would the cost be for transportation between two points (collection to transfer station or treatment plant.

Keeping in view the initial target of segregation of 50 per cent of organic waste and the concerns of stakeholders with regard to the difficulties in meeting this target, three overall options can be outlined: for very optimistic situation (100 percent segregation of organic waste), targeted situation (50 percent segregation of organic waste) and situation based on stakeholders' concern (not segregation - mixed waste, at least for initial few years:

**I.** Transporting of organic wastes directly, bypassing transfer for composting plant and transporting other waste to transfer station for sorting and material recovery for recycling.
**II.** Transporting of 50 per cent of organic waste directly, while all other waste and 50 per cent of organic waste is transported to the transfer station for sorting.
**III.** Transporting all the waste to transfer station for sorting.

All of these three options are based on the same baseline information, which was collected and projected by IVB Project Team.

Amount of waste from residential and commercial sources is about **177** tons/day which will increase to **180** tons/day in 2015 and up to **207** tons/day in 2030. Out of this, organic waste is **100** tons/day, which will increase to **102** tons/day in 2015 and up to**107** tons/day in 2030. The other waste, including papers and plastics, is

**77** tons/day, which increase to **78** tons/day in 2015 and up to **100** tons/day in 2030.

Waste collection in NH is carried out by one transfer station. Waste for landfilling is transported out of NH to a sanitary landfill located 130 km away from NH Municipality. The recycling sorting facility is located inside the transfer station and small recycling businesses are situated in different points of the city. Two private landfills for industrial waste are available for NH Industries. Hazardous waste treatment and disposal facilities are located outside NH Municipality. Current waste generation and collection rates is shown in Tables 27 and 44. Total waste generation, its breakdown in organic waste, recyclables and mix waste with future trends is shown in Table 44. Composition of municipal waste is shown in Table 25.

**Option I: Segregation of all organic waste from other waste**

If waste is well segregated at source, then transfer station could be bypassed and all organic waste can be directly transported to organic treatment plant. For this option, the underlying assumption is that waste segregation is in line with the standards. The other waste is first taken to transfer station and then sorted as recycling and non-recycling waste, which is transported to disposal sites (landfill).

There is no organic waste treatment plant to convert organic into a resource such as compost, biogas, ethanol, bio-methane, etc. It is assumed that an organic waste treatment plant will be constructed. It is also assumed that this organic waste treatment plant is located near transfer station. This location would also be useful if organic waste is of low quality and/or the compost is not suitable for agriculture, in which case, the waste/compost can directly transport to landfill with the non-recyclable waste. This would help to avoid emission problems, which are normally encountered when

organic waste is directly sent to a landfill, without prior biological treatment (composting).

**Option II: Segregation of 50% of organic waste**

If some areas, where organic segregation has not yet picked up quite well, then the organic waste from areas, where segregation is being practiced, can be directly transported to organic treatment plant. For this option, the underlying hypothesis is that waste segregation is in line with the standards for about 50% of areas within NH. The other waste is first taken to transfer station and then sorted as recycling and non-recycling waste, which is transported to disposal sites (landfill).

**Option III: No segregation – all mixed waste**

Under this option, all the waste is transported to transfer station for sorting to recovered recycling waste. First assumption is that as all the waste is dirty and mixed, only 5% recycling waste is recovered. Second assumption is that all the waste is transported to landfill.

**Note:** As NH Municipality has a contractor for collection and transportation of MSW, based on the above options appropriate operational plans should be requested by the SMAM waste director.

**TRANSITION FROM MIXED WASTE TO SEGREGATED WASTE**

It is highly probable, that transition from current mixed waste collection (Option III) to segregated waste collection (Option I or Option II) may take a few years. To accommodate this transition time in the planning for collection and transportation of municipal waste from commercial and residential sources, the system could be

designed for mixed waste (Option III) for few initial years and then for 50 percent organic waste segregation (Option II) and finally for 100 percent segregation of organic waste (Option I).

*Municipal Solid Waste from Industries*

Organic waste in industries is usually generated at restaurants; hence it could be easily segregated at source. This segregation at source can help to recover most of the recycling waste, especially plastic, paper, rubber and metals. Assuming that a cleaner production program will be implemented in NH industrial sector, 80 percent organic waste from industries will be segregated and about 80 percent waste is recovered for recycling, then a insignificant part will be left for treatment and disposal. This remaining waste would only require one trip a day; however, keeping in view more collection time required to cover all the industries, one dedicated vehicle of five tons could be sufficient.

*Construction and Demolition Waste*

In NH, construction and demolition waste is generated from two sources: New constructions and demolition/reforms (Fig. 05 and Table 40). However, most of the waste is not segregated properly within this sector. Once the generator is responsible for this type of waste, NH government does not foresee the need to make an operational plan for construction and demolition waste.

*Sludge from Wastewater Treatment Plants*

Currently there is no wastewater treatment plant in NH Municipality.

*Hazardous Waste Collection System (Hospitals and Industries)*

Currently, there are two qualified enterprises for the collection and disposal of hazardous waste from industry: Ultresa and Fundamental.

Hazardous waste from healthcare is about 454 tons/annum, and from industries is about 5,350 tons/annum. With additional the policy, technical and voluntary measures (presented in previous sections), current operations for collection and disposal of hazardous waste can continue.

A strict monitoring system should make sure that hazardous waste is not mixed with non-hazardous waste by any chance and proper collection and handling of each type of hazardous waste is in line with the standards.

*Industrial Waste Collection*

Most of the non-hazardous industrial waste from processing activities is collected by small recycling companies, sometimes without any charge. Hence, NH is not required to provide additional services for collection of industrial waste.

## 5.2 Sorting, Treatment and Disposal

### 5.2.1 Strategies for Transfer Station and Sorting for Material Recovery

Municipal waste is the only waste that is transported to transfer station from residential and commercial sources. Industrial processing waste is segregated at source for material recovery. Industries are themselves responsible to sell the recycling waste and manage the residual waste on their own. Therefore, the policy, technological and volunteer measures for transfer stations are in line with the quantity

and composition of municipal waste and the targets for material recovery from municipal waste. The recyclable waste, separated from mixed waste at transfer station, will increase the amount of already available recyclable waste and will raise the possibility for growth in recycling-based industries.

The important targets for transfer station are to sort at least 50% of waste by 2015 and 90% of waste by 2030. With the segregation of organic waste at source, most of plastic, paper, glass and metal waste could be recovered as "clean" recyclable waste. In addition to material recovery, the other function of transfer station is compaction and/or baling of residual waste for onward transportation to the disposal site. Following policy, technological and volunteer measures will help to maximize resource recovery at transfer station as well as to improve the efficiency in transporting waste to a treatment/disposal site.

### 5.2.2 Policies for transfer station

Policies for transfer station are aimed to achieve the desired objectives of the ISWM Plan as follows:

- ✓ To promote social inclusion through creating employment with the organization of recycling/processing chain
- ✓ To assist economic development through industry/business
- ✓ To educate and motivate the community on solid waste
- ✓ To reduce the cost of waste management

In line with policies for environment and public safety some rules should be observed:

- ✓ Hazardous waste is not allowed at the transfer station
- ✓ National and local work related safety regulations should be followed at the transfer station

- ✓ Environmental safety regulations should be catered at the transfer station and second level contamination should not be permitted. Accordingly, pollutant emissions, noise and odour should be within the limits set by the standards/regulations
- ✓ Remove all waste delivered to the facility by the end of each day and clean the receiving floor daily
- ✓ Design safe roads to the transfer station avoiding work accidents with the transportation's employees

### 5.2.3 Voluntary measures at transfer station

- ✓ Awareness raising and environmental education facilities for communities
- ✓ Arrangement of visits for students and communities to know the process and benefit of resource recovery and environmentally sound technologies

### 5.2.4 Technological measures at transfer station

Improvements in existing transfer station to perform their functions with appropriate technologies should be done, based on the detailed calculations for waste segregation at source for food waste, and the amount of waste for collection and transportation to transfer station.

- ✓ Proper equipment for manual separation of materials should be installed. This usually includes a sorting belt or table and containers for storing the separated materials
- ✓ Mechanical separation could be considered for the sake of higher efficiency and workers' safety. This will include installation of equipment for size reduction, classification, screening, magnetic separation, etc.

- ✓ Selection of technology should be based on a structured methodology covering all aspects (technical, economic, social and environmental)
- ✓ Waste compactors should be used at transfer stations to compact the waste before transporting to treatment/disposal sites
- ✓ Bailing systems should be installed for bailing voluminous materials such as cardboard, magazines, paper, plastics, aluminum cans, steel cans, copper, etc.

### 5.2.5 Strategies for Biological Treatment

Since the major portion of the waste is organic it is important that we have a treatment facility in operation to treat the wastes at the transfer station area. The treatment technologies selected in the case of NH is limited to biological (bio gas & composting) due to nature and volume of waste. Suitable policy measures, voluntary actions and technological interventions are important to try out this treatment facility successfully as this treatment plant will become the major solution to organic wastes.

### 5.2.6 Policies for Biological Treatment

- ✓ Supportive policy frame work to encourage use of digestors for producing biogas from organic wastes
- ✓ Environmental and safety standards to be stipulated for biogas plant/compost plants
- ✓ Hazardous waste should not be allowed at the treatment plant

### 5.2.7 Voluntary Actions

- ✓ Citizens groups to promote use of biogas and compost made from wastes

- ✓ Develop a Marketing mechanism for selling of enriched compost fertilizer

### 5.2.8 Technological Measures

- ✓ Develop a model Biogas/compost plant for others to learn
- ✓ Develop a biogas portable storage container/cylinder for transport by households from biogas generating station
- ✓ Establish a knowledge centre to promote technologies to communities on treatment of wastes for recovery of energy/fertilizer

### 5.2.9 Strategies for Reuse, Recycling and Resource Recovery

The major thrust in the ISWM plan will be to recover as much as wastes possible from the wastes generated. Therefore a very high priority will be given to the reuse/recycling and recovery of resources from wastes.

### 5.2.10 Policies for Reuse, Recycling and Resource Recovery

- ✓ Supportive policy framework to encourage people to use recycled materials and products
- ✓ Economic Incentives to investors for establishing recycling plants for recovery of resources
- ✓ Curricula changes in educational system to include natural resource conservation
- ✓ Develop guidelines and standards for recycled materials and products
- ✓ Development of Pilot Projects that will generate new business for the local recycling market, based on local market and laboratory studies.

### 5.2.11 Voluntary Actions

- ✓ Awareness among community on economic and environmental benefits of reusing and recycling of materials
- ✓ Initiatives at School levels to educate and encourage students to become champions in reusing and recycling
- ✓ Training of potential small scale industrialists on starting up recycling of wastes

### 5.2.12 Technological Measures

Set up a model recycling plant for each type of recoverable waste, considering the possibility to implement a eco district at transfer station area.

### 5.2.13 Final Disposal

It is anticipated that residual waste for final disposal will not increase substantially, if targets for segregation of organic waste at source and its biological treatment for resource recovery. In this case, the current private landfill may continue to cater the needs of NH Municipality.

## 5.3 Environmental Benefits of ISWM Plan

A separate manual could be developed to assess and quantify environmental benefits of implementation of ISWM Plan in Novo Hamburgo. The major benefits will be gained in the following areas:

- ✓ Reduced amount of waste due to 3R (reduce, reuse, and recycle) and segregation at source resulting in reduced number of trips for waste transfer

  – benefits in terms of reduction in local air pollution and GHG emissions

- ✓ Increased level of material recovery (recycling) at transfer station
  - benefits in terms of savings in environmental resources
- ✓ Increased level of resource recovery such as compost
  - benefits in terms of savings in production of chemical fertilizer and improvements in fertility of soil
- ✓ Increased level of energy recovery (gas/fuel/electricity) at treatment plant
  - benefits in terms of savings in imports of gas, petroleum and electricity
  - benefits in terms of reduced amount of GHG emissions due to reduced burning of fossil fuels
- ✓ Reduced level of waste disposal at landfill
  - reduced amount of GHG emissions and land
  - benefits in terms of saving in fuel for transportation

# 6. MONITORING AND FEEDBACK MECHANISM

## 6.1 Introduction to Key Performance Indicators

ISWM Plan for Novo Hamburgo needs to achieve several goals and objectives during its period of implementation. The successful achievement of short term and long term targets which are based on the goals and objectives requires effective monitoring of the performance of each and every scheme developed as a key task of the action plan. The results of monitoring will provide adequate feedback to the decision makers to review the performance and make necessary adjustments or changes to steer the course of the action plan to be more meaningful.

A good monitoring and review process will provide many benefits to all stakeholders such as:

- ✓ Provide information regularly to all stakeholders on the status of the ISWM plan;
- ✓ Analyze the status of the implementation of schemes;
- ✓ Assess the effectiveness of the schemes and whether they lead to achievement of goals and objectives;
- ✓ Modify, change or strengthen the ongoing schemes in the ISWM plan;
- ✓ Develop new schemes to realize the goals and objectives more effectively;
- ✓ Lessons to be learnt on the success of the ISWM plan and share the newly gained knowledge with relevant parties.

Though monitoring is a continuous process, for the purpose of review the plan needs to have time bound performance measurement. This could be achieved by developing a set of Key Performance Indicators (KPI's).

KPI's translate the performance of the Solid Waste Management activities into meaningful and concise quantitative measures which can be either assessed or compared against predefined targets. The KPI's will measure whether the ISWM plan is providing services at desired level through implementation.

The KPIs can be Operational, Financial or Social depending on the relevance of performance to various stakeholders.

The attributes of the **KPI**'s should pass the **SMART** test as described below.

**Specific**

Each KPI should reflect the effectiveness of performance of a specific activity. The KPI's should not be developed to measure integrated or overall achievements of the ISWM. Instead they will indicate the effectiveness of each scheme and provide required information for decision making.

**Measurable**

Each KPI should be based on quantifiable data and therefore the KPI's should be measurable instead of qualitative. There can be KPI's which measure qualitative impacts of ISWM but they will be translated into quantitative measures through data gathered on the output.

**Achievable**

All KPI's are based on achievable tasks and schemes. Some of the schemes which need national and state level decision making will not be measured using KPI's though they are essential for long term sustenance of the solid waste management in Novo Hamburgo and other parts of the country.

**Realistic**

All KPI's are relevant to Novo Hamburgo solid waste management and are derived from the system in place and proposed ISWM. Therefore all KPI's are actionable, realistic, and practical in nature and are outcome oriented.

**Time bound**

All KPI's should be calculated on a monthly or yearly basis. Also this attribute will facilitate the stakeholders to evaluate the progress and continual improvement of the ISWM over time. It will show whether a scheme implemented has been effective during a particular period of time and if inadequate to adapt, modify or change the scheme to a more meaningful activity.

KPI's are developed to show the impact of the proposed ISWM Plan on the solid waste management in Novo Hamburgo. These indicators therefore should be made public and transparent so that all stakeholders will immediately assess the impact of new ISWM in Novo Hamburgo. To achieve the goals and objectives NHM may have to build up partnerships with different parties in and outside of Novo Hamburgo. The KPI's will indicate the effectiveness of these partnerships and NHM could use the indicators for making decisions on the required adaptations, modifications and changes to the partnership. They also can use these indicators as one of the criteria for dissolving existing partnerships or developing new partnerships.

The Key Performance Indicators represent the "check" stage of the PDCA cycle used in management system planning. The PDCA cycle for the proposed ISWM plan for Novo Hamburgo could be drawn as follows:

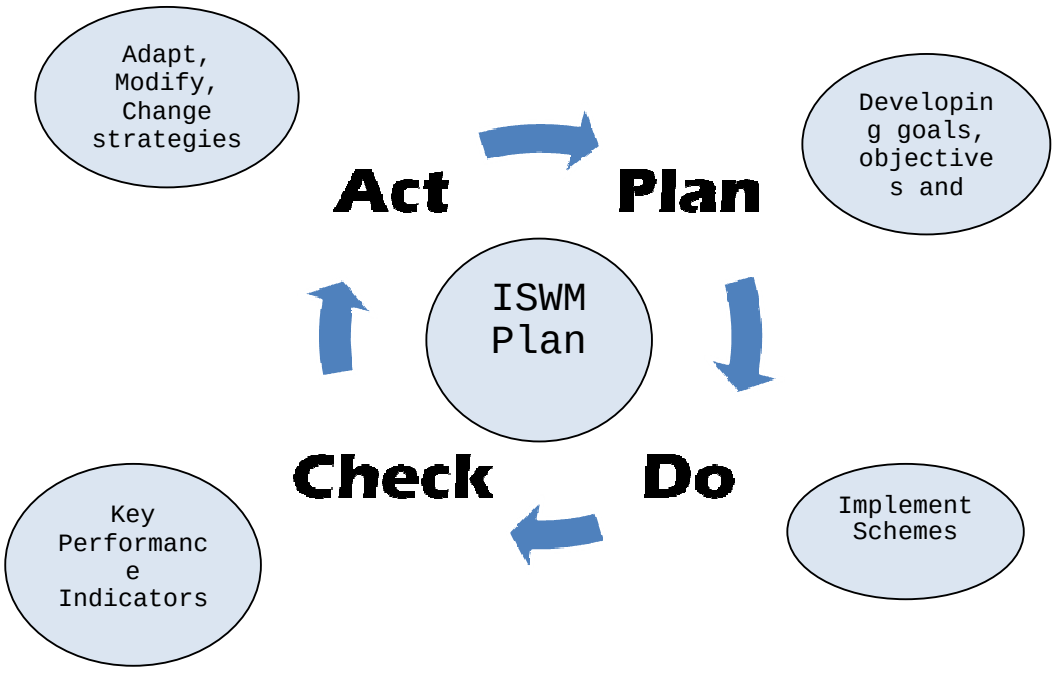


FIG. 10 - Role of KPIs in the Overall Plan Development and Implementation Process

## 6.2 Selection of Indicators

When developing a set of KPI's for Novo Hamburgo a simple and straight forward strategy was used. The NHM has formulated its ISWM objectives and goals to fulfill them. The goals and objectives were then translated into short term and long term targets. Also the achievement of each and every stage of the solid waste Management needs to be monitored to ensure smooth operation and to prevent the breakdown of the proposed plan. Therefore to meet the above expectations following procedure was adopted to develop the KPI's.

- ✓ KPI's will be indicative of operational efficiency, financial diligence and the social satisfaction of the ISWM plan implementation;
- ✓ All KPI's are linked to Goals, Objectives and the short term and long term targets;
- ✓ KPI's are designed for key tasks and schemes in all stages of ISWM;
- ✓ All KPIs are to be translated to quantifiable form;
- ✓ Performance data has to be gathered to calculate the KPI's.

The effectiveness of the KPIs is dependant on the collection and recording of data. Therefore the availability and quality of data will be an important factor. A methodology should be developed to collect data for each KPI. This methodology should be simple and user-friendly to ensure that it is understood by citizens, NHM workers as well as other stakeholders.

All the data gathered should be recorded in simple worksheets designed for that purpose and the format of each worksheet has to be determined after consultation of each user. Every effort should be made to make the data is reliable, complete and consistent and valid.

Occasional spot checks and cross checks are essential to ensure that the methodology is used in an appropriate manner.

### a. The use of KPI's by different Stakeholders

Each of the KPI's developed must ultimately be used by the stakeholders to measure if the activities proposed by the ISWM Plan meet their expectations. The table given below illustrates how each of the stakeholders will use the KPI's during their role in the overall ISWM Plan.

| Stakeholder | How the KPI's will be used |
|---|---|
| Novo Hamburgo Municipality | • Judge the performance of the sanitary employees<br>• To evaluate the effectiveness of strategies<br>• To introduce new processes<br>• Initiate new partnerships<br>• Seek further funding<br>• Rewarding the personnel involved in ISWM |
| State Environmental Council | • Compare performance of different local authorities<br>• To evaluate the effectiveness of the by-laws and other strategies |
| Ministry of Cities | • To decide on allocation of funds for projects<br>• Criteria for rewarding the local authorities excel in the SWM |
| Ministry of Environment | • To link the performance to national Solid waste management program<br>• To provide financial assistance to worthy projects |
| Central Environmental Authority | • Identify gaps in the legal and regulatory systems<br>• Strengthen the existing solid waste management policy frame work |
| Donors/Funding agencies | • Select the projects for funding<br>• Evaluate the project performance<br>• Benchmarking with other projects for future funding strategies |
| Community Based Organizations | • Evaluate the effectiveness of their actions in the ISWM<br>• Seek ways to improve their performance in the ISWM projects |
| Citizen Groups | • Judge the effectiveness of the ISWM<br>• Identify areas of concern for consultation and active participation |

Table 47 - Stakeholder use of KPI's

**b. Selection of Indicators**

The performance indicators were developed based four main areas of concern in the management of solid waste which are, technical, financial, social and environmental issues. These are listed below.

| **Technical** | | | |
|---|---|---|---|
| **Stage** | **Desired Outcome** | **Key Performance Criteria** | **Output Measure** |
| Sorting | • Segregation of large volume of waste | • Availability of containers for segregation (bins/bags) | % households carrying out segregation |
| | | | % waste segregated per day |
| Collection | • Waste collected from larger population<br>• Waste disposed by households and commercial establishments to be collected<br>• Collection of larger volume of solid waste | • Collection equipment deployed<br>• Effective utilization of collection equipment<br>• Higher population served | Total waste collected (per month) |
| | | | Total hazardous waste collected (per month) |
| | | | % equipment used per total solid waste volume |
| | | | % of waste collectors |
| | | | % of population served |
| Transport | | • Transportation equipment used<br>• Number of trips carried out by each vehicle | Total waste transported |
| | | | % community served |
| | | | % of vehicles in use from total fleet |
| Treatment | • More organic waste treated<br>• All hazardous waste treated | • Larger quantity treated | % of waste treated |
| | | | % of hazardous waste treated |
| | | | Quantity of biogas generated and/or |
| | | | Quantity of compost produced per plant |
| | | | Number of households carrying out composting |
| Disposal | • Effective disposal of residual waste<br>• Availability of an engineered sanitary landfill | • No waste left behind in public areas<br>• Longer lifetime of sanitary landfill (even | % reduction in waste taken to sanitary landfill |
| | | | Remaining year of sanitary landfill |

| | | | |
|---|---|---|---|
| | (outside Municipality) | considering the private landfill outside Municipality) | |
| Resource Recovery and Recycling | • More material recovered from waste | • Larger quantity of waste re-used or sent for recycling | Volume of waste re-used |
| | | | Quantity of waste recycled |
| | | | % of waste recycled |
| | | | % of waste recycled into value added products |
| **Financial** | | | |
| **Stage** | **Desired Outcome** | **Key Performance Criteria** | **Output Measure** |
| Sorting | • Reducing cost of providing containers for segregation | • High quality durable containers provided. | Total cost of containers provided |
| | | • Reusable containers provided | % of containers replaced within first year |
| | | • Sponsors for providing containers | |
| Collection & Transportation | • Optimize expenditure for effective solid waste management | • Reduction in expenditure per ton of waste collected and transported<br>• Reduction in expenditure per employee for collection and transportation<br>• Reduction in expenditure for collection and transportation per unit (household/commercial establishment/institution | Cost of collection and transportation per ton of solid waste |
| | | | Cost of collection and transportation per employee |
| | | | Cost of collection and transportation per household unit / institution unit / commercial unit |
| | | | Quantity of fuel used per vehicle per month |

| | | | |
|---|---|---|---|
| | | etc.) | |
| Treatment | • Higher quantity of waste treated | • Increased income generation from treatment of solid waste | Total income generated through treatment plants |
| | | | Income generated through selling compost and/or |
| | | | Income generated through selling biogas |
| | | | Change in energy cost due to usage of biogas |
| | | | % income against expenditure for treatment |
| Disposal | • Reduce expenditure on disposal of solid waste | • Lower cost of disposal<br>• Lower cost of disposal per ton of waste disposed | % cost of operating disposal site from total SWM cost |
| | | | Cost of disposal per ton of solid waste |
| Resource Recovery and Recycling | • Increase economic returns to community from waste recovery | • Higher income generated from waste recycling/recovery<br>• Reduce cost of SWM management through resource recovery | Total income generated from resource recovery |
| | | | % income generated |
| | | | % reduction in SWM expenditure due to resource recovery |
| General | • Effective SWM with least cost | • Cost of waste management reduced against total revenue | % income from environmental services against total expenditure |
| | | | % of total expenditure against NHM budget |
| **Social** | | | |
| **Stage** | **Desired Outcome** | **Key Performance Criteria** | **Output Measure** |

| | | | |
|---|---|---|---|
| Sorting | • All households educated on sorting<br>• All households understand the segregation of hazardous waste | • More households commence sorting | % of households carrying out sorting |
| | | | % of Commercial establishments carrying out sorting |
| | | | Number of awareness programs held |
| | | | Number of persons in the community trained on sorting |
| | | | Number of households segregate hazardous waste for safe treatment & disposal |
| Collection & Transportation | • All households manage their waste effectively | • No wastes remain unattended | % waste uncollected |
| | | | % of households cooperating with NHM |
| | | | Number of complaints on non collection |
| | | | % of leave taken by contractor sanitary employees |
| Treatment | • All households either compost their organic waste or give it to a composting station | | Number of home composting units in operation |
| | | | Volume of waste given to composting / bio gas plants |
| Disposal | • All the members of community understand the importance of effective solid waste management<br>• High Community participation in solid waste management | | % of households not served by NHM system |
| | | | % increase of community participation in SWM |
| Resource | • Most of the non- organic | | Number of scavengers collecting wastes for recycling trained |

| | | | |
|---|---|---|---|
| Recovery and Recycling | wastes sent for recovery of resources | | |
| | | | % increase in the number of households selling recyclable wastes |
| | | | Number of persons trained on recycling |
| General | • Improved community awareness on SWM<br>• Higher participation of community in waste management<br>• Better working conditions for sanitary workers | | Number of awareness programs conducted |
| | | | % of community participated in awareness programs |
| | | | Number of trainers trained for future awareness programs |
| | | | Number of school initiatives on SWM |
| **Environmental** | | | |
| **Stage** | **Desired Outcome** | **Key Performance Criteria** | **Output Measure** |
| Sorting | • All households educated on Environmental Impacts of Solid waste<br>• All households understand the harmfulness of hazardous waste to humans and environment | • More households sensitized about resource wastage and environmental pollution through solid waste | % of households sorting waste |
| | | | Number of awareness programs held |
| | | | Number of persons in the community trained on environmental pollution and resource conservation |
| | | | Number of households segregate hazardous waste for safe treatment & disposal |
| Collection & Transportation | • All households manage their waste effectively to minimize environmental | • No wastes remain unattended | % waste uncollected |
| | | | % of households cooperating with NHM |
| | | | Number of complaints on non collection |

| | | | |
|---|---|---|---|
| | pollution | | % of streets not cleaned daily |
| | | | % of households where waste not collected daily |
| Treatment | • All households either compost their organic waste or give it to a composting station | Major portion of the wastes are attended through recovery and treatment | Number of home composting units in operation |
| | | | Volume of waste given to composting / bio gas plants |
| Disposal | • All the members of community understand the importance of effective solid waste management<br>• High Community participation in solid waste management | To dispose minimum volume of waste at an engineered sanitary landfill | % reduction of wastes disposed to landfill site |
| | | | % school programs started |
| | | | % increase of community participation in SWM |
| | | | % reduction of waste going to landfill site |
| | | | % increase in resource recovery |
| Resource Recovery and Recycling | • Most of the non- organic wastes sent for recovery of resources | Annual increase of resource recovery from wastes | % increase in the number of households selling recyclable wastes |
| | | | Number of persons trained on recycling |
| | | | Number of awareness programs conducted |
| General | • Improved community awareness on SWM and environmental pollution prevention<br>• Higher concern of community in maintaining a | Annually improving the quality of life of the community by applying green practices | % of community participated in awareness programs |
| | | | Number of citizen suggestions received for clean city |
| | | | Number of school initiatives on resource recovery and pollution prevention |

| | | | |
|---|---|---|---|
| | pollution free city<br>• Clean & Green city surroundings | | Number of solid waste related complaints made to Municipal Environmental Committee |
| | | | Water quality of water bodies in Novo Hamburgo |
| | | | % Reduction of biodiversity loss due to improved solid waste management |

## c. Summary of Selected Indicators

| **Technical** |
|---|
| % households carrying out segregation |
| % waste segregated per day |
| Total waste collected (per month) |
| Total hazardous waste collected (per month) |
| % equipment used per total solid waste volume |
| % of waste collectors |
| % of population served |
| % of waste collected per transfer station |
| Total waste transported |
| % community served |
| % of vehicles in use from total fleet |
| % of waste treated |
| % of hazardous waste treated |
| Quantity of biogas generated and/or |
| Quantity of compost produced per plant |
| Number of households carrying out composting |
| % of waste composted at household level |
| % reduction in waste taken to sanitary landfill |
| Remaining year of sanitary landfill |
| Volume of waste exchanged |
| Quantity of waste re-used |
| % of waste recycled |
| % of waste recycled into value added products |
| **Financial** |
| Total cost of containers provided |
| % of containers replaced within first year |
| Cost of collection and transportation per ton of solid waste |
| Cost of collection and transportation per employee |
| Cost of collection and transportation per household unit / institution unit / commercial unit |
| Quantity of fuel used per vehicle per month |
| Total income generated through treatment plants |
| Income generated through selling compost and/or |
| Income generated through selling biogas |
| Change in energy cost due to usage of biogas |
| % income against expenditure for treatment |
| % cost of operating for disposal from total SWM cost |
| Cost of disposal per ton of solid waste |
| Total income generated from resource recovery |
| % income generated |

| |
|---|
| % reduction in SWM expenditure due to resource recovery |
| % income from environmental services against total expenditure |
| % of total expenditure against NHM budget |
| **Social** |
| % of households carrying out sorting |
| % of Commercial establishments carrying out sorting |
| Number of awareness programs held |
| Number of persons in the community trained on sorting |
| Number of households segregate hazardous waste for safe treatment & disposal |
| % waste uncollected |
| % of households cooperating with NHM |
| Number of complaints on non collection |
| % of leave taken by contractor sanitary employees |
| Number of contractor sanitary employees arriving to work on time |
| Number of home composting units in operation |
| Volume of waste given to composting / bio gas plants |
| % of households not served by NHM system<br>% increase of community participation in SWM |
| Number of scavengers collecting wastes for recycling trained |
| % increase in the number of households selling recyclable wastes |
| Number of persons trained on recycling |
| Number of awareness programs conducted |
| % of community participated in awareness programs |
| Number of trainers trained for future awareness programs |
| Number of school initiatives on SWM |
| **Environmental** |
| % of households sorting waste |
| Number of awareness programs held |
| Number of persons in the community trained on environmental pollution and resource conservation |
| Number of households segregate hazardous waste for safe treatment & disposal |
| % waste uncollected |
| % of households cooperating with NHM |
| Number of complaints on non collection |
| % of streets not cleaned daily |
| % of households where waste not collected daily |
| Number of home composting units in operation |
| Volume of waste given to composting / bio gas plants |
| % reduction of wastes disposed to landfill site |
| % school programs started |
| % increase of community participation in SWM |
| % reduction of  waste going to landfill site |

| |
|---|
| % increase in resource recovery |
| % increase in the number of households selling recyclable wastes |
| Number of persons trained on recycling |
| Number of awareness programs conducted |
| % of community participated in awareness programs |
| Number of citizen suggestions received for clean city |
| Number of school initiatives on resource recovery and pollution prevention |
| Number of solid waste related complaints made to Municipal Environmental Committee |
| Water quality of water bodies in Novo Hamburgo |
| % Reduction of biodiversity loss due to improved solid waste management |


United Nations
Environment Programme
www.unep.org


Instituto Venturi
Para Estudos Ambientais
www.institutoventuri.com.br