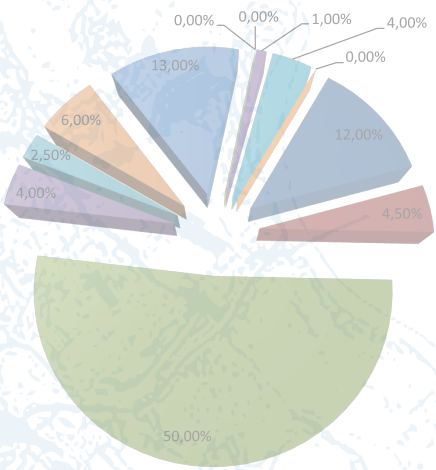
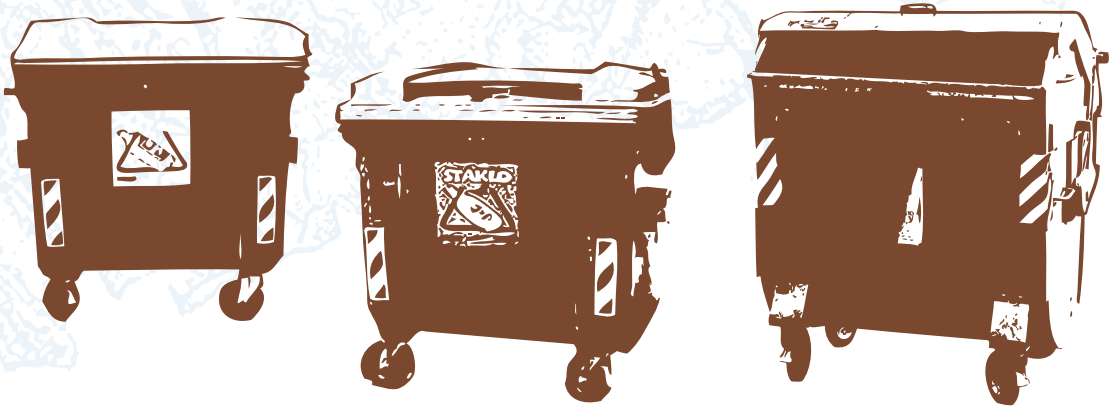
Municipal Solid Waste Information System (SWIS) Model

USERS MANUAL

10	11	12	13	14	15	16
Quantities of Collected waste Deposited on Landfill in tonnes	Structure of total waste deposited on landfill after separation as % of total	Total % of separated and deposited waste	Separated waste marketed for recycling or on stock as % of total separated	Separated waste recycled and marketed in tonnes	Separated waste incinerated with or without energy recovery as % of total separated	Separated waste incinerated with or without energy recovery in tonnes
1491	18,73%	100%	100%	373	0%	0
699	8,78%	100%	60%	0	40%	0
3882	48,78%	100%	0%	0	0%	0
621	7,80%	100%	0%	0	0%	0
116	1,46%	100%	100%	272	0%	0
466	5,85%	100%	100%	466	0%	0
606	7,61%	100%	60%	848	40%	565
0	0,00%	100%	0%	0	0%	0
0	0,00%	100%	0%	0	0%	0
16	0,20%	100%	40%	56	60%	84
62	0,78%	100%	10%	56	90%	503
0	0,00%	100%	0%	0	0%	0
7.958	100%	15.062	out of total waste separated	2.070	out of total waste separated	1.152
52,84%		100%		29,14%		16,22%





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2011

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Acknowledgements

Municipal Solid Waste Information System (SWIS) Model was prepared under the NALAS Task Force on Solid Waste Management in the scope of the project financed by GIZ Open Regional Fund for Municipal Services and implemented by the Standing Conference of Towns and Municipalities - Association of Local Authorities in Serbia (SCTM) through a collaborative effort among the expert team consisted of:

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1. Introduction and recommendations

Why is a **S**olid **W**aste management **I**nformation **S**ystem needed?

There is a common understanding that waste management in the region of Southeast Europe is burdened with a lack of relevant information on municipal waste at the local level, and consequently, often characterized by inadequate tariffs and inefficient service. The need for municipalities and Public Utility Companies (PUCs) to undertake efforts in order to provide services as efficient and affordable as possible is therefore clear. In order to improve service levels in municipal waste management policy at the local level, efficiency and quality must be enhanced under the umbrella of an affordable tariff structure. This makes continual analysis and planning essential.

Service level evaluation, performance indicator comparison and planning needs require the development of standardized solid waste management calculation tools based on up-to-date information. The harmonisation of the information required for processing and comparison purposes is crucial, and is mirrored in the needs of waste management information tools.

It is commonly recognized that solid waste management in South East Europe is weakened by the lack of reliable data at local, institutional and national level.

The SWIS model is a tool designed for municipal waste management data collection and analysis and is intended for use by public entities in charge for the provision of this service. It will help local governments to collect and process relevant data on the most important questions in municipal waste management such as:

- What are the quantities of waste generated, and how much is collected?
- What is the structure of mixed municipal waste?

- What is the amount of separation achieved?
- Is the waste treated and how is it disposed of?
- What are the costs and what is the efficiency level of the present system?

In general terms, the potential for **utilization of the SWIS data model in SEE countries** are:

- Standardizing the core information needs of countries in the region that can be adapted to the specifics of a given LGA or region.
- Introducing potential contemporary practices in data collection into municipal waste management.
- Promoting professional networking among SEE municipalities and municipal waste operators and assisting them in information exchange between themselves and also with other stakeholders.
- Assisting the LGAs in capacity building through training of staff.
- Understanding the role of different stakeholders at different levels of the waste management chain.
- Identifying the challenges and opportunities to improve municipal waste management.
- Introduction of planning tools to meet high service levels, increased service quality under the umbrella of affordable fees and charges (optioneering)
- Introduction of an improved, accurate and simplified reporting system from the local to the national authority
- Comparison of service levels and performances at local, national and region-wide level (macro evaluation) and comparison of key performance indicators with international benchmarks
- Day-to-day updating provides real-time indication (micro evaluation)
- Introduction of an extendable and modifiable tool according experience, emerging needs and future requirements and transferable to other database systems and specific applications (future linkages with GIS system)
- Exchange of experience with installed and used waste management systems for the identification of most appropriate systems, applicable for various conditions (optimisation)
- Identification of capacity, human resource, budget sharing potential and needs
- Monitoring of service level indicators in case of service contracts, concession contracts or PPP structure for contractual performance auditing

The primary goal of the SWIS model is to assist local governments in assessing and organizing information collection and processing, in a manner that will help them to obtain a clear picture of the state of waste management in their community, as a first but crucial step towards improving the methodological and organizational framework of municipal waste management and a starting point in considering and planning further steps on how to improve waste management in their communities.

On the operative and organizational level of LGA the SWIS data model can be used to utilize the collected and processed information and to interpret the calculated results for various purposes according to the needs of specific municipalities, while dealing with waste management issues such as:

- Monitoring organized waste collection service coverage
- Monitoring the amounts of collected municipal waste
- Forecasting future quantities for collection and transport
- Monitoring the management of generated municipal waste and uncontrolled waste disposal
- Monitoring the effectiveness of municipal waste collection and transport
- Monitoring the municipal waste structure
- Monitoring and planning waste separation options
- Monitoring the disposal system and treatment technologies
- Monitoring the disposing facility lifetime with or without separation
- Monitoring the present cost of municipal waste collection and transport
- Making assumptions for financing investments in equipment and vehicles
- Making assumptions for full cost coverage
- Monitoring the efficiency of the municipal company/operator
- Making assumptions for waste management plans
- Monitoring the implementation of the waste management plans
- Publishing annual waste statistics and achieving uniform methodology and reporting structure
- Comparing efficiency-, service and quality levels with other LGAs/countries/regions

2. Data Entry Operational Manual

2.1. General info on the model data entry – usage

The SWIS model, in Excel, is based on the concept that **relevant data** on the individual elements of municipal waste management **is entered only once**, in the designed cell in one worksheet table (**cells coloured white**).

Some cells are marked with a red triangle in the top right corner. If the mouse is pointed to that cell, a pop-up explanatory text will appear, guiding the user toward proper and complete data entry.

The entered data is then calculated in the original worksheet table. Data entered once, and calculated in one worksheet, is afterwards automatically copied to other relevant worksheets and tables. This previously entered data is then combined with other newly entered data generating results and different waste management indicators.

The cells in tables-worksheets where **data is not entered** are the (**blue coloured cells**) which are calculative and are write-protected to avoid accidental data loss and calculative mistakes. Some calculative cells have a built-in logical control and warn (TRUE, FALSE) if entered information is illogical in comparison to previously entered data, or change colour if data is incomplete or irregular (for example if the total percentage is less or more than 100%). Worksheets (1-6) also contain graphs to help visualize the calculative result of data entered.

It is important to remember that the original received model in Excel should always be saved under it's original name, and that all the other workbooks that result from working with various data entries can and should be saved on the computer disc under different file names.

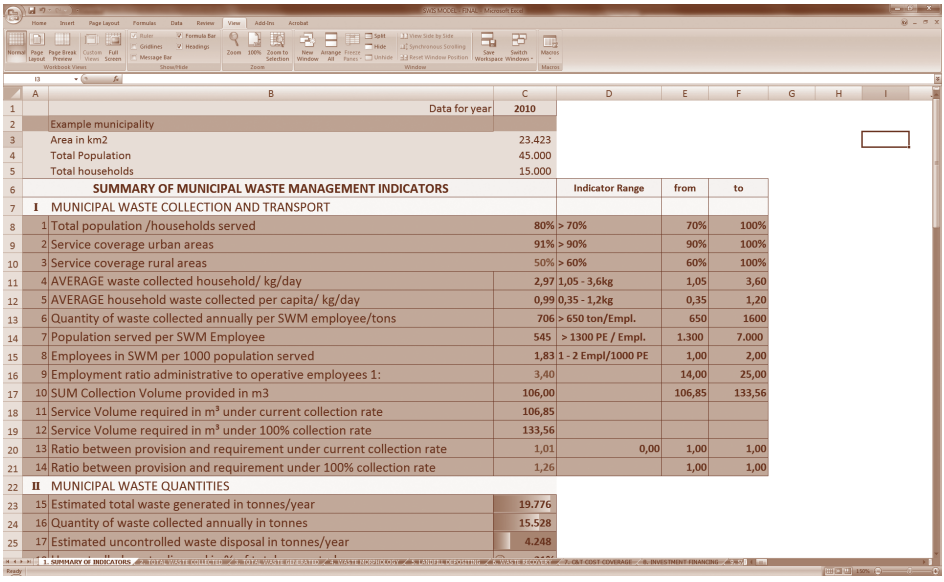
Also, when experimenting with different data options, if the user is unsure of the data entries, or does not want to save the entered data, the "no" option under "save changes" option should be chosen when exiting the workbook and the original municipal data will be restored next time the workbook is opened.

To move through the workbook, and jump to and from worksheets, a menu containing all data entry worksheets and the result worksheet is offered on the HOME page, a HOME button at the end of each worksheet, or the sheet buttons at the bottom of each page.

For the comparison of various models with different municipal data the worksheet must be copied and new data entered with reference to options, variants or models.

2.2. Worksheet 1 – Summary of waste management indicators

Figure 1.1. Summary of waste management indicators



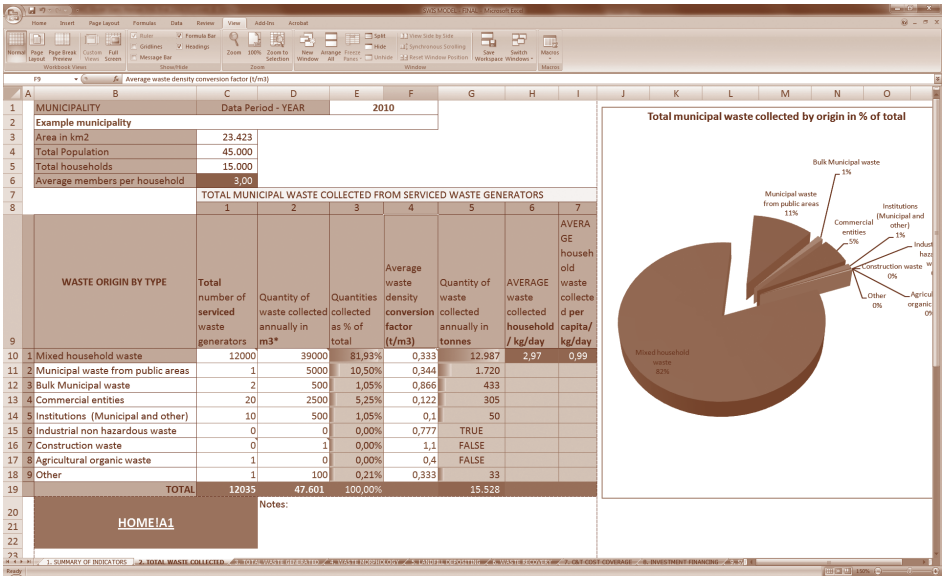
1		Data for year	2010			
2		Example municipality				
3		Area in km2	23.423			
4		Total Population	45.000			
5		Total households	15.000			
6		SUMMARY OF MUNICIPAL WASTE MANAGEMENT INDICATORS		Indicator Range	from	to
7	I	MUNICIPAL WASTE COLLECTION AND TRANSPORT				
8	1	Total population /households served	80%	> 70%	70%	100%
9	2	Service coverage urban areas	91%	> 90%	90%	100%
10	3	Service coverage rural areas	50%	> 60%	60%	100%
11	4	AVERAGE waste collected household/ kg/day	2,97	1,05 - 3,6kg	1,05	3,60
12	5	AVERAGE household waste collected per capita/ kg/day	0,99	0,35 - 1,2kg	0,35	1,20
13	6	Quantity of waste collected annually per SWM employee/tons	706	> 650 ton/Empl.	650	1600
14	7	Population served per SWM Employee	545	> 1300 PE / Empl.	1.300	7.000
15	8	Employees in SWM per 1000 population served	1,83	1 - 2 Empl/1000 PE	1,00	2,00
16	9	Employment ratio administrative to operative employees 1:	3,40		14,00	25,00
17	10	SUM Collection Volume provided in m3	106,00		106,85	133,56
18	11	Service Volume required in m^3 under current collection rate	106,85			
19	12	Service Volume required in m^3 under 100% collection rate	133,56			
20	13	Ratio between provision and requirement under current collection rate	1,01	0,00	1,00	1,00
21	14	Ratio between provision and requirement under 100% collection rate	1,26		1,00	1,00
22	II	MUNICIPAL WASTE QUANTITIES				
23	15	Estimated total waste generated in tonnes/year	19.776			
24	16	Quantity of waste collected annually in tonnes	15.528			
25	17	Estimated uncontrolled waste disposal in tonnes/year	4.248			

This worksheet is write-protected and contains the summary of municipal waste indicators in 41 rows. **Data is not entered directly into this worksheet.**

In the Model it is located and numerated as Worksheet 1, as it is intended to be used as an executive summary of all data entered in the Model in Worksheets 2 – 8. This Worksheet compiles the calculative results of data from Worksheets 2 – 8 in summary form. Any changes in data in any of the Worksheets 2 – 8, will automatically be recorded in this Worksheet.

2.3. Worksheet 2 – Total waste collected

Figure 2. Total waste collected



1	MUNICIPALITY		Data Period - YEAR		2010					
2	Example municipality									
3	Area in km2	23.423								
4	Total Population	45.000								
5	Total households	15.000								
6	Average members per household	3,00								
7		TOTAL MUNICIPAL WASTE COLLECTED FROM SERVICED WASTE GENERATORS								
8		1	2	3	4	5	6	7		
9	WASTE ORIGIN BY TYPE	Total number of serviced waste generators	Quantity of waste collected annually in m3*	Quantities collected as % of total	Average waste density conversion factor (t/m3)	Quantity of waste collected annually in tonnes	AVERAGE waste collected household / kg/day	AVERAGE household waste collected per capita/ kg/day		
10	1 Mixed household waste	12000	39000	81,93%	0,333	12.987	2,97	0,99		
11	2 Municipal waste from public areas	1	5000	10,50%	0,344	1.720				
12	3 Bulk Municipal waste	2	500	1,05%	0,866	433				
13	4 Commercial entities	20	2500	5,25%	0,122	305				
14	5 Institutions (Municipal and other)	10	500	1,05%	0,1	50				
15	6 Industrial non hazardous waste	0	0	0,00%	0,777	TRUE				
16	7 Construction waste	0	1	0,00%	1,1	FALSE				
17	8 Agricultural organic waste	1	0	0,00%	0,4	FALSE				
18	9 Other	1	100	0,21%	0,333	33				
19	TOTAL	12035	47.601	100,00%		15.528				
20		Notes:								
21	HOME!A1									

In the white cells of this worksheet basic information about the municipality is entered, such as:

- the time period of data collection (the calculative elements of the model are adjusted to a calendar year),
- the name of the municipality

MUNICIPALITY	Data Period - YEAR	**2010**
ENTER the name of the municipality		

- municipal area in km^2,
- total population,
- total households.

Area in km^2	23,423
Total Population	45,000
Total households	15,000
Average members per household	**3.00**

In the blue coloured cell, the average number of members per household is calculated.

After entry in these fields, this data will be copied to all other worksheets.

The table TOTAL MUNICIPAL WASTE COLLECTED FROM SERVICED WASTE GENERATORS gives an overview of waste origin, by type, such as:

1	Mixed household waste
2	Municipal waste from public areas
3	Bulk Municipal waste
4	Commercial entities
5	Institutions (Municipal and other)
6	Industrial non hazardous waste
7	Construction waste
8	Agricultural organic waste
9	Other

This column contains data on what the origin of municipal waste is, by type.

The labelling of rows 2-9 can be changed and can be adapted to specific municipal needs, except for row 1 - Mixed household waste, because of specific calculative reasons (average waste per household and per capita).

Numeric values entered in **column 1**, should represent the number of serviced waste generators that the municipality is actually servicing through organized waste collection.

This numeric value entered in row 1. (Mixed household waste) should represent the number of serviced households. This number is usually smaller than the total number of households entered in the table above, unless service coverage is 100%.

If the entered numerical value is larger than the previously entered number of households, the cell will change colour to red, indicating an irregular data entry.

If 0 is entered in column 1 but quantities are entered in column 2, the number 0 will change colour to red, and the logical control in column 5 will indicate that such an entry is FALSE. At the same time columns 6 and 7 will show #DIV/0!

If a value larger than 0 is entered in column 1, indicating the number of serviced waste generators, a numeric value larger than 0 indicating quantities of waste also has to be entered in column 2. If not, through the built-in logical control, the model will indicate that such an entry is FALSE in column 5.

Numeric values entered in **column 2** are the measured or to the best of knowledge estimated quantities of municipal waste **in m3,** intended for use in municipalities that have no means of measuring the collected quantities in tonnes. In this case these municipalities will have to enter values for average conversion factors from volume to mass (m3 to tonnes) in Column 4, from m3 to tonnes based on measured or best estimated average values.

1	2
Total number of **serviced** waste generators	Quantity of waste collected annually in **m³***
12000	39000
1	5000
2	500
20	2500
10	500
0	0
0	1
1	0
1	10
12035	47,511

If local self government **gathers data** on collected waste **in tonnes**, a change should be made in the labelling text of column 2 from m3 to tonnes, and data entered in tonnes, but in that case the density conversion factor in column 4 must always be entered as 1.

If a value larger than 0 is entered in column 1, indicating the number of serviced waste generators, a numeric value larger than 0 indicating quantities of waste also has to be entered in column 2. If not, the model will indicate through the built-in logical control that such an entry is FALSE in column 5.

4
Average waste density **conversion factor (t/m³)**
0.333
0.344
0.866
0.122
0.1
0.777
1.1
0.4
0.333

Numeric values entered in **column 4**, are the typical conversion factors for a specific type of waste, measured or to the best of knowledge estimated factors of volume to weight conversion factors of different types of municipal waste.

For example, the mostly commonly used average conversion factor for mixed municipal household waste is 0.333 meaning that a volume of approximately 3 m3 of household waste weighs 1 tonne, and so on (0.032- 0.080 for paper, 0.32 – 0.128 for plastics, 0.168 – 0.501 for organic matter, 0.048 – 1.100 for metals) depending on specific municipal data.

This data will differ between municipalities in each country, depending on the composition of municipal waste, for example whether it is an urban or rural area, and may differ between countries in the region.

From this point on, all the waste quantities in this and all other worksheets are expressed in tonnes/kilograms.

By entering this data the computation result of total quantities of collected waste in tonnes, and average daily waste collected, per household (calculated in column 6) and per capita in kilograms (calculated in column 7), will become available to the municipality in the calculative cells of the table.

A notes text box is also provided, below the worksheet, for internal use.

This worksheet also contains a graph of the calculative result, visualizing all changes of data entered.

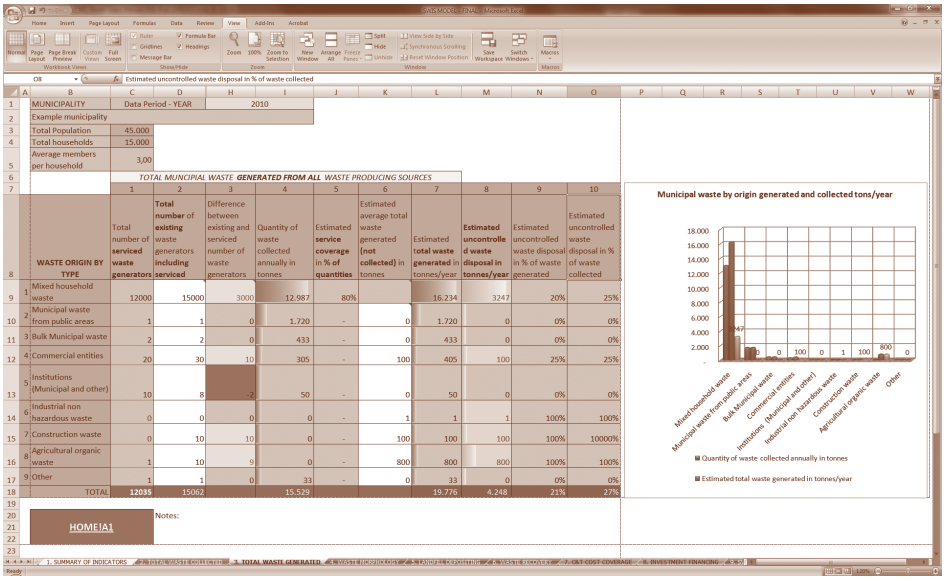
This is the basic worksheet from where information on quantities in tonnes is used in other worksheets, so it is important for it to be as exact as possible or estimated to the best knowledge of local conditions.

When data is entered in Worksheet 2 (TOTAL WASTE COLLECTED), press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to Worksheet 3 – TOTAL WASTE GENERATED. The same can be accomplished by pressing the TOTAL WASTE GENERATED worksheet tab at the bottom of the page.

2.4. Worksheet 3 – Total waste generated

*TOTAL MUNCIPIAL WASTE **GENERATED FROM ALL** WASTE PRODUCING SOURCES*

Figure 3. Total waste generated



1	MUNICIPALITY		Data Period - YEAR		2010							
2	Example municipality											
3	Total Population	45.000										
4	Total households	15.000										
5	Average members per household	3,00										
6												
7			TOTAL MUNCIPIAL WASTE **GENERATED FROM ALL** WASTE PRODUCING SOURCES									
8	WASTE ORIGIN BY TYPE	1 Total number of **serviced waste generators**	2 **Total number** of **existing** waste generators **including serviced**	3 Difference between existing and serviced number of waste generators	4 Quantity of waste collected annually in tonnes	5 Estimated **service coverage** in **% of quantities**	6 Estimated average total waste generated **(not collected)** in tonnes	7 Estimated **total waste generated** in tonnes/year	8 **Estimated uncontrolled waste disposal in tonnes/year**	9 Estimated uncontrolled waste disposal in % of waste generated	10 Estimated uncontrolled waste disposal in % of waste collected
9	1 Mixed household waste	12000	15000	3000	12.987	80%		16.234	3247	20%	25%
10	2 Municipal waste from public areas	1	1	0	1.720	-	0	1.720	0	0%	0%
11	3 Bulk Municipal waste	2	2	0	433	-	0	433	0	0%	0%
12	4 Commercial entities	20	30	10	305	-	100	405	100	25%	25%
13	5 Institutions (Municipal and other)	10	8	-2	50	-	0	50	0	0%	0%
14	6 Industrial non hazardous waste	0	0	0	0	-	1	1	1	100%	100%
15	7 Construction waste	0	10	10	0	-	100	100	100	100%	10000%
16	8 Agricultural organic waste	1	10	9	0	-	800	800	800	100%	100%
17	9 Other	1	1	0	33	-	0	33	0	0%	0%
18	TOTAL	12035	15062		15.529			19.776	4.248	21%	27%

Municipal data is copied automatically from Worksheet 2.

Column 1, with data on the number of serviced waste generators is automatically copied from worksheet 2.

In this worksheet **data is entered in two columns (2 and 6),** all the other columns (3,4,5, 7-10) are self calculative.

In column 2, an exact or approximated number of all waste generators, including those not covered by organized waste collection, is entered. The numeric value in column 2 can be equal to cells in column 1 which means that service coverage is 100%, so there should be no difference between waste collected and waste generated.

2	3
Total number of **existing** waste generators **including serviced**	Difference between existing and serviced number of waste generators
15000	3000
1	0
2	0
30	10
8	-2
0	0
10	10
10	9
1	0
15062	

For waste from households, the numeric value representing the total number of households from the table containing municipal information above should be entered. If the value of cells in column 2 is less than column 1 (negative value), the cells will change colour to red, indicating an irregular or illogical data entry, that needs to be clarified.

If however, the numeric value in the column 2 cells is larger than in column 1, meaning that not all waste generators are covered by collection, their number is automatically detected as a difference in column 3 coloured in yellow, indicating that a data entry is necessary in column 3.

In other words, if there is a difference between the number of covered and existing waste generators, data or estimation on waste quantities should be entered in column 6.

Column 3, is self-calculative, and indicates the difference between the entered number of serviced and the number of existing waste generators, or the number of waste generators that are not covered by organized municipal waste collection.

If a numeric value in column 3 is larger than 0, a numeric value has to be entered in column 6 or the cells will change to red, indicating an irregular or illogical data entry, that needs to be clarified.

The quantities of waste deemed to be generated by these waste producers but not collected, are entered in tonnes, preferably by actually weighing them or by best possible estimate.

In **Column 6**, data (estimated to the best of knowledge or measured) is entered in tonnes for quantities of waste generated by waste producers that are not covered by organized waste collection, in accordance with data calculated in column 3.

If the value of cells in column 3 are >0, a numerical value of known or estimated quantities in tonnes should be entered in column 6. If not, the cells will change to red, indicating an irregular or illogical data entry that needs to be clarified.

The exception in this column which does not require data entry is the blue coloured self-calculating cell indicating the average quantities of mixed household waste which are calculated automatically in column 7, according to % of service coverage, from column 5.

By entering data in columns 2 and 6 of this worksheet, in column 7 the local self government will generate a computation result of the total approximated quantities of municipal waste generated, including quantities covered by organized waste collection.

The total self-calculated quantities of municipal waste in column 8 indicate an estimation of how much waste out of total is not collected, representing the measured or estimated uncontrolled waste disposal in tonnes, at sites out of municipal control.

6
Estimated Average Total waste generated (**not collected**) in tonnes
0
0
0
0
0
1000
800
0

Column 9 computes the average structure and the total percentage of uncontrolled waste disposal in comparison to total generated waste quantities.

The percentages and total in column 10 indicate how much more waste has to be collected in tonnes, in comparison to present collection, also indicating the most probable additional increase in labour, fuel and other variable costs necessary to collect and transport all generated municipal waste in an organized manner.

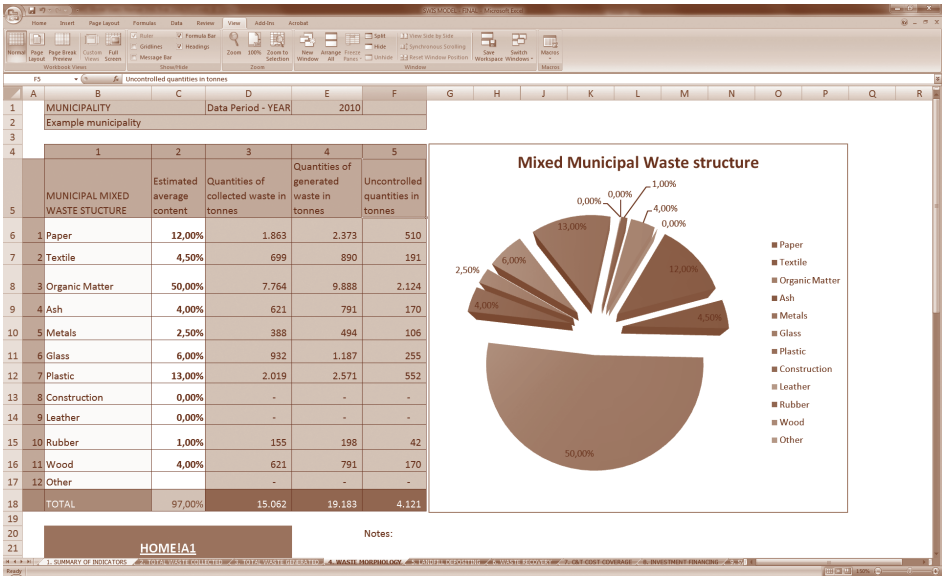
This worksheet also contains a graph of the calculative result, visualizing all changes of data entered.

A notes text box is also provided, below the worksheet, for internal use.

When data is entered in this Worksheet, press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to the next Worksheet. The same can be accomplished by pressing the next worksheet tab at the bottom of the page.

2.5. Worksheet 4 – Waste morphology

Figure 4. Waste morphology



		MUNICIPALITY		Data Period - YEAR	2010	
		Example municipality				
	1	2	3	4	5	
	MUNICIPAL MIXED WASTE STUCTURE	Estimated average content	Quantities of collected waste in tonnes	Quantities of generated waste in tonnes	Uncontrolled quantities in tonnes	
1	Paper	12,00%	1.863	2.373	510	
2	Textile	4,50%	699	890	191	
3	Organic Matter	50,00%	7.764	9.888	2.124	
4	Ash	4,00%	621	791	170	
5	Metals	2,50%	388	494	106	
6	Glass	6,00%	932	1.187	255	
7	Plastic	13,00%	2.019	2.571	552	
8	Construction	0,00%	-	-	-	
9	Leather	0,00%	-	-	-	
10	Rubber	1,00%	155	198	42	
11	Wood	4,00%	621	791	170	
12	Other		-	-	-	
	TOTAL	97,00%	15.062	19.183	4.121	

HOME|A1

Notes:

In this worksheet numeric data is entered in only one column – **column 2** containing data on the measured or estimated average content of collected mixed municipal waste. The labelling of different components in the municipal waste structure in Column 1 can be changed and adapted according to municipal needs.

The numeric data entered in this column can be as a round number, for example 10 which will automatically be shown as 10.00%, or a number with a decimal point using a dot, not comma for separation. If a comma is used for separation #VALUE! will appear in the self calculative columns 3, 4 and 5.

If the total of the entered structure in percentages is smaller or larger than 100%, the total cell will change colour to red indicating that data should be clarified.

Based on the entered structure, the self calculative columns 3, 4 and 5, will show the total tonnage of the collected and generated municipal waste. This will enable the municipality to understand what kind of materials are deposited or available for further recovery and processing management.

The structure of mixed municipal waste will differ from municipality to municipality and between regions. The structure given in the original graph represents the typical waste structure in Serbia, according to measurements performed by a reputable institution. This waste structure may be indicative, but every municipality should have its own measurements or best as possible estimates.

The quality of data on the composition of mixed municipal waste is one of the most important and valuable pieces of information for waste management and planning. It is important as it is used for determining the structure of waste deposited, as well as the possibilities of waste management in the process of separation and recycling of waste collected. Activities for the collection of separate waste fractions are usually planned on the basis of this information so they should be carefully prepared or elaborated for the municipalities or regions where such activities may start.

The accurate determination of the composition of mixed municipal waste can be, technically and statistically, a difficult and expensive task, but if properly performed represents valuable data.

This worksheet also contains a graph of the calculative result, visualizing all changes of data entered.

A notes text box is also provided, below the worksheet, for internal use.

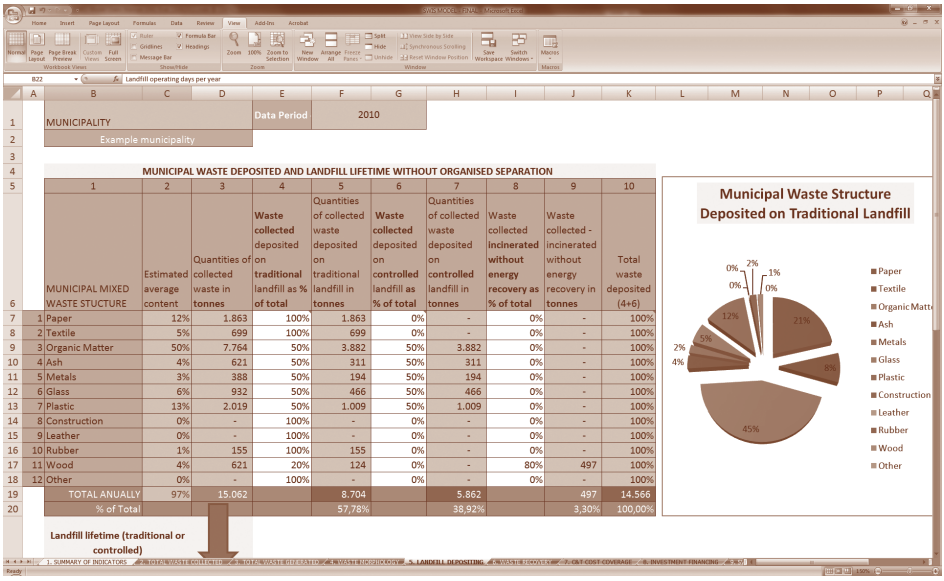
2
Estimated Average Content
12.00%
4.50%
50.00%
4.00%
2.50%
6.00%
13.00%
0.00%
0.00%
1.00%
4.00%
3.00%
100.00%

When data is entered in this Worksheet, press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to the next Worksheet. The same can be accomplished by pressing the next worksheet tab at the bottom of the page.

2.6. Worksheet 5 – Landfill depositing

MUNICIPAL WASTE DEPOSITED AND LANDFILL LIFETIME WITHOUT ORGANISED SEPARATION

Figure 5.1. Landfill depositing



1	MUNICIPALITY				Data Period	2010					
2	Example municipality										
3											
4	MUNICIPAL WASTE DEPOSITED AND LANDFILL LIFETIME WITHOUT ORGANISED SEPARATION										
5	1	2	3	4	5	6	7	8	9	10	
6	MUNICIPAL MIXED WASTE STUCTURE	Estimated average content	Quantities of collected waste in tonnes	Waste collected deposited on traditional landfill as % of total	Quantities of collected waste deposited on traditional landfill in tonnes	Waste collected deposited on controlled landfill as % of total	Quantities of collected waste deposited on controlled landfill in tonnes	Waste collected incinerated without energy recovery as % of total	Waste collected - incinerated without energy recovery in tonnes	Total waste deposited (4+6)	
7	1 Paper	12%	1.863	100%	1.863	0%	-	0%	-	100%	
8	2 Textile	5%	699	100%	699	0%	-	0%	-	100%	
9	3 Organic Matter	50%	7.764	50%	3.882	50%	3.882	0%	-	100%	
10	4 Ash	4%	621	50%	311	50%	311	0%	-	100%	
11	5 Metals	3%	388	50%	194	50%	194	0%	-	100%	
12	6 Glass	6%	932	50%	466	50%	466	0%	-	100%	
13	7 Plastic	13%	2.019	50%	1.009	50%	1.009	0%	-	100%	
14	8 Construction	0%	-	100%	-	0%	-	0%	-	100%	
15	9 Leather	0%	-	100%	-	0%	-	0%	-	100%	
16	10 Rubber	1%	155	100%	155	0%	-	0%	-	100%	
17	11 Wood	4%	621	20%	124	0%	-	80%	497	100%	
18	12 Other	0%	-	100%	-	0%	-	0%	-	100%	
19	TOTAL ANUALLY	97%	15.062		8.704		5.862		497	14.566	
20	% of Total				57,78%		38,92%		3,30%	100,00%	

Municipal Waste Structure Deposited on Traditional Landfill

Paper
Textile
Organic Matte
Ash
Metals
Glass
Plastic
Construction
Leather
Rubber
Wood
Other

Landfill lifetime (traditional or controlled)

Data in this Worksheet is entered if there is no separation.

If municipal waste separation exists, or waste separation is an option in planning (to estimate results of such options), after entering values in the Landfill lifetime Table in **row 13,** representing the number of working days of the landfill per year, in **row 15** of the table representing the projected or estimated total capacity of the presently used landfill in tonnes and in **row 16** of the table representing the estimated landfill capacity used to date **go directly to Worksheet 6**.

In this worksheet data is entered in two columns, **column 4** if municipal waste is deposited on a traditional landfill, **or column 6** if municipal waste is deposited on a controlled landfill and **column 8** if a portion of municipal waste is incinerated without energy recovery.

The estimated average content and quantities in columns 2 and 3, are automatically copied from the previous table where they are calculated from data entered on waste morphology.

Numeric values, as percentages entered in **column 4** should represent the quantities collected and deposited on a traditional landfill, if there is no separation or incineration. In most cases where **traditional landfills** are in use and where separation is non existent and if there is no incineration, an entry of 100 is correct.

Numeric values, as percentages, entered in **column 6** represent the quantities collected and deposited on a **controlled landfill**, if there is no separation or incineration (without energy recovery).

If a traditional landfill exists, the quantities on a controlled landfill will be 0%, and vice versa. Cases where both are used are rare and represent a temporary exception to the rule.

The quantities of waste are automatically copied from the previous table where they are calculated from data entered in percentages, based on the existing waste morphology.

Data entered in **Column 8**, represents the percentages of municipal waste being incinerated without energy recovery.

Column 10 represents the total municipal waste deposited or incinerated in percentages, which should add up to 100% for each category, or the cells will change colour to red, indicating that data should be clarified.

This worksheet table also contains information on the structure of municipal waste and the quantities of recyclable materials that can be used for other purposes, but are deposited on a traditional or controlled landfill because there is no organized selection.

4	6	8
Waste Collected Deposited on **Traditional** Landfill as **% of total**	**Waste Collected** Deposited on **Controlled** Landfill as **% of total**	Waste collected **incinerated without energy recovery as % of total**
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%
100%	0%	0%

2.6.1. Landfill lifetime calculation

Numeric values entered in **row 13** of the table**,** represent the number of working days of the landfill per year.

Numeric values entered in **row 15** of the table represent the projected or estimated total capacity of the presently used landfill in tonnes, to the best of knowledge or estimate. If the municipality is participating in a regional landfill scheme, the entered value should be the capacity of the controlled landfill belonging or assigned to that municipality.

Numeric values entered in **row 16** of the table represent the estimated landfill capacity used to date, meaning for example that the total landfill capacity is 80% filled, up to the end of the reporting period, usually a calendar year. When the municipality is participating in a regional landfill scheme, the entered value should be the ***used*** capacity of the controlled landfill belonging or assigned to that municipality.

Depending on the previously entered data on used landfill capacity and the daily amounts of municipal waste deposited, this worksheet computation result in **row 18** of the table is the remaining landfill lifetime left for use if municipal waste is continually deposited at a given rate with or without incineration.

Due to the circumstance that in some cases traditional sites are still in operation in parallel with sanitary (controlled) landfills which have been constructed, the results split into traditional (dumpsite) disposal and sanitary controlled (sanitary landfill) disposal. The results depend on the percentage of traditional and controlled (sanitary) disposal stated in column 4 and 6. This can only be an exception to the rule, as the intention is to close traditional landfills.

If the traditional landfill is to be closed and replaced with a sanitary landfill, the remaining capacity has to be signified with a 0. Aftercare periods are not part of this calculation.

This data can be used by the municipality to estimate the time at disposal before the traditional landfill is used up, and at what stage it will have to be ready to organize new facilities or plan a different type of waste management.

This worksheet also contains a graph of the calculative result, visualizing all changes of data entered.

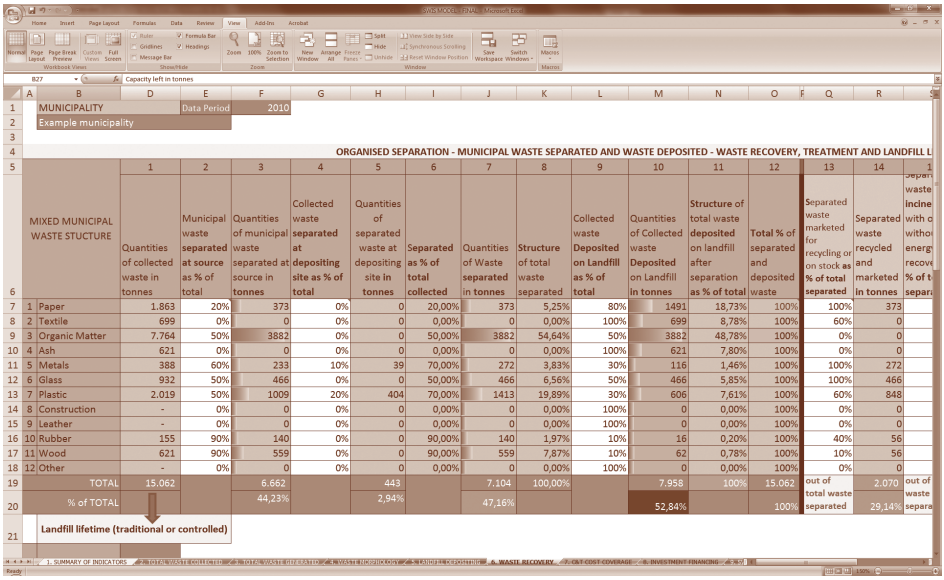
A notes text box is also provided, below the worksheet, for internal use.

When data is entered in this Worksheet, press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to the next Worksheet. The same can be accomplished by pressing the next worksheet tab at the bottom of the page.

2.7. Worksheet 6 – Waste recovery

ORGANISED SEPARATION - MUNICIPAL WASTE SEPARATED AND WASTE DEPOSITED - WASTE RECOVERY, TREATMENT AND LANDFILL LIFETIME

Figure 6. Waste recovery



1	MUNICIPALITY		Data Period	2010												
2	Example municipality															
3																
4	ORGANISED SEPARATION - MUNICIPAL WASTE SEPARATED AND WASTE DEPOSITED - WASTE RECOVERY, TREATMENT AND LANDFILL L															
5		1	2	3	4	5	6	7	8	9	10	11	12	13	14	1
6	MIXED MUNICIPAL WASTE STUCTURE	Quantities of collected waste in tonnes	Municipal waste **separated at source** as % of total	Quantities of municipal waste separated at source in **tonnes**	Collected waste **separated at depositing site as % of total**	Quantities of separated waste at depositing site in **tonnes**	**Separated as % of total collected**	Quantities of Waste **separated** in tonnes	**Structure** of total waste separated	Collected waste **Deposited on Landfill as % of total**	Quantities of Collected waste **Deposited** on Landfill in **tonnes**	**Structure of total waste deposited** on landfill after separation **as % of total**	**Total %** of separated and deposited waste	Separated waste marketed for recycling or on stock **as % of total separated**	Separated waste recycled and marketed **in tonnes**	Separ waste incine with c withou energ recov % of t separ
7	1 Paper	1.863	20%	373	0%	0	20,00%	373	5,25%	80%	1491	18,73%	100%	100%	373	
8	2 Textile	699	0%	0	0%	0	0,00%	0	0,00%	100%	699	8,78%	100%	60%	0	
9	3 Organic Matter	7.764	50%	3882	0%	0	50,00%	3882	54,64%	50%	3882	48,78%	100%	0%	0	
10	4 Ash	621	0%	0	0%	0	0,00%	0	0,00%	100%	621	7,80%	100%	0%	0	
11	5 Metals	388	60%	233	10%	39	70,00%	272	3,83%	30%	116	1,46%	100%	100%	272	
12	6 Glass	932	50%	466	0%	0	50,00%	466	6,56%	50%	466	5,85%	100%	100%	466	
13	7 Plastic	2.019	50%	1009	20%	404	70,00%	1413	19,89%	30%	606	7,61%	100%	60%	848	
14	8 Construction	-	0%	0	0%	0	0,00%	0	0,00%	100%	0	0,00%	100%	0%	0	
15	9 Leather	-	0%	0	0%	0	0,00%	0	0,00%	100%	0	0,00%	100%	0%	0	
16	10 Rubber	155	90%	140	0%	0	90,00%	140	1,97%	10%	16	0,20%	100%	40%	56	
17	11 Wood	621	90%	559	0%	0	90,00%	559	7,87%	10%	62	0,78%	100%	10%	56	
18	12 Other	-	0%	0	0%	0	0,00%	0	0,00%	100%	0	0,00%	100%	0%	0	
19	TOTAL	15.062		6.662		443		7.104	100,00%		7.958	100%	15.062	out of total waste separated	2.070	out of waste separa
20	% of TOTAL			44,23%		2,94%		47,16%			52,84%		100%		29,14%	
21	Landfill lifetime (traditional or controlled)															

Numeric values, as percentages, entered in **column 2** and **column 4** of the worksheet table should represent data on waste separated at source or/and at the depositing site, which are then automatically calculated into tonnes, based on the entered waste structure in worksheet 4 and copied as tonnes in column 1.

Based on the data entries in column 2 and 4, this operation enables the calculation of quantities totally separated in tonnes and the structure of the municipal waste separated in columns 7 and 8.

2	4	9
Municipal waste **separated at source** as **%** of total	Collected waste **separated at depositing site as % of total**	Collected waste **Deposited on Landfill as % of total**
60%	30%	30%
0%	0%	100%
50%	0%	50%
0%	0%	100%
60%	10%	30%
50%	0%	50%
50%	20%	30%
0%	0%	100%
0%	0%	100%
90%	0%	10%
90%	0%	10%
0%		100%

If any cells in column 2 or 4 have a value larger than 0, respective numeric values must also be entered in columns 13, 15 or 17 of the same table, where data is entered on what the nature of treatment of separated waste is.

Numeric values, as percentages, entered in **column 9**, represent the structure and quantities of waste in tonnes that is left after separation, and deposited on landfills, as a % of total municipal waste collected. This operation enables the computation result of quantities totally deposited (land filled) in tonnes as well as the structure of the municipal waste deposited on the landfill in column 10 and 11.

Column 12, automatically adds up the percentages of separated and deposited municipal waste entered in columns 2,4 and 9 and should be equal to 100%. If not, the respective cells in Column 12 will change colour, indicating a wrong data entry or that data should be clarified.

On the right side of the worksheet table **data is entered in columns 13, 15 and 17.**

If any cells in column 2 and 4 have value, the respective numeric values MUST also be entered in columns 13, 15 or 17. This means that if only 20% is separated, but 100% of this is marketed, the entry in the cells in this column should be 100%. This can be checked through quantities that should match in total.

Numeric values, as percentages **out of** total waste separated, entered in **column 13**, represent the structure and quantities of the separated waste that has been marketed for recycling or is on stock for those purposes.

Numeric values, as percentages **out of** total waste separated, entered in **column 15**, represent the structure and quantities of the separated waste that has been incinerated with energy recovery.

Numeric values, as percentages **out of** total waste separated, entered in **column 17**, represent the structure and quantities of the separated waste that has been used for composting.

13	15	17
Separated waste marketed for recycling or on stock **as % of total separated**	Separated waste **incinerated** with energy recovery **as % of total separated**	**% of** waste separated **composted of total separated**
80%	20%	0%
60%	40%	0%
0%	0%	100%
0%	0%	0%
100%	0%	0%
100%	0%	0%
60%	40%	0%
0%	0%	0%
0%	0%	0%
40%	60%	0%
10%	90%	0%
0%	0%	0%
out of total waste separated	**out of total waste separated**	**out of total waste separated**

Column 19 is self calculative and computes the entered totals of separated waste (or data on the "destiny" of the waste that has been separated), so if any cells in column 2 and 4 have value (quantities of waste separated), the respective numeric values MUST also be entered in columns 13, 15 or 17, (out of total waste separated) or the total in column 19 will be >< 100% and the respective cells will change colour to red, indicating a wrong data entry or that data should be clarified. In this case, if data is verified, if the sum in a cell is < 100% this can mean that the separation resulted in expenses that are not justified, or if > 100% that the entered data has to be checked again. This also means that the total quantities in column 19 should be equal to the total sum of Quantities of Waste separated in tonnes in column 7.

By entering data, this worksheet table enables the municipality to take a "snapshot" picture of what quantities by type of materials are or can potentially be recycled, or used for biological or energy recovery and how much municipal waste in tonnes is being land filled, including the structure of the waste going into the ground.

2.7.1. Landfill lifetime calculation

Depending on the entered data in the previous worksheet (5) on used landfill capacity and the daily amounts of municipal waste deposited, **row 19** of this worksheet automatically calculates the remaining landfill lifetime left for use if municipal waste is continually deposited but waste separation is carried out, in comparison to landfill lifetime without separation in **row 20**.

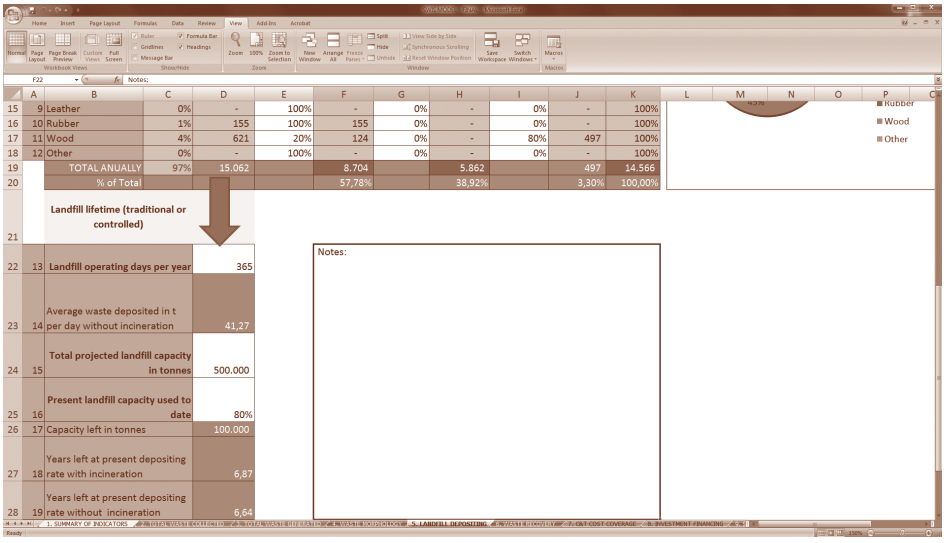
This may be valuable information for the municipality as it estimates the prolonged landfill lifetime if separation is an option in waste management.

In addition, the computation result of this worksheet shown in the totals of columns 7 (quantities of separated waste) and column 10 (quantities of land filled waste) represents valuable information to the local government as it may be used to point out to the municipality the potential savings (as a result of difference in quantities of deposited waste) in tipping or depositing fee charges usually charged at the gate of a controlled landfill.

This worksheet also contains 4 graphs of the calculative result, visualizing all changes of data entered.

A notes text box is also provided, below the worksheet, for internal use.

Figure 5.2. Landfill lifetime



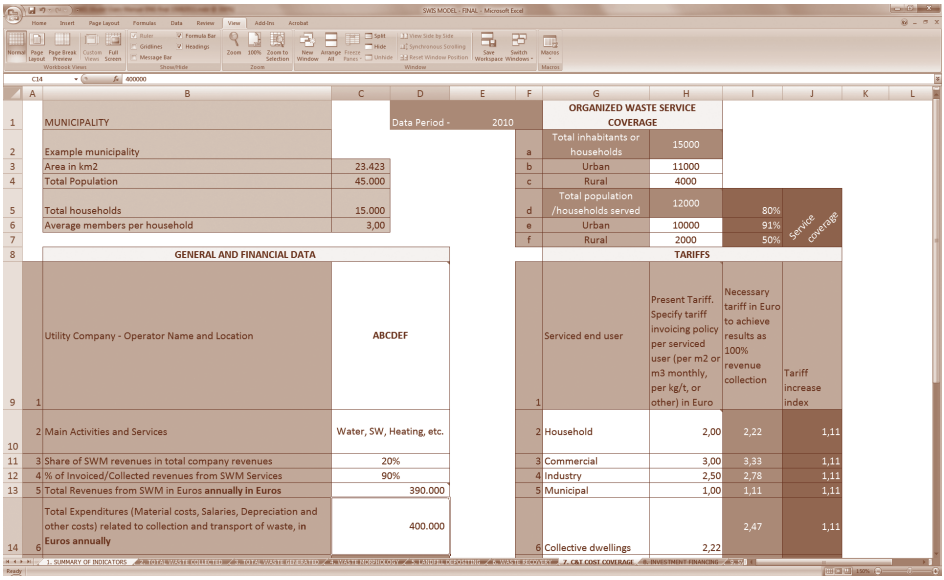
15	9	Leather	0%	-	100%	-	0%	-	0%	-	100%
16	10	Rubber	1%	155	100%	155	0%	-	0%	-	100%
17	11	Wood	4%	621	20%	124	0%	-	80%	497	100%
18	12	Other	0%	-	100%	-	0%	-	0%	-	100%
19		TOTAL ANUALLY	97%	15.062		8,704		5.862		497	14.566
20		% of Total				57,78%		38,92%		3,30%	100,00%
21		Landfill lifetime (traditional or controlled)									
22	13	Landfill operating days per year		365							
23	14	Average waste deposited in t per day without incineration		41,27							
24	15	Total projected landfill capacity in tonnes		500.000							
25	16	Present landfill capacity used to date		80%							
26	17	Capacity left in tonnes		100.000							
27	18	Years left at present depositing rate with incineration		6,87							
28	19	Years left at present depositing rate without incineration		6,64							

When data is entered in this Worksheet, press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to the next Worksheet. The same can be accomplished by pressing the next worksheet tab at the bottom of the page.

2.8. Worksheet 7 – Collection and transport cost coverage

ORGANIZED WASTE SERVICE COVERAGE

Figure 7. C&T Cost coverage



1	MUNICIPALITY		Data Period -	2010		ORGANIZED WASTE SERVICE COVERAGE					
2	Example municipality				a	Total inhabitants or households	15000				
3	Area in km2	23.423			b	Urban	11000				
4	Total Population	45.000			c	Rural	4000				
5	Total households	15.000			d	Total population /households served	12000	80%	Service coverage		
6	Average members per household	3,00			e	Urban	10000	91%			
7					f	Rural	2000	50%			
8	GENERAL AND FINANCIAL DATA					TARIFFS					
9	1 Utility Company - Operator Name and Location	ABCDEF			1	Serviced end user	Present Tariff. Specify tariff invoicing policy per serviced user (per m2 or m3 monthly, per kg/t, or other) in Euro	Necessary tariff in Euro to achieve results as 100% revenue collection	Tariff increase index		
10	2 Main Activities and Services	Water, SW, Heating, etc.			2	Household	2,00	2,22	1,11		
11	3 Share of SWM revenues in total company revenues	20%			3	Commercial	3,00	3,33	1,11		
12	4 % of Invoiced/Collected revenues from SWM Services	90%			4	Industry	2,50	2,78	1,11		
13	5 Total Revenues from SWM in Euros **annually in Euros**	390.000			5	Municipal	1,00	1,11	1,11		
14	6 Total Expenditures (Material costs, Salaries, Depreciation and other costs) related to collection and transport of waste, in **Euros annually**	400.000			6	Collective dwellings	2,22	2,47	1,11		

In this table the total number of inhabitants or households (row a) is copied from previously entered data. What needs to be entered in the white cells of **rows b and c** of the Organised waste Service Coverage Table is the number of urban and rural households, whose sum should equal the total population or households, in the table to the left, automatically generated from worksheet 2. If this sum is different, the cell (in row a) will change colour to red, indicating a data discrepancy that should be verified.

Rows e and f of the Organised waste Service Coverage Table, in the white cells, should contain data on the number of inhabitants or households covered by organized waste collection services. The sum of these two rows is calculated in row d (the numeric value in

this cell can be equal to total inhabitants or households in case of 100% service coverage, but cannot be larger. This value should be equal to the value entered in row1, column1 of Worksheet 2). If this sum is different, the cell (in row d) will change colour to red, indicating a data discrepancy that should be verified.

From this point on, the model calculates the percentage of organized waste service coverage.

2.8.1. General and financial data

This worksheet can be used for assessing the cost of collection and transport of municipal waste.

In **rows 1 and 2** basic information such as the name and location of the PUC, general information on main activities and services, indicating if it is a specialized or mixed communal services company.

Row 3 should provide basic data on what the share of waste management revenues is (in %), compared to total revenues.

In **row 4**, of the GENERAL AND FINANCIAL DATA Table, data on the percentage of collected tariffs in comparison to total invoiced revenues is entered. This data is used to calculate the necessary level of tariffs needed in order to achieve revenues at 100% collection, after tariffs are entered in the table on the right side of the worksheet (TARIFFS Table). When the appropriate tariff invoicing policy is entered, and the present tariff level, the TARIFFS Table will calculate the necessary increase in tariff in order to achieve full cost coverage, (under the assumption that the tariffs are calculated on that basis) and if the collection of accounts receivable is equal to the invoiced amount.

Row 5 should contain financial data (in Euros, with the possibility of entering all financial data in local currency) on annual revenues originating from municipal waste management.

Row 6 should contain financial data (in Euros, with the possibility of entering all financial data in local currency) on Total annual expenditures on municipal waste management (Material costs, Salaries, Depreciation and other costs) related to collection and transport of waste, (in Euros, with the possibility of entering all financial data in local currency).

After entering data on the total revenues and expenditures of organized waste collection and transport, in row 8 and 9, the model calculates the necessary increase in revenues or decrease in costs which needs to be achieved in order to balance revenues and expenditures.

In **row 11** the number of employees of the Public Utility Company engaged in waste management is entered. After this entry the model computes efficiency indicators for the Public Utility Company or operator such as quantity of waste collected annually per employee in tonnes, population served per employee, and employees per 1000 population served. Preferably the number entered should be the number of employees directly engaged in waste management.

Based on the financial data entered in this worksheet, the model calculates the cost of collecting and transporting municipal waste in Euros (or local currency if entered) per tonne in Row 15. This information is crucial for the company as well as for the municipality, as any future steps for improving efficiency or investment planning will depend on the quality of this data. That is why, before entering, this data needs to be carefully verified.

A notes text box is also provided, below the worksheet, for internal use.

When data is entered in this Worksheet, press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to the next Worksheet. The same can be accomplished by pressing the next worksheet tab at the bottom of the page.

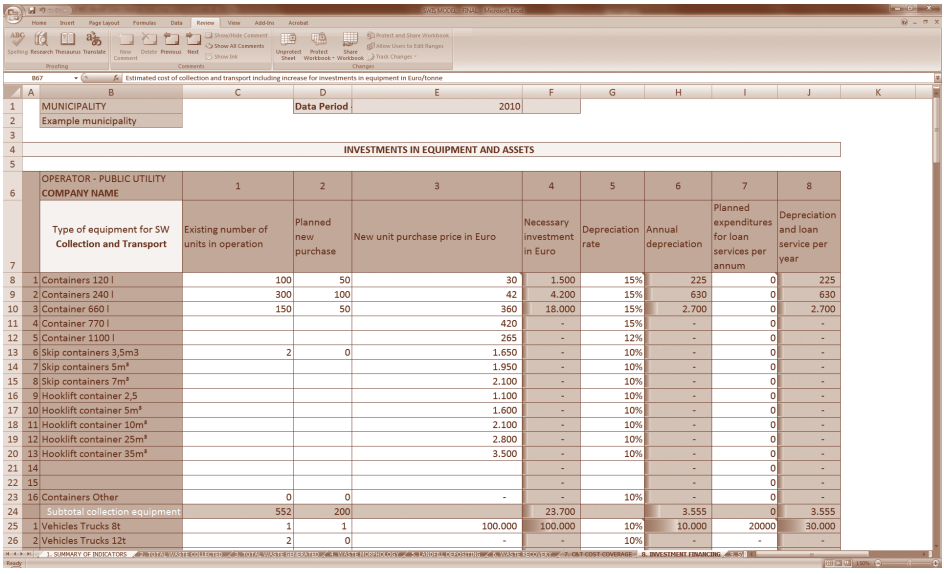
2.9. Worksheet 8 – Investment financing

INVESTMENTS IN EQUIPMENT AND ASSETS FOR MUNICIPAL WASTE COLLECTION, TRANSPORT, WASTE TREATMENT AND LANFILLS

This worksheet table can be used for assessing the additional expenditures for equipment renewal and investments in vehicles. Data is entered in columns 1-3, 5 and 7.

By entering the numeric values (row labelling for various equipment can be adapted to municipal needs) for the existing number of units in operation (**column 1**) and planned new purchases of waste containers and/or vehicles (**column 2**) and single unit price (**column 3**), the model will calculate the total planned investment value in Euros or local currency.

Figure 8. Investment financing



	A	B	C	D	E	F	G	H	I	J	K
1		MUNICIPALITY		Data Period	2010						
2		Example municipality									
3											
4				INVESTMENTS IN EQUIPMENT AND ASSETS							
5											
6		OPERATOR - PUBLIC UTILITY COMPANY NAME	1	2	3	4	5	6	7	8	
7		Type of equipment for SW Collection and Transport	Existing number of units in operation	Planned new purchase	New unit purchase price in Euro	Necessary investment in Euro	Depreciation rate	Annual depreciation	Planned expenditures for loan services per annum	Depreciation and loan service per year	
8	1	Containers 120 l	100	50	30	1.500	15%	225	0	225	
9	2	Containers 240 l	300	100	42	4.200	15%	630	0	630	
10	3	Container 660 l	150	50	360	18.000	15%	2.700	0	2.700	
11	4	Container 770 l			420	-	15%	-	0	-	
12	5	Container 1100 l			265	-	12%	-	0	-	
13	6	Skip containers 3,5m3	2	0	1.650	-	10%	-	0	-	
14	7	Skip containers 5m³			1.950	-	10%	-	0	-	
15	8	Skip containers 7m³			2.100	-	10%	-	0	-	
16	9	Hooklift container 2,5			1.100	-	10%	-	0	-	
17	10	Hooklift container 5m³			1.600	-	10%	-	0	-	
18	11	Hooklift container 10m³			2.100	-	10%	-	0	-	
19	12	Hooklift container 25m³			2.800	-	10%	-	0	-	
20	13	Hooklift container 35m³			3.500	-	10%	-	0	-	
21	14					-		-	0	-	
22	15					-		-	0	-	
23	16	Containers Other	0	0	-	-	10%	-	0	-	
24		Subtotal collection equipment	552	200		23.700		3.555	0	3.555	
25	1	Vehicles Trucks 8t	1	1	100.000	100.000	10%	10.000	20000	30.000	
26	2	Vehicles Trucks 12t	2	0	-	-	10%	-	-	-	

Data is entered (**column 5**) on the deprecation rate for equipment and vehicles in use.

Data based on information on financing costs from banks on the annual amount of loan services (optional) is entered in **column 7.**

Column 8 calculates the sum of annual depreciation and financing costs, by type of assets and the total sum per year.

This data is copied to the COLLECTION AND TRANSPORT COST CORRECTION Table, where in **row 3** data can be entered on estimated increase or decrease of the variable cost of collection and transport, i.e. increase of fuel costs, or decrease of maintenance costs, etc.

By entering data in this table the Model calculates the total investment value, depreciation and financing costs, all resulting in the calculation of the annual increase of cost for collection and transport per tonne in Euros and percentages, compared to present costs.

From row 39 all recycling, recovery and waste treatment investments are inserted. For depreciation reasons the investment is split into investigation, design and permission costs, financial requirements for land purchasing, mechanical installations, mobile equipment and installation and civil construction.

From row 48 sanitary landfill construction related investments are inserted. For depreciation reasons the investment is split into investigation, design and permission costs, financial requirements for land purchasing, mechanical installations, mobile equipment and installation and civil construction.

By entering data, the Model calculates the total investment value, depreciation and financing costs, all resulting in the calculation of the annual increase of costs for collection, transport treatment and landfilling per tonne in Euros and percentages, compared to present costs.

This Worksheet provides the municipality with information on what funds need to be invested in necessary or planned new equipment and vehicles, the cost of financing and the effect of different options of financing (in case of shortage of own funds) on the cost calculation for collection and transport of municipal waste, waste treatment and landfill investments. Furthermore, the cost calculated in this Worksheet (row 7of the COLLECTION, TRANSPORT, RECYCLING AND LANDFILL COST CORRECTION) represents a foundation for calculating full cost coverage tariffs, as it includes operative costs, depreciation and investment (financing) costs. A notes text box is also provided, below the worksheet, for internal use.

When data is entered in this Worksheet and all the necessary calculations have been performed, press the HOME button at the bottom of the worksheet to return to the DATA ENTRY MENU, and go to the RESULT MENU – SUMMARY OF INDICATORS, or go to the next Worksheet. The same can be accomplished by pressing the next worksheet tab at the bottom of the page.

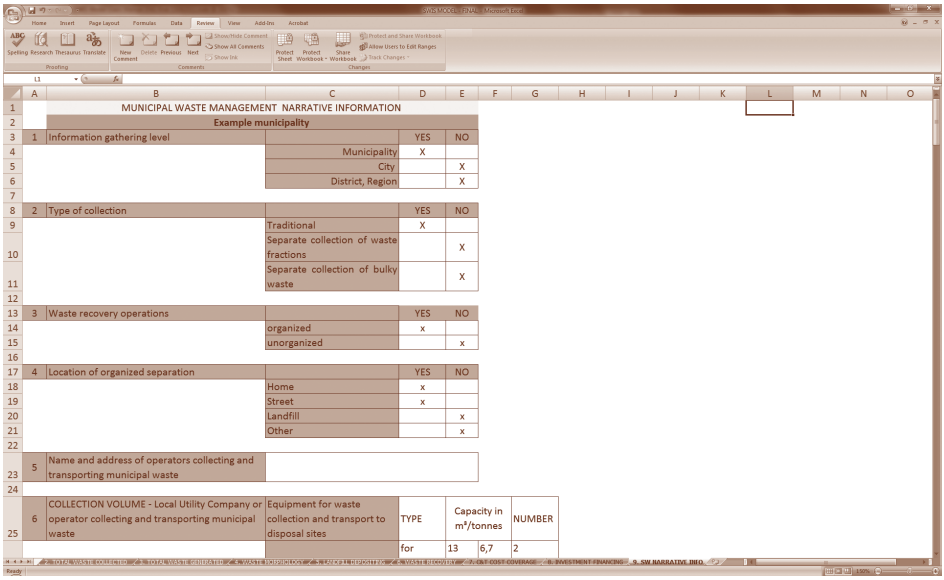
2.10. Worksheet 9 – Municipal waste management narrative info

This worksheet is not used for calculations, but for gathering basic textual information on the organization of municipal waste management.

In this worksheet textual information is entered on: Type of collection, Waste recovery operations, Location of organized separation, Local Utility Company – operator, Landfill - depositing site information, Full cost coverage for collection and transport to landfill/ depositing site, and Other.

The inventory of containers results in the presently provided volume as an indicator and comparable figure to the provided one under current service levels and those for optimal future service coverage levels of (100%).

Figure 9. SW narrative info



MUNICIPAL WASTE MANAGEMENT NARRATIVE INFORMATION

Example municipality

1	Information gathering level		YES	NO
		Municipality	X	
		City		X
		District, Region		X
2	Type of collection		YES	NO
		Traditional	X	
		Separate collection of waste fractions		X
		Separate collection of bulky waste		X
3	Waste recovery operations		YES	NO
		organized	x	
		unorganized		x
4	Location of organized separation		YES	NO
		Home	x	
		Street	x	
		Landfill		x
		Other		x
5	Name and address of operators collecting and transporting municipal waste			

6	COLLECTION VOLUME - Local Utility Company or operator collecting and transporting municipal waste	Equipment for waste collection and transport to disposal sites	TYPE	Capacity in m³/tonnes	NUMBER
			for	13 6,7	2

3. Result Interpretation

The primary goal of the SWIS model is to assist local governments in assessing and organizing information collection and processing, in a manner that will help them to obtain a clear picture of the state of waste management in their community.

The most important issues in municipal waste management that need to be assessed and the results of data processed and analyzed are:

- What are the quantities of waste generated, and how much is collected?
- What is the structure of mixed municipal waste?
- What is the amount of separation achieved?
- Is waste treated, if so how, and how is it disposed of?
- What are the costs and efficiency of the present system?

This is a starting point for LGA's in considering and planning further steps on how to improve municipal waste management in their communities.

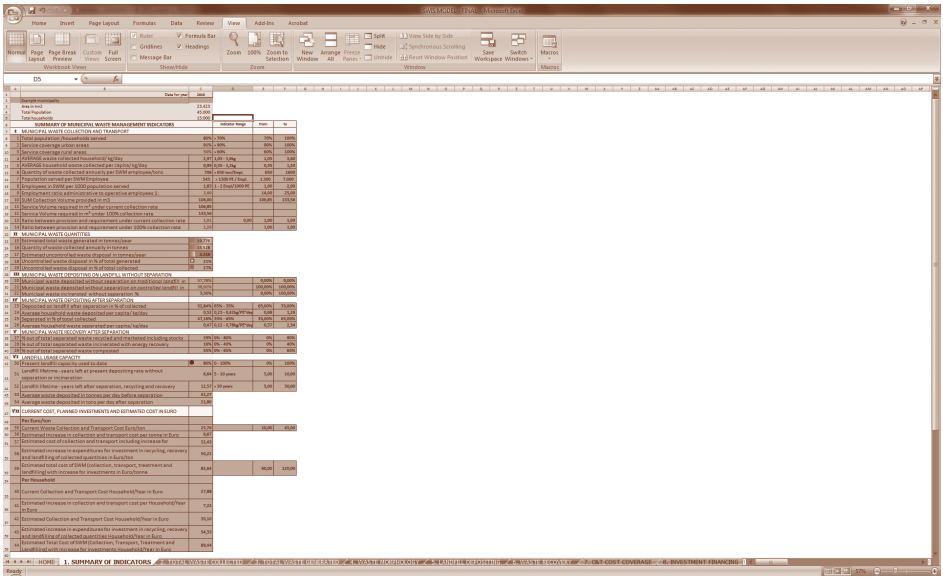
3.1. Result related data entries

The data in ***Worksheet 1*** enables the local governments to create a "snapshot" in real-time of the current situation in municipal waste management as an executive summary of all present activities, as it compiles all the data entry worksheets and their calculations in summary form. In addition, it offers the municipalities the possibility to explore different options by entering planned waste management data in data entry Worksheets 2-8, as it compiles all the previous worksheets and their calculations in summary form.

This Worksheet consists of **44 indicators**, resulting from the data entry Worksheets. At a glance, each of the indicators provides information (based on the availability and quality of municipal data entered) on important aspects of municipal waste management. After data entry has been finalized, it is up to the municipalities to analyze the results and plan measures to improve the quality of waste management.

This worksheet also contains **average indicator ranges** for comparison of obtained solid waste management indicators with recognised averages in the field. This can be an introduction to **benchmarking** for municipal authorities and service providers, as it can be expected that after entering relevant and reliable data, the results can be compared with others performing solid waste management in a similar environment (for example: urban or rural, territory coverage size, quantity and age of equipment, number of inhabitants, industrial or economic development level, hilly or flat terrain, and so on).

Figure 1.2. Example on results sheet



As mentioned, this Worksheet is a summary of results derived from data entry Worksheets 2-8. The potential for analysis and use of these indicators is given separately by each worksheet, as follows:

By entering data in ***Worksheet 2***, the computed result enables the municipality to asses information on:

- total number of serviced waste generators
- average waste density (conversion factor from m3 to tonnes)
- total quantities of collected municipal waste in tonnes, by type of waste origin
- optimize equipment and facilities to quantities
- making assumptions on future quantities
- planning different (new options) on waste management
- the structure of municipal waste by type of waste origin
- average daily quantities of waste collected per household and per capita in kilograms
- current provided collection volume (data from narrative info and container inventory)
- required collection volume under current collection rate
- required collection volume under 100% collection rate

By entering data in ***Worksheet 3***, the computed result enables the municipality to asses information on:

- the total approximated quantities of municipal waste that is generated, including quantities covered by organized waste collection.
- number of known waste generators not covered by organized waste collection
- estimation of how much waste out of total is not collected, representing the measured or estimated uncontrolled waste disposal in tonnes, at sites out of municipal control.
- potential for improving service coverage
- potential for reducing uncontrolled waste disposal

By entering data and determining the structure of municipal waste in ***Worksheet 4*** the local government can utilize this information for:

- determining the average structure of waste
- assessing the potentials of waste management in the process of separation and recycling
- plan targets for waste separation

By entering data in ***Worksheet 5***, the computed result enables the municipality to asses information on:

- total quantities of municipal waste deposited on landfills
- the structure of municipal waste and the quantities of recyclable materials that can be used for other purposes, but are deposited on a landfill because there is no organized selection
- the potential of waste separation by type of recyclable material
- the remaining landfill lifetime left for use if municipal waste is continually deposited at a given rate without separation
- planning new facilities or different type of waste management
- the potential additional expenditures in tipping or depositing fee charges usually charged at the gate of a controlled landfill.

By entering data in ***Worksheet 6***, the computed result enables the municipality to:

- determine how much municipal waste (in tonnes) is being separated and how much land filled, including the structure of the waste going into the landfill unused.
- explore various options for future steps and plans on the quantities of municipal waste by type of materials that are already separated (in order to improve selection for those who have started this activity) or can potentially be recycled (for those in the planning phase),
- determine the destiny of the separated materials, (marketed, composted or incinerated) so the local government will be able to asses the economic results and the environmental impact of these efforts.
- create awareness in the municipality of what the useful remaining lifetime of landfill is if municipal waste is continually deposited but waste separation is carried out, in comparison to landfill lifetime without separation.
- estimate the potential savings (as a result of the reduction of quantities of deposited waste) in tipping or depositing fee charges, usually levied at the gate of a controlled landfill.

By entering data in ***Worksheet 7***, the municipality can use the computed information for:

- assessing the cost of collection and transport of municipal waste per tonne with existing equipment and the present type of waste management
- assessing the necessary increase in revenues or decrease in costs which needs to be achieved in order to balance revenues and expenditures.
- assessing efficiency indicators such as the quantity of waste collected annually per employee in tonnes, population served per employee, and employees per 1000 population served.
- planning organizational or structural improvements in municipal waste collection and transport
- comparison with other municipalities operating under similar conditions.

The computed results in ***Worksheet 8*** enable the municipality to assess information on:

- what funds need to be invested in necessary or planned new purchases of equipment and vehicles,
- the cost of financing and the effect of different options of financing (in the event of shortage of own funds)
- the cost calculation for collection and transport of municipal waste, as a foundation for calculating full cost coverage tariffs, as it includes operative costs, depreciation and investment (financing) costs.

Worksheet 9. – Municipal waste management narrative info

This worksheet is only partly used for calculations, but mainly for gathering basic textual information on the organization of municipal waste management.

In this Worksheet the textual information on:

- Type of collection,
- Waste Recovery operations,
- Location of organized separation,

- Local Utility Company – operator,
- Landfill - depositing site information,
- Full cost coverage for collection and transport to landfill/ depositing site, etc.

can be used for waste management planning as well as providing various domestic and other institutions and potential investors on basic facts about the current state of waste management.

The computed results in ***Narrative info*** enable the municipality to assess information on:

- current provided collection volume,
- Service Volume required in m^3 under current collection rate
- Service Volume required in m^3 under 100% collection rate
- Ratio between provision and requirement under current conditions
- Ratio between provision and requirement under 100% collection rate conditions

3.2. Indicator interpretation

The ranges of appropriate results depend greatly on topography, geography, city and peripheral structures, available technology and facilities and the overall economic situation (affordability). In addition, there are also local or regional structures of crucial importance and operating practices (collection during night, double shift system to achieve fixed cost digression) and the current banking-loaning possibilities and conditions.

The ranges which can be modified shall be made explicit in a service level statement included in a policy clearly addressing the declaration of political will to:

A) Deliver an efficient and affordable service for the benefit of the population
B) Achieve increased service levels and audit those against service level- and key performance indicators

Two new terms shall be incorporated in all strategic and planning papers in a uniform way:

- Service levels (rate of service as a % to full service provision)
- Key Performance Indicators (KPIs – efficiency indicators to allow comparison between different models, plans and service providers)

Table 1. Summary of indicators (Result sheet)

	Data for year	2010			
	Example municipality				
	Area in km2	23.423			
	Total Population	45.000			
	Total households	15.000			
	SUMMARY OF MUNICIPAL WASTE MANAGEMENT INDICATORS		**Indicator Range**	**from**	**to**
I	MUNICIPAL WASTE COLLECTION AND TRANSPORT				
1	Total population /households served	80%	> 70%	70%	100%
2	Service coverage urban areas	91%	> 90%	90%	100%
3	Service coverage rural areas	50%	> 60%	60%	100%
4	AVERAGE waste collected household/ kg/day	2,97	1,05 - 3,6kg	1,05	3,60
5	AVERAGE household waste collected per capita/ kg/day	0,99	0,35 - 1,2kg	0,35	1,20
6	Quantity of waste collected annually per SWM employee/tons	706	> 650 ton/Empl.	650	1600
7	Population served per SWM Employee	545	> 1300 PE / Empl.	1.300	7.000
8	Employees in SWM per 1000 population served	1,83	1 - 2 Empl/1000 PE	1,00	2,00
9	Employment ratio administrative to operative employees 1:	3,40		14,00	25,00
10	SUM Collection Volume provided in m3	106,00		106,85	133,56
11	Service Volume required in m^3 under current collection rate	106,85			
12	Service Volume required in m^3 under 100% collection rate	133,56			
13	Ratio between provision and requirement under current collection rate	1,01	0,00	1,00	1,00
14	Ratio between provision and requirement under 100% collection rate	1,26		1,00	1,00
II	MUNICIPAL WASTE QUANTITIES				
15	Estimated total waste generated in tonnes/year	19.776			
16	Quantity of waste collected annually in tonnes	15.528			
17	Estimated uncontrolled waste disposal in tonnes/year	4.248			
18	Uncontrolled waste disposal in % of total generated	21%			
19	Uncontrolled waste disposal in % of total collected	27%			
III	MUNICIPAL WASTE DEPOSITING ON LANDFILL WITHOUT SEPARATION				
20	Municipal waste deposited without separation on *traditional landfill* in %	57,78%		0,00%	0,00%
21	Municipal waste deposited without separation on *controlled landfill* in %	38,92%		100,00%	100,00%
22	Municipal waste *incinerated* without separation %	3,30%		0,00%	100,00%
IV	MUNICIPAL WASTE DEPOSITING AFTER SEPARATION				
23	Deposited on landfill after separation in % of collected	52,84%	65% - 35%	65,00%	35,00%
24	Average household waste deposited per capita/ kg/day	0,52	0,23 - 0,42kg/PE*day	0,68	1,26
25	Separated in % of total collected	47,16%	35% - 65%	35,00%	65,00%
26	Average household waste separated per capita/ kg/day	0,47	0,12 - 0,78kg/PE*day	0,37	2,34
V	MUNICIPAL WASTE RECOVERY AFTER SEPARATION				
27	% out of total separated waste recycled and marketed including stocks	29%	0% - 80%	0%	80%
28	% out of total separated waste incinerated with energy recovery	16%	0% - 40%	0%	40%
29	% out of total separated waste composted	55%	0% - 65%	0%	65%
VI	LANDFILL USAGE CAPACITY				
30	Present landfill capacity used to date	80%	0 - 100%	0%	100%
31	Landfill lifetime - years left at present depositing rate without separation or incineration	6,64	5 - 10 years	5,00	10,00
32	Landfill lifetime - years left after separation, recycling and recovery	12,57	> 30 years	5,00	30,00
33	Average waste deposited in tonnes per day before separation	41,27			
34	Average waste deposited in tons per day after separation	21,80			
VII	CURRENT COST, PLANNED INVESTMENTS AND ESTIMATED COST IN EURO				
	Per Euro/ton				
35	Current Waste Collection and Transport Cost Euro/ton	25,76		10,00	45,00
36	Estimated increase in collection and transport cost per tonne in Euro	6,67			
37	Estimated cost of collection and transport including increase for investments	32,43			
38	Estimated increase in expenditures for investment in recycling, recovery and landfilling of collected quantities in Euro/ton	50,22			
39	Estimated total cost of SWM (collection, transport, treatment and landfilling) with increase for investments in Euro/tonne	82,64		60,00	120,00
	Per Household				
40	Current Collection and Transport Cost Household/Year in Euro	27,88			
41	Estimated increase in collection and transport cost per Household/Year in Euro	7,22			
42	Estimated Collection and Transport Cost Household/Year in Euro	35,10			
43	Estimated increase in expenditures for investment in recycling, recovery and landfilling of collected quantities Household/Year in Euro	54,35			
44	Estimated Total Cost of SWM (Collection, Transport, Treatment and Landfilling) with increase for investments Household/Year in Euro	89,44			

The summary page includes a total of 44 service level- and key performance indicators.

(1-3) Collection rate of urban and semi-urban areas shall be above 90%. Previous research has shown that Semi-urban areas such as city peripheries do not show big variations compared to urban areas, and are therefore included in the collection (service rate) of urban areas. The collection rate in rural areas shall be higher than 60%, which would result in a total service level of 70-80% municipal solid waste collection rate.

Proposed collection rates (service level indicators) in regard to time:

Urban and semi-urban areas:	>90%	→	>95%	→	~100%			
Rural areas:	>60%	→	>70%	→	>80%	→	>85%	→ ~100%

The total (depends on ratio of population in urban, semi-urban and rural areas and calculated according assumption 35-45%:65:55%)

Total:	>70%	→	>80%	→	>85%	→	>90%	→ >95%

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(4) The waste generation / collection of households depends on the per capita waste generation situation and on average members per household

It is strongly recommended to carry out a specific household waste generation survey – a standard programme and template is attached in chapter 4.4.

(5) Per capita waste generation/collection depend greatly on the economic situation, financial affordability and spatial location (urban or rural). The generation of municipal wastes ranks from 0.35 kg up to 1.2 kg (excluding ELVs, WEEEs and other special waste streams, not within the responsibility of the public service provider)

(6-9) Employee specific benchmarks depend on the rate of mechanisation. the mechanisation rate to be chosen depend significantly on income structure, unemployment rate and social constrains. An average mechanisation rate and usual (not optimum) ratio of administrative to operative staff allows **650** tonnes/employee and year. High mechanisation and an optimised ratio allow up to **1600** tonnes/employee and year.

The optimised ratio of administrative to operative staff starts from **1:14** and rises in extremely efficient service provision to **1:25**.

The population served per employee depends greatly on the spatial location, distance to the landfill, and collection system and population density of the served area. In urban areas, and at an average mechanisation rate, the usual ratio can be 3900 inhabitants served. This figure can reach levels above **7000** inhabitants. In rural areas one third (**1300** up to 2300 inhabitants) is realistic.

(10-14) The volume currently provided is the product of located container and collection devises by transport fluctuation. The current volume required is the product of the served population times the daily waste generation per inhabitant, divided by the specific waste density. The ratio between required and provided volume will be close to 1. The ratio between required volume under 100% collection conditions and current provided describes the additional volume needed and will support the investment decision-making process. If additional volume cannot be installed due to the lack of an investment budget, a more-shift system can be taken into consideration, with the additional positive affect of fixed-cost digression.

The required volume is strongly dependent on the daily waste generation rate per inhabitant and the waste density. The provided volume is the sum of every provided collection system for residues and recyclables.

(15-19) These calculation figures are mainly for information and comparison purposes. The difference between theoretical calculated waste generation and actually collected waste, results in the estimate of "uncontrolled" disposal.

(20-22) Waste disposal on traditional and sanitary sites are for information and planning purposes. Most cases have an either – or situation, only a few are mixed systems, where traditional disposal is operated in parallel with the sanitary landfill, especially during remediation activities filling the remaining volume.

(23-26) The deposit of waste onto landfill after separation (source, area, MBA, on disposal site, etc.) is the remaining percentage and strongly depends on segregation efficiency. Recycling rates are in the range from 0% to 65% (effective recycling quota – not to be compared with "recycling" rates actually published for Austria, Sweden and other EU countries, where thermal use and other recovery strategies are included in the recycling rates – >86%). The recycling rates per capita in kg per day depend on the spatial location (urban / rural) and waste generation per day, on the collection system for recyclables and on the waste composition (big differences between urban and rural areas). Ranges from 0 up to 0.42 kg/per inhabitant per day have to be taken into consideration. The figures reflect the effective (real) recycling quotas and not the recycling potential, which depends on consumer behaviour and waste composition.

(27-29) These benchmarks refer to the segregated waste and identify the amount of segregated waste recycled, recovered, reused, etc. Leftovers are mainly disposed of, or used for thermal energy recovery. Separated waste components might have recycling rates between 0 up to 80%, recovery rates up to 40% and composting rates up to 65% (MBA – figures). All percentages are in relation to separate collected, recycled, recovered, reused and composted input weight.

(30-34) These benchmarks refer to landfill capacities and remaining capacities, and result in years left for landfilling purposes referring to:

- traditional disposal activities with and without recycling and recovery
- sanitary disposal activities with and without recycling and recovery

New installations shall have a lifespan (disposal period) of 30 years minimum in correlation with a minimum 25 years depreciation period of construction facilities and reasonable CBA calculation modelling. Traditional sites shall not remain in use longer than the usual transition period of **10**-15 years. The lifespan of a disposal facility increases proportional to the recycling, recovery and reduction (avoidance) rates achieved.

(35-44) These figures, refer mainly to the financial implications for tariff development purposes with the aim of achieving full cost coverage. A comparison of current required collection costs with future projected costs (achieving 100% waste and tariff collection costs while taking the poor into consideration approximately 6-10% poverty rate included results in 90% of fee collection rates) and also with future required investment costs including investment requirements for segregation, recycling, landfilling, treatment, recovery, reuse, etc. result in a cost per tonne for municipal companies or operators and also fees per household and year (for full cost coverage). These figures represent only rough indicators based only on the overall increase of total expenditures. For a more accurate calculation an exact break down of costs and revenues for each segment should be performed, also including the specifics of possible technologies, financing options and institutional/organisational issues.

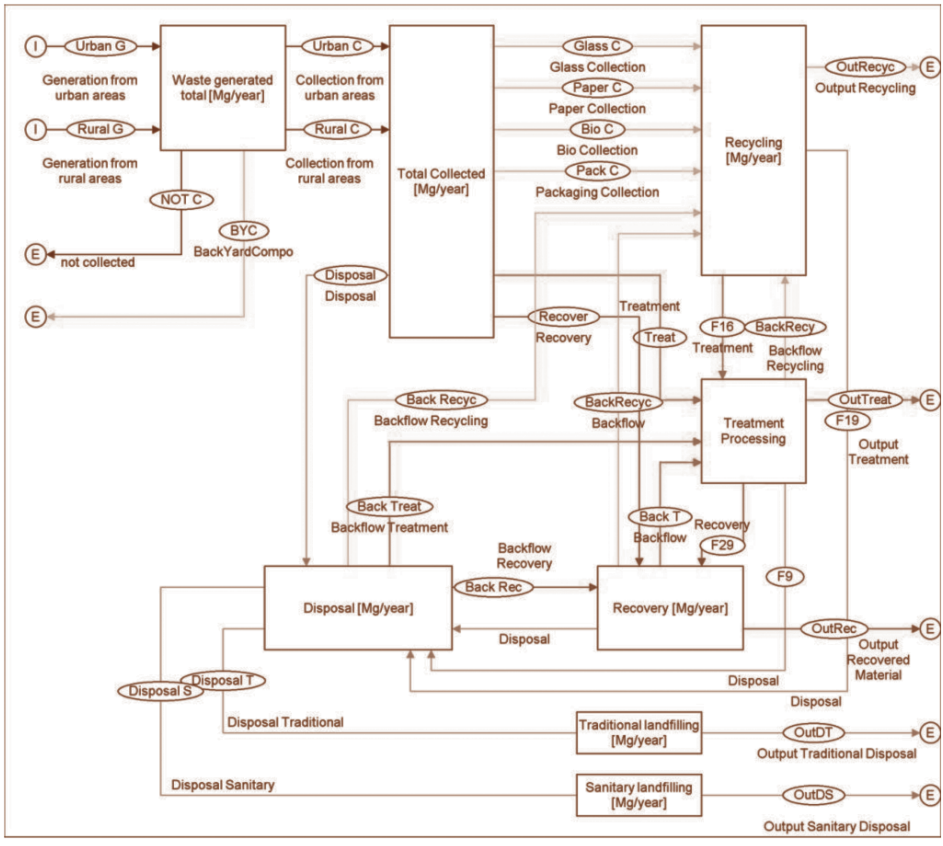
For landfilling there is currently a minimum tariff of 15 Euro per tonne benchmarked in order to ensure an adequate and standardised landfill operation including depreciation. Therefore the difference between collection costs alone, and the sum of collection and disposal costs will be >15 Euro. Independently of how the investment is financed (grants, soft loan, commercial loan, subsidies) the tariff calculation has been carried out under full-cost recovery perspectives.

3.3. Waste stream analyses (STAN model) – the next step

This chapter constitutes additional information provided. All data collection and processing activities lead into the next logical step of waste stream analyses for which various models can be used. One of these is STAN, which shall be introduced in this page.

STAN (short for subSTance flow ANalysis) is a freeware that helps to perform material flow analysis according to the Austrian standard ÖNorm S 2096 (Material flow analysis - Application in waste management).

Figure 10. Flow analysis – example for municipal service provision



After building a graphical model with predefined components (processes, flows, system boundary, text fields) you can enter or import known data (mass flows and stocks, volume

flows and stocks, concentrations, transfer coefficients) for different layers (good, substance, energy) and periods to calculate unknown quantities. All flows can be displayed in Sankey style, i.e. the width of a flow is proportional to its value. The graphical picture of the model can be printed or exported. For data import and export Microsoft Excel is used as an interface.

You also have the option of considering data uncertainties. The calculation algorithm uses mathematical statistical tools such as data reconciliation, error propagation and gross error detection.

4. Attachments

4.1. Remarks on data collection and most commonly used definitions

4.1.1. General remarks

The data requirements for this model are an attempt to "cover" relevant data for municipal waste collection and its computation in a information system model, but might not fit all countries as they have different levels of industrial development, social welfare, prosperity, consumption habits and technical development of waste management. This may sometimes lead to different data entries resulting in different indicators or misunderstandings of the indicators provided in the model, despite explanations and definitions.

4.1.2. Data gaps

First it must be mentioned that non-available information does not necessarily signify the existence of a data gap. If data refers to a certain kind of waste management and this management does not exist, then, of course, this data cannot be entered. Lack of data for such a reason can be called an artificial data gap. These data gaps resulting from non-existent waste management activities like 'collection of separate waste fractions' and 'other waste treatment facilities' (i.e. other than land filling) may explain major data gaps in the accession countries influencing possible comparison in waste management.

4.1.3. Lack of sufficient waste book-keeping

In addition to the artificial data gaps mentioned above, 'semi artificial ' data gaps also exist. These are due to the non-capability or unwillingness of enterprises (municipal waste collectors) to specify waste sources and waste types for the wastes they are collecting. These data gaps cannot be solved in the short or medium term. First of all, there should be an obligation for the enterprises to report on their waste management and these reports have to be controlled. Secondly, the reporting should be harmonized by the application of reporting formats. Data gaps resulting from non or less developed enterprise waste book-keeping can only be closed by the development and implementation of reporting formats from the side of the administration and by training of the employees responsible in the enterprises.

4.1.4. Data gaps resulting from non-existent surveys or missing data compilation

The data gaps which appear in waste management are mostly:

- the composition of mixed municipal waste;
- the collection of separate waste fractions;
- other waste treatment installations.

Although various studies on mixed municipal waste composition were carried out, it is very difficult for the accession countries to develop in this field. The most important problem which can be tackled directly is data quality.

4.1.5. Data quality

Data quality depends on the availability of technical and administrative tools.

First of all, weighing bridges for the precise determination of the quantities of wastes must be available. This is usually not the case for most of the landfills operating in the accession countries. In addition, the precise determination of waste types, waste sources and the structure of waste with municipal companies or operators in most accession countries is just starting and cannot be regarded as reliable.

4.1.6. Most commonly used definitions[1] in waste management

4.1.6.1. Waste

- refers to materials that are not primary products (i.e. products produced for the market) for which the generator has no further use for their own purposes of production, transformation or consumption, and which he discards, or intends or is required to discard. Wastes may be generated during the extraction of raw materials, during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity.

4.1.6.2. Municipal waste

- Municipal waste includes household waste and similar waste.

The definition also includes:

- bulky waste (e.g. white goods, old furniture, mattresses); and yard waste, leaves, grass clippings,
- households commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings).
- waste from selected municipal services, i.e. waste from park and garden maintenance, waste from street cleaning services (street sweepings, and the content of litter containers, market cleansing waste)[2].

1 Eurostat/OECD

2 Municipal waste) is a complex and blurred term. In general, it includes household waste and waste originating from other sources. The degree of precision and accuracy in definition is not yet satisfactory in most regions. This makes any comparison between countries fragile. Comparisons, having in mind different practices, can at best indicate differences.
Regarding municipal waste in general, there are three types of waste distinguished: Household waste (as a specific waste type); Bulky waste and others.
It is not easy for the accession countries nor for EU Member States and other OECD countries to split up their waste amounts collected accordingly. The reasons are that bulky waste belongs to household waste type if it is collected despite its 'bulkiness' together with 'normal' household waste. Only if the 'bulkiness'-character leads to separate collection activities, can it and should it be then specified. This might lead to a certain level of confusion because bulkiness is a relative concept related to the volume of garbage tonnes and containers available. Also the differentiation between household waste including similar waste and 'other wastes' is not obvious or easy to identify.

4.1.6.3. Biodegradable waste

Any waste that is capable of undergoing anaerobic or aerobic decomposition such as food waste or garden waste, but also paper waste.

4.1.6.4. Bulky waste

Waste that, due to its bulky character needs special consideration for its management, such as white goods, old furniture, mattresses, etc. Excludes construction and demolition waste.

4.1.6.5. Composting

A biological process that submits biodegradable waste to anaerobic or aerobic decomposition, and that results in a product which is recovered.

4.1.6.6. Construction and demolition waste

Construction and demolition waste: rubble and other waste material arising from the construction, demolition, renovation or reconstruction of buildings or parts thereof, whether on the surface or underground. Consists mainly of building material and soil, including excavated soil. Includes waste from all origins and from all economic activity sectors.

4.1.6.7. Controlled landfill

Landfill whose operation is submitted to a permit system and to technical control procedures in compliance with the national legislation in force. Includes specially engineered landfill.

4.1.6.8. Disposal

Disposal is defined as any waste management operation serving or carrying out the final treatment and disposal of waste. It covers the following main operations:

Final treatment:

- Incineration without energy recovery (on land; at sea)
- Biological, physical, chemical treatment resulting in products or residues that are discarded, i.e. going to final disposal.

Final disposal:

- Deposit into or onto land (e.g. landfill), including specially engineered landfill
- Deep injection
- Surface impoundment
- Release into water bodies

4.1.6.9. Landfill

Landfill is defined as deposit of waste into or onto land, including specially engineered landfill, and temporary storage of over one year on permanent sites.

4.1.6.10. Service level indicator – Population served by public service provider

The percentage of addresses within a municipality where household waste is collected regularly by or on behalf of the municipal authorities.

4.1.6.11. Recovery

Recovery is defined as any waste management operation that diverts a waste material from the waste stream and which results in a certain product with a potential economic or ecological benefit. Recovery mainly refers to the following operations:

- material recovery, i.e. recycling;
- energy recovery, i.e. re-use a fuel;
- biological recovery, e.g. composting;
- re-use.

Direct recycling or reuse within industrial plants at the place of generation is excluded.

4.1.6.12. Recycling

Recycling is defined as any reprocessing of material in a production process that diverts it from the waste stream, except reuse as fuel. Both reprocessing as the same type of product, and for different purposes should be included. Direct recycling within industrial plants at the place of generation should be excluded.

4.1.6.13. Treatment

Treatment means the physical, thermal, chemical or biological processes that change the characteristics of the waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery.

4.1.6.14. Waste management

Waste management means the collection, transport, treatment and disposal of waste, including after-care of disposal sites.

4.2. Standard calculations

4.2.1. Standard collection calculation

0.6 kg/PE*day	≡ 3.5 l / PE*day
70%	collection rate in urban areas
25%	collection rate in peripheral areas
2%	yearly increase of waste production
750 kg/m^3	compacted waste on landfill
325 kg/m^3	loose waste from households

PE…	Population Equivalent
Vl…	Volume loose
Vc…	Volume compacted
Vtc…	Volume total compacted
VT…	Volume Total (inclusive cover material)
Wl…	specific Weight of loose fraction
Wc…	specific Weight of compacted fraction
Ru…	Collection Rate in urban areas
Rr…	Collection Rate in rural areas
Wr…	Waste increase rate
Y…	Years
Wp…	Waste production
Cf…	Cover material factor in 1+ % (0.15)

$Wp = PE \times 0.6\ kg/day \times 365\ days$	➔ [kg/Year]
$Vl = Wp / Wl$	➔ [m^3]
$Vc = Wp / Wc$	➔ [m^3]
$Vtc = (Vcu \times Ru) \times (Wr)^Y + (Vcr \times Rr) \times (Wr)^Y$	➔ [m3]
$Vtc_y = [(Vcu \times Ru) + (Vcr \times Rr)] \times (Wr)^Y$	➔ [m^3]
$VT_y = Vtc \times Cf$	➔ **[m^3]**

4.2.2. Landfill calculation schemes

7 to 10%	Amount of demolition waste
2 to 03%	Amount of scrap metal
0 to 01%	Amount of other fractions
2%	yearly increasing of waste production
560 kg/m^3	compacted waste on landfill with Dozer
750 kg/m^3	compacted waste on landfill with Compactor
1000 kg/m^3	demolition waste
325 kg/m^3	lose waste from households
1.72	compaction rate with Dozer
2.31	compaction rate with Compactor
10%	settling rate of demolition waste

HW…	Household Waste	
DW…	Demolition Waste	
SM…	Scrap Metal	
OF…	Other Fraction	
V_{hw}…	Volume household waste	[in m^3]
V_{dw}…	Volume demolition waste	[in m^3]
V_{sm}…	Volume scrap metal	[in m^3]
V_{of}…	Volume other fractions	[in m^3]
P_{hw}…	Partial amount of household waste	[in %]
P_{dw}…	Partial amount of demolition waste	[in %]
P_{sm}…	Partial amount of scrap metal	[in %]
P_{of}…	Partial amount of other fraction	[in %]

CR_{hw}…	Compaction Rate household waste	[fact.]
SR_{dw}…	Settling Rate demolition waste	[in %]
Vtl…	Volume total lose	[in m^3]
Vtc…	Volume total compacted	[in m^3]
VT…	Volume Total (incl. Cover Material)	[in m^3]
Wl…	specific Weight of lose fraction	[in kg/m^3]
Wc…	specific Weight of compacted fraction	[in kg/m^3]
WDR...	Waste disposal rate	[in m^3]
WRR…	Waste recycling rate	[in m^3]
Wir…	Waste increase rate	[in %]
Y…	Years	[in a]
Wp…	Waste production	[in kg]
Cf…	Cover material factor	[in 1+ %]

$V_{hw} = Vtl * P_{hw}$	➔ [m^3]
$V_{dw} = Vtl * P_{dw}$	➔ [m^3]
$V_{sm} = Vtl * P_{sm}$	➔ [m^3]
$V_{of} = Vtl * P_{of}$	➔ [m^3]
$Vtl = W_{DR} + W_{RR} = V_{hw} + V_{dr} + V_{sm} + V_{of}$	➔ [m^3]
$W_{DR} = V_{hw} + V_{dw} + V_{of}$	➔ [m^3]
$W_{RR} = V_{sm}$	➔ [m^3]
$Vtc = [(V_{hw} \times CR_{hw}) + (V_{dw} \times SR_{dw}) + V_{of}] \times (W_{ir})^{Y}$	➔ [m^3]
$VT_y = Vtc \times Cf$	➔ **[m^3]**

4.3. Advanced waste collection efficiency calculations

4.3.1. Waste collection time – Time Index

One very important figure, the Time Index, which reflects the Waste Collection time (WCt), and results in the ratio of the Loading Time (LT) and the Transport Time (TT).

4.3.2. Specific loading time (sLT)

This shows the time, which is used to drive one container to tip, and to drive back to point Y divided by the size of the container:

Table 2. Waste collection with skip – 5m³ containers

Capacity Calculation – Logistic System – Skip (5m³)															
TERMS		in Town				Landfill			in Town						
ZONE	Container Size [m³]	Time to Load [min]	Time for net [min]	Time to point x [min]	TOTAL	Time to Landfill [min]	Time to tip [min]	TOTAL	Time from Landfill [min]	Time to reload [min]	TOTAL	Waste Collection Time (WCT)	Percent Loading Time (%LT)	Percent Transport Time (%TT)	Time Index Loading Time (LT) Transport Time (TT) LT : TT 1 : X
I	5	5	3	8	**16,00**	20	6	**26,00**	20	5	**25,00**	**70,00**	**23%**	**77%**	**3,38**
II	5	5	3	6	**14,00**	20	6	**26,00**	20	5	**25,00**	**63,00**	**22%**	**78%**	**3,50**
III	5	5	3	5	**13,00**	20	6	**26,00**	20	5	**25,00**	**63,00**	**21%**	**79%**	**3,85**
IV	5	5	3	4	**12,00**	20	6	**26,00**	20	5	**25,00**	**64,00**	**19%**	**81%**	**4,33**
V	5	5	3	3	**11,00**	20	6	**26,00**	20	5	**25,00**	**65,00**	**17%**	**83%**	**4,91**

The Time Index describes the proportion between the net Loading Time (LT) to the net Transport Time (TT). A system will show a Time Index between 1:0.25 to 1 : 0.4.

The above table demonstrates inefficiency in the Time Index of 1: 3.4 to 1: 4.9. This shows very exactly that inefficient way times (over 70%) must be reduced by using less containers with higher volume capacity or to change the system to a 1.1m³ system, as shown in the next table.

Table 3. Waste collection with tractor

	in Town				in Town		TOTAL		
Item	**Time to Load [min]**	**Time for net [min]**	**Time to point x [min]**	**Loading Time [min]**	**Time to Landfill [min]**	**Time to tip [min]**	**Time from Landfill [min]**	**Time to reload [min]**	**TOTAL/TOUR**
Tractor 4m³	90		10	**100**	25	8	25	0	**158**

Transport Time (TT) : Loading Time (LT) = 158 – 100 : 100 = 58 : 100 = **1 : 1.72**

% of Transport Time (TT) of Waste Collection time (WCt) = **37%**

% of Loading Time (LT) of Waste Collection time (WCt) = **63%**

Table 4. Waste collection with compaction trucks for 1.1m³ containers

Capacity Calculation - Logistic System – Compaction Truck (1.1m³)															
TERMS		**in Town**				**Landfill**			**in Town**						
ZONE	**Container Size [m³]**	**Time to Load [min]**	**Time for net [min]**	**Time to point x [min]**	**TOTAL**	**Time to Landfill [min]**	**Time to tip [min]**	**TOTAL**	**Time from Landfill [min]**	**Time to reload [min]**	**TOTAL**	**Waste Collection Time (WCT)**	**Percent Loading Time (%LT)**	**Percent Transport Time (%TT)**	**Loading Time (LT) Transport Time (TT) LT : TT 1 : X**
I	1,1	4	0	0,23	**4,23**	0,57	0,17	**0,74**	0,57	0,14	**0,71**	**5,69**	**74%**	**26%**	**0,34**
II	1,1	4	0	0,17	**4,17**	0,57	0,17	**0,74**	0,57	0,14	**0,71**	**5,63**	**74%**	**26%**	**0,35**
III	1,1	4	0	0,14	**4,14**	0,57	0,17	**0,74**	0,57	0,14	**0,71**	**5,60**	**74%**	**26%**	**0,35**
IV	1,1	4	0	0,11	**4,11**	0,57	0,17	**0,74**	0,57	0,14	**0,71**	**5,57**	**74%**	**26%**	**0,35**
V	1,1	4	0	0,09	**4,09**	0,57	0,17	**0,74**	0,57	0,14	**0,71**	**5,54**	**74%**	**26%**	**0,36**

All these Times Indices are in the range of 1 : 0.25 to 1 : 0.4.

Main Figures and Measurements to decrease the Time Index :

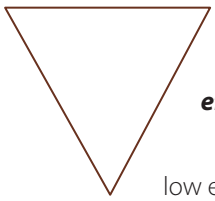
- System Change (from skip system to waste bin system)
- Size change of skip system (from 5m³ to 7m³) and container reduction
- Loading Stations for waste transfer (especially for tractors)

System Replacement		Skip System	Skip System	Skip System	Waste Bins	Tractor
	SIZE in m³	m³	m³	m³	m³	m³
System	xx	3	5	7	1.1	4
Skip-System	3	1	2	2	0	1
Skip-System	5	1	1	1	0	1
Skip-System	7	0	1	1	0	1
Waste Bin	1,1	2	4	5	1	3
Tractor System	4	1	1	2	0	1

4.3.3. Change of priorities regarding efficiency rates

Because of former system calculation shows the result that following hierarchy shall not be interrupted:

1 Compaction Truck – "Compactor"
2 Compaction Truck – Rotopress
3 Skip Truck 7 m³
4 Skip Truck 5 m³
5 Tractor



Only an upper system shall replace a lower system because of the lower time index, which also results in lower operation costs.

4.4. Analysis standards

The analysis shall be split into three different objectives:

- Qualitative Analysis in order to identify the waste composition and density
- Quantitative Analysis in order to identify the specific waste production per Inhabitant (PE) and day
- Transport and Collection rate analysis in order to identify the waste amount transported to the landfills in comparison to the produced waste within the investigation area

4.4.1. Qualitative analysis

4.4.1.1. Techniques

Qualitative waste analysis shall either be carried out in waste (management) recycling centres or on the spot of collection (field). All investigation areas have to be split into zones of 20,000 PE, while in every zone an amount of at least 3m^3 shall be analysed (equal to 3 containers of 1.1m^3). All investigation points have to be described regarding their characteristics, collection system and identified with GPS (UTM coordinates).

A leader, an assistant, 3 to 4 workers and a local supervisor shall conduct the analysis. The labour force shall be hired locally or has to be organised from the public service provision company. The different components have to be segregated by hand and all organic components to be screened with a 40 mm grid. The weight and the volume of each component are to be measured, recorded and photographically documented.

Equipment needed is limited to 3 shovels, 3 brooms, 60 litre Plastic bags for volume determination, 2 hand scales (1 to 3 kg and 1 to 20 kg) and PPE[3] for working and site safety such as uniforms, working boots, leather gloves and FFP1 dust filters. In addition a calculator and recording sheets (forms) will be required.

4.4.1.2. Segregated components

The investigation includes 20 different components such as Organic >40mm, Organic <40mm; Plastic packages such as PP, PS (foamed and not foamed), LDPE, HDPE; PET with recycling potential, compound materials such as nappies with energy recovery potential; recyclable glass (coloured and transparent) and none-recyclable glass (eg. Mirror); wood; inert material; hazardous components; paper (class I – III) and cardboard (class IV), and metals (Alu cans, ferrous metals and other none-ferrous metals). This detailed investigation allows a later calculation based grouping of components. In addition, all components are described according their specific characteristics.

The organic component <40mm shall be analysed in the laboratory regarding humidity (water content in %), Ash content [%] and wet density [ml/1000ml]. Samples are prepared according to the "Quarter Methodology", while the whole amount of waste <40mm is divided quarterly several times until a relevant amount of 3 to 5 kg is reached. This amount was pre-segregated from plastic compounds and all artificial TOC[4] influencing components.

3 PPE = Personal Protection Equipment
4 TOC = Total Organic Carbon [in %] – European Landfill Standard <5% implemented since 01.01.2004 in Austria and 01.07.05 in Germany.

4.4.1.3. Form for qualitative analysis

Table 5. Standard template for qualitative municipal solid waste analysis

Municipal Solid Waste Analysis					
Mun/Com/Vil	(1)	Analysis Nr.	Date		(4)
Zone	(2)	(3)	System		(5)
Structure Description				(6) (7)	
Amount of Containers	(8)	Containers			
Amount of Volume	=(15)	litre			
Results	kg	Litre	Density	Mass %	Description
Organic	(9.1)	(10.1)	(11.1)	(12.1)	(13.1)
Organic <40mm	-	-	-	-	
Paper (Class I - III)	-	-	-	-	
Cardboard (Class IV)	-	-	-	-	
Glass (bottles)	-	-	-	-	
Glass (other)	-	-	-	-	
Ferrous Metal	-	-	-	-	
Metal - alumin (cans)	-	-	-	-	
None-Ferrous Metals	-	-	-	-	
Wood	-	-	-	-	
Compound Material	-	-	-	-	
PET	-	-	-	-	
LDPE - Plastics	-	-	-	-	
HDPE - Plastics	-	-	-	-	
Polystyrene foamed	-	-	-	-	
Polystyrene - PS[5]	-	-	-	-	
Other Plastics	-	-	-	-	
Textiles	-	-	-	-	
Inert Material	-	-	-	-	
Hazardous Waste	-	-	-	-	
others	-	-	-	-	
Results	(14)	(15)	(16)	(17)	

(1)… Name of Municipality or Commune or Village with a (Abbreviation) in Brackets – M for Municipality; C for Commune and V for Village;

(2)… Zone of the investigation area in Roman letters; Example: **I**

(3)… Analysis Number in Arab numerals; Example: **1;** it can happen, that one zone, for whatever reason has to be analysed twice.

(4)… date of analysis in dd/mm/yyyy; Example: **02/06/2011**

5 Not foamed

(5)… The system of the existing collection in volume and unit; Example: 1.1m^3; 5m^3, 0.06m^3, loose,…

(6)… Description of the waste producing facilities and living structure; Example: 85% apartments, 10% houses, 5% business and coffee shops

(7)… Coordinates of the waste collection point, measured with GPS in WGS 1984 and UTM Grid for further processing in GIS. One analysis investigates minimum 1 zone, which includes minimum 3 collection points. All of the points have to be measured. The points have to be described as following:

A) Location I – X

B) GPS – Waypoint Number; Example: WP 254

C) Coordinates in Raster Sector; Altitude; X-Coordinates; Y-Coordinates; separated by semicolon; Example: UTM 34T; 879; 0481369; 4496271

Example: Location I - WP 254 (UTM 34T; 879; 048136; 4496271); Location II - WP255 (UTM 34T; 866; 0481184; 4496526)

(8)… Amount of investigated bins; Example: 3

(9)… Sum of weight for each component in kg

(10)… Sum of volume for each component in litres

(11)… Calculation of Density according Formulas a.) – Result in kg/m^3

(12)… Calculation of % of total amount according Formula b1.) – Result in %

(13)… Description of specific condition of waste and composition; Example: 10% newspaper, 80% office paper, 10% mixed paper

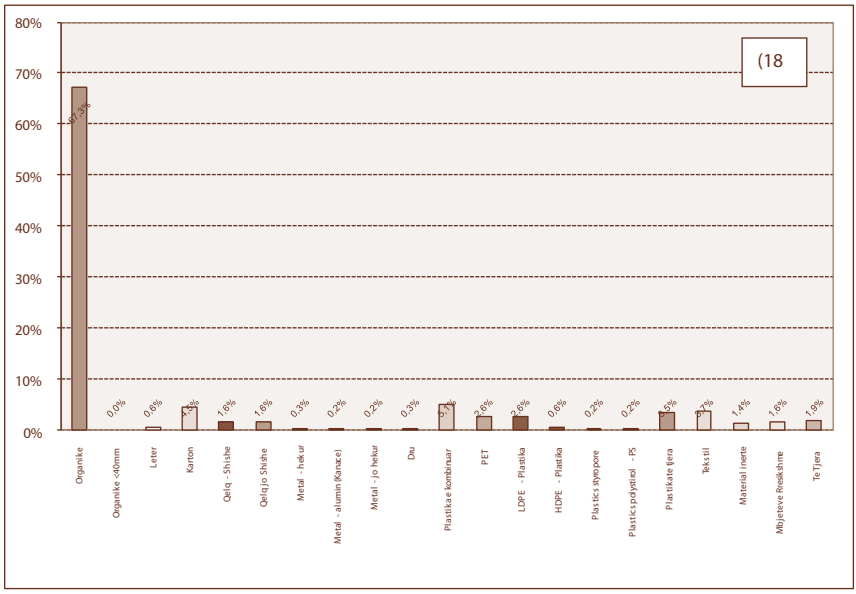
(14)… Total sum of all component weights (Σ_w) in kg

(15)… Total sum of all component volumes (Σ_v) in litres

(16)… Calculation of Total Density according Formulas a.) – Result in kg/m^3

(17)… Sum of total weight percentages; Result has to be 100%

(18)… Chart of weight percentages – x-categories are identical to waste components, y-axis are the percentages with a scale not exceeding an interval of 10%, bars in different colours for better identification. The chart has to be developed for each zone. The Form and chart are produced in an Excel worksheet operating several functions automatically. In addition, the chart generates automatically. All figures, shown in red in the chart have to be filled in, all figures shown in blue are automatic calculations. The chart is self-generating.



4.4.1.4. Formulas

a) Density Calculation

$$\frac{\Sigma_w \text{Weight}_{net} \text{ of Component X [in kg]}}{\Sigma_v \text{Volume}_{net} \text{ of Component X [in litre]}} / 1000 \text{ litre} \times m^{-3} = \textbf{Density Component X [kg xm}^{-3}\textbf{]}$$

b) Percentage of Component to total amount

b_1) Weight or Mass %

$$\frac{\text{Component X [in kg]}}{\Sigma \text{ Components [in kg]}} \quad X\ 100 = \text{Amount of Component X [in \%]}$$

b_2) Volume %

$$\frac{\text{Component X [in litre]}}{\Sigma \text{ Components [in litre]}} \quad X\ 100 = \text{Part of Component X [in \%]}$$

c) Water Content of Biodegradable Waste <40mm

$$\frac{a^{6} - b}{a - c} = \frac{\text{Mass}_{net}\ [\text{in gr}]}{\text{Mass}_{brut}\ [\text{in gr}]} \times 100 = \text{Water Content [in \%]}$$

4.5. Quantitative analysis

4.5.1. Techniques

The quantitative analysis focuses on the daily waste production for a period of minimum 14 days and an optimum period of 21 days. A minimum of 20 households are investigated on a daily basis (also on weekends). Further, the number of occupants in each of the investigated households is registered. All waste production data is recorded in grams.

The equipment needed is limited to Plastic bags, distributed to the involved households, one-hand scales (1 to 3 kg) and PPE[7] for working and site safety such as leather gloves. A calculator and recording sheets (forms) are also needed

The quantitative analysis follows in those zones (collection points), where the qualitative analysis had been conducted, in the surroundings of each collection point. Persons familiar with the local conditions and situations are hired and in most of the operation are inspected by the supervisor of the municipality or commune.

4.5.1.1. Form for qualitative analysis

(1)… Name of Municipality or Commune or Village with a (Abbreviation) in Brackets – M for Municipality; C for Commune and V for Village;

(2)… Zone of the investigation area in Roman letters; Example: **I**

(3)… first day of analysis in dd/mm/yyyy; Example: **02/06/2011**

(4)… last day of analysis in dd/mm/yyyy; Example: **15/06/2011 (=first day+ (n days –1))**

(5)… Amount of inhabitants permanently living in the investigated household

(6)… Waste Production in grams for each day

6 a = Mass gross (material + impurities) before drying process; b = Mass brut (material + impurities) after drying process of impurities; c = mass of impurities;

7 PPE = Personal Protection Equipment

Table 6. Standard template for qualitative municipal solid waste analysis

Quantitative Waste Analysis Form																						
Mun/Com/Vil	(1)			Zone	(2)		First Day			(3)			Last Day			(4)						
Household HH	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	SUM
PE/HH	(5)																				
Day 1	(6)																				
Day 2																					
Day 3																					
Day 4																					
Day 5																					
Day 6																					
Day 7																					
Day 8																					
Day 9																					
Day 10																					
Day 11																					
Day 12																					
Day 13																					
Day 14																					
Day 15																					
Day 16																					
Day 17																					
Day 18																					
Day 19																					
Day 20																					
Day 21																					
SUM	(7)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(8)
Days	(9)																				
Prod/day	(10)																				
Prod/day x PE	(11)																				

(7)… Sum of the amount of waste (in grams) produced during the investigation period of the investigated household

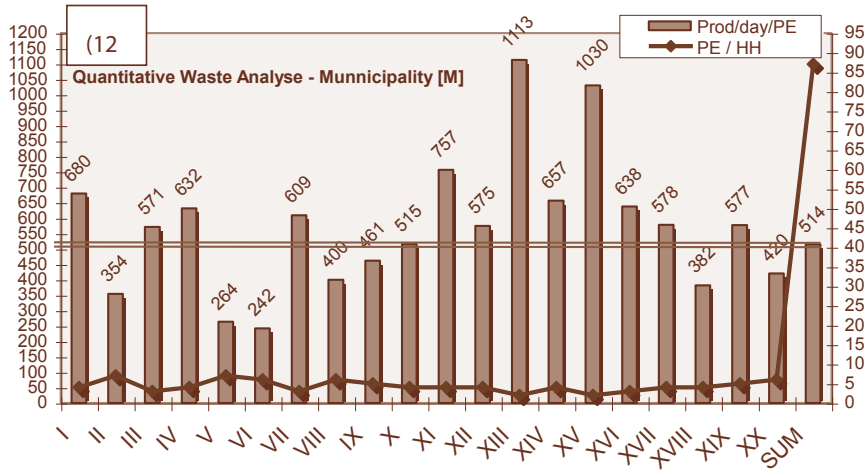
(8)… Sum of the amount of waste (in grams) produced during the investigation period from all investigated households

(9)… Analysis period of the investigated households (in days)

(10)… Waste production per day (in grams) of the investigated household; according to formula c) → Result in grams / day (or grams x day-1)

(11)… Waste production per day and inhabitant (PE) of the investigated household; according to formula d) → Results in grams / day / PE (or in grams x day^{-1} x PE^{-1})

(12)… Chart of average waste production per day and population equivalent (inhabitants) in grams – x-categories are identical with households investigated, on the y1-axis are the average waste production per day and inhabitant, with a scale not exceeding an interval of 50 grams and in bar form. Y2-axis is the inhabitants of the different households as a line. The chart can be developed for each municipality or commune.



4.5.1.2. Formulas

c) Average Waste Production per Day

$$\frac{\Sigma_{w}\,\text{Weight of Waste of household}_{\,1\rightarrow XX}\ [\text{in grams}]}{\Sigma_{d}\,\text{Days of investigation}_{\,1\rightarrow 21}\ [\text{in days}]} = \textbf{average Waste Production / Day [grams/day]}$$

d) Average Waste Production per Day and Inhabitant

$$\frac{\text{Average Waste Production / Day of household}_{\,1\rightarrow XX}\ [\text{in grams / day / household}]}{\Sigma_{PE}\,\text{Population Equivalent of household}_{\,1\rightarrow XX}\ [\text{in PE}]} =$$

= average Waste Production / Day / Population Equivalent [grams / day / PE]

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This project is financed by:

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CIP - Каталогизација во публикација
Национална и универзитетска библиотека "Св. Климент Охридски", Скопје

004.658:[628.472.3:352(035)

MUNICIPAL solid waste information system (SWIS) model : users manual. - Skopje : Network of Associations of Local Authorities of South East Europe - NALAS, 2011. - 65 стр. : илустр. ; 23 см

ISBN 978-9989-2928-9-7

а) Управување со база на податоци - Цврст отпад - Локална самоуправа - Прирачници
COBISS.MK-ID 89224202

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