Office of Environmental Enforcement

Protocol For The Evaluation Of Biodegradable Municipal Waste Sent To Landfill

Environmental Protection Agency

Protocol For The Evaluation Of Biodegradable Municipal Waste Sent To Landfill

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- Irish Wastes Management Association (IWMA)
- Greenstar
- Bord na Mona Resource Recovery
- Midland Regional Waste Management Steering Group
- Office of Local Authority Management (OLAM) Incorporating the County and City Managers Association (CCMA)

LIST OF TERMS

1 Bin means a collection system without source segregated collection. **2 Bin or 3 Bin System** refers to a source segregated collection system where dry recyclables and residual wastes are separately collected (2 bin), or where dry recyclables, organics and residuals are separately collected (3 bin).

Biodegradable means waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, paper and cardboard etc.

Biodegradable Municipal Waste (BMW) means the biodegradable component of municipal waste, not including bio-stabilised residual waste. Biodegradable municipal waste is typically composed of food and garden waste, wood, paper, cardboard and textiles.

BMW Factor means the proportion of waste which is biodegradable. For example, paper has a BMW factor of 1.0 which means it is considered 100% biodegradable.

Biological Treatment means composting, anaerobic digestion, mechanical-biological treatment or any other biological treatment process for stabilising and sanitising biodegradable waste, including pre-treatment processes.

Bio-stabilised Residual Waste means residual biodegradable municipal waste that has been treated to achieve an EPA-approved biodegradability stability standard prior to landfilling or alternative use agreed.

Bio-Waste means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants.

Clean MRF means a materials recovery (or recycling/reclamation) facility which receives, separates and prepares recyclable materials that have already been separated at source from municipal solid waste generated by either household or commercial sources.

Commercial Waste is a term used to describe the non-household fraction of municipal waste, which is produced by commercial premises such as shops, offices and restaurants, as well as municipal premises such as schools, hospitals etc. It also includes non-process industrial waste arising from factory canteens, offices etc. Commercial waste is broadly similar in composition to household waste, consisting of a mixture of paper and cardboard, plastics, organics, metal and glass.

Composite Sample means two or more increments mixed together in appropriate proportions, either discretely or continuously (blended composite sample), from which the average value of a desired characteristic may be obtained.

Construction and Demolition Waste is all waste that arises from construction, renovation and demolition activities and all wastes mentioned in Chapter 17 of the European Waste Catalogue (EWC).

Dirty MRF means a materials recovery facility that accepts a mixed residual waste stream and then proceeds to separate out designated recyclable materials through a combination of manual and mechanical sorting. The sorted recyclable materials may undergo further processing required to meet technical specifications established by end-markets (such as SRF manufacture) while the balance of the mixed waste stream is sent to a disposal facility such as a landfill.

Household Waste is defined as waste produced within the curtilage of a building or self-contained part of a building used for the purposes of living accommodation.

Increment means an individual portion of material collected by a single operation of a sampling device which will not be analysed/investigated as a single entity, but will be mixed with other increments in a composite sample.

Loss on Ignition (LOI) is a measure of the quantity of organic matter in the sample that can be combusted at 550°C. The loss in weight during combustion equates to the mass of organic matter in the sample.

Mechanical-Biological Treatment (MBT) means the treatment of residual municipal waste through a combination of manual and mechanical processing and biological stabilisation, in order to stabilise and reduce the volume of waste which requires disposal.

Municipal Solid Waste (MSW) means household waste as well as commercial and other waste which, because of its nature or composition, is similar to household waste. It excludes municipal sludges and effluents.

Refuse Derived Fuels (RDF) are fuels produced from waste through a number of different processes such as mechanical separation, blending and compressing to increase the calorific value of the waste. Such waste derived fuels can be comprised of paper, plastic and other combustible wastes and can be combusted in an energy-from-waste plant, cement kiln or industrial furnace.

Residual Waste means the fraction of collected waste remaining after a treatment or diversion step, which generally requires further treatment or disposal.

Sample means the portion of material selected from a larger quantity of material.

Solid Recovered Fuel (SRF) means solid fuel prepared from non-hazardous waste to be utilised for energy recovery in incineration or co-incineration plants and meeting the classification and specification requirements laid down in CEN/TS 15359.

Stabilisation in the case of bio-stabilised residual waste means the reduction of the decomposition properties of the waste to such an extent that offensive odours are minimised and that the Respiration Activity after four days (AT4) is <10mg O_2/g DM (until 1-1-2016), and <7mg O_2/g DM thereafter. Waste that has been stabilised to this standard is assigned a BMW factor of zero.

Treatment/Pre-Treatment includes, in relation to waste, any manual, thermal, physical, chemical or biological processes that change the characteristics of waste in order to reduce its volume, or hazardous nature or facilitate its handling, disposal or recovery.

Note: The list of terms above is intended to assist understanding of this report and does not purport to be a legal interpretation of said terms.

EXECUTIVE SUMMARY

This protocol has been developed to provide guidance on how to determine the amount of biodegradable municipal waste (BMW) in municipal solid waste (MSW) that is sent to landfill. It facilitates Ireland's obligations in determining compliance with BMW diversion targets that are set in the Landfill Directive (1999/31/EC).

In determining the BMW content of a municipal waste stream, two general approaches may be used:

1. Where appropriate, EPA approved BMW factors can be used to calculate the BMW content of the waste stream, or
2. With the agreement of the EPA, alternative BMW factors can be used for municipal waste streams if they have been determined following a waste characterisation survey carried out in accordance with this protocol.

The accurate determination and reporting of the quantity of BMW landfilled can only occur if there is a detailed understanding of the origin and nature of the waste stream consigned to landfill.

It is necessary for the landfill operator to have a close working relationship with customers so that the nature of municipal waste accepted for disposal at the landfill is fully understood, meaning that the BMW content can be accurately established, tracked and reported.

1. INTRODUCTION

This protocol has been developed to provide guidance on how to determine the amount of biodegradable municipal waste (BMW) in municipal solid waste (MSW) that is sent to landfill.

The Landfill Directive (1999/31/EC) sets out specific limitations on the amount of BMW that can be landfilled in member states. Further information about these limitations and on waste treatment requirements for landfill can be found in the EPA's Technical Guidance Document "Municipal Solid Waste - Pre-treatment & Residuals Management" published in 2009. Table 1 lists the national obligations for BMW diversion from landfill.

Table 1. BMW Landfill Directive Obligations

Target Date	Landfill Directive Obligations	Maximum Quantity Of BMW Allowed To Be Landfilled (Tonnes)
16/07/2010	75% of total amount (by weight) of BMW produced in 1995	916,000
16/07/2013	50% of total amount (by weight) of BMW produced in 1995	610,000
16/07/2016	35% of total amount (by weight) of BMW produced in 1995	427,000

In order to assist Ireland's obligations under the Landfill Directive, the EPA reviewed all operational MSW landfill licences in 2009. New conditions were inserted into the licences limiting the acceptance of BMW and requiring the determination of the biodegradable content of MSW.

It is important to note that the landfill limits apply to the BMW content of MSW only. Other wastes such as construction and demolition waste, sludges, effluents and industrial process wastes are not considered municipal waste and are hence outside the scope of this protocol.

In determining the BMW content of a municipal waste stream, two general approaches may be used:

1. Where appropriate, EPA approved BMW factors can be used to calculate the BMW content of the waste stream, or
2. With the agreement of the EPA, alternative BMW factors can be used for municipal waste streams if they have been determined following a waste characterisation survey carried out in accordance with this protocol.

The accurate determination and reporting of the quantity of BMW landfilled can only occur if there is a detailed understanding of the origin and nature of the waste stream consigned to landfill.

A draft version of this protocol was published in November 2009. This was followed by a period of public consultation until the 1st April 2010. A total of 15 submissions were received from various organisations (see Acknowledgements section for details). These submissions have been considered during the finalisation of this protocol.

Section 2 of this protocol outlines the general approach for calculating the BMW content in MSW sent to landfill while Section 3 presents the EPA approved BMW factors for seventeen of the most common municipal waste streams landfilled.

In December 2009, the EPA began a campaign to test the methodologies proposed in the draft protocol for measuring the BMW content and to develop BMW factors for residues arising from treatment facilities. Between December 2009 and November 2010, surveys were undertaken at 22 waste treatment facilities around Ireland. This work was used to derive the BMW factors for mechanical treatment residues as set out in Section 3 of this protocol and to validate the sampling procedures outlined in Section 4 of this protocol.

Section 5 outlines the general approach for sampling and testing bio-stabilised residual waste.

2. GENERAL APPROACH

This section outlines the general approach that must be used when calculating the BMW content in MSW sent to landfill.

2.1 TREATMENT PROCESSES

Treatment includes any manual, thermal, physical, chemical or biological processes that change the characteristics of the waste in order to reduce its volume or hazardous nature or facilitate its handling, disposal or recovery. Further information about waste treatment requirements for landfill can be found in the EPA's Technical Guidance Document "Municipal Solid Waste–Pre-treatment & Residuals Management" published in 2009.

MSW treatment processes produce a range of outputs, some of which are residual wastes that are destined to be landfilled (see Figure 1 below).

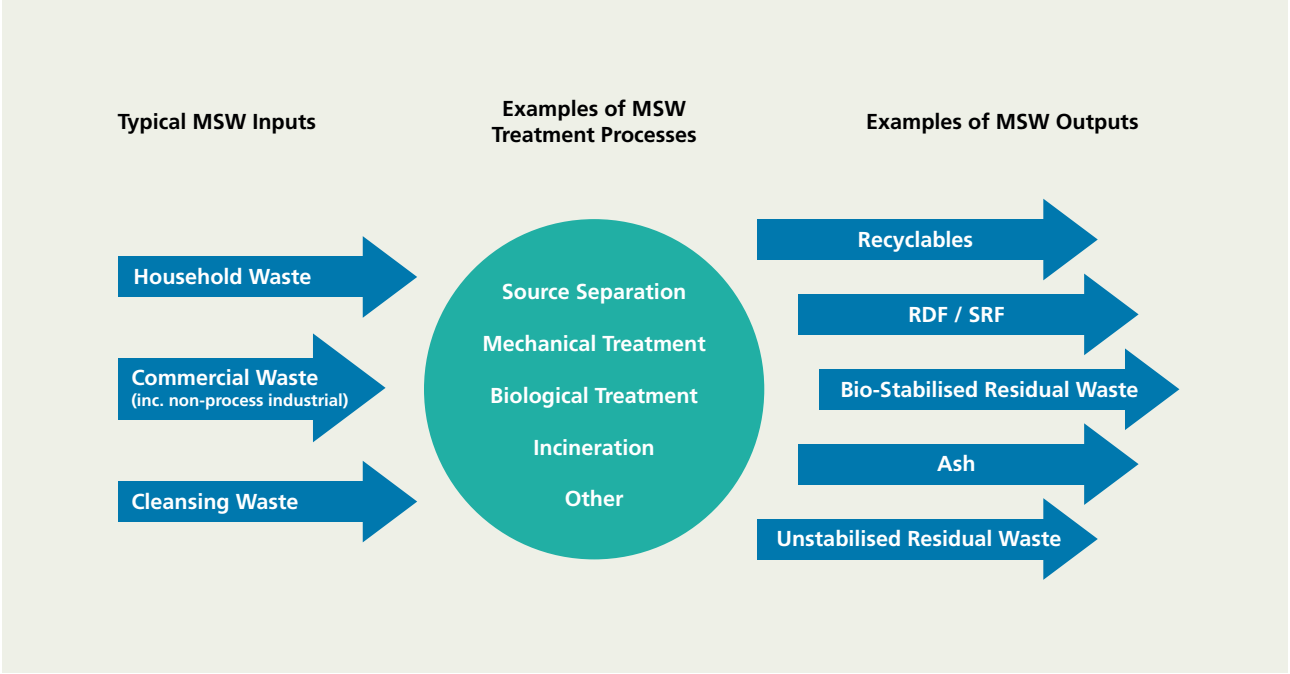

Figure 1. Overview of the inputs and outputs of various MSW treatment processes

2.2 STEPS IN DETERMINING THE BMW CONTENT

Figure 2 below illustrates the steps that must be followed in determining the BMW content of residual municipal waste streams going to landfill.

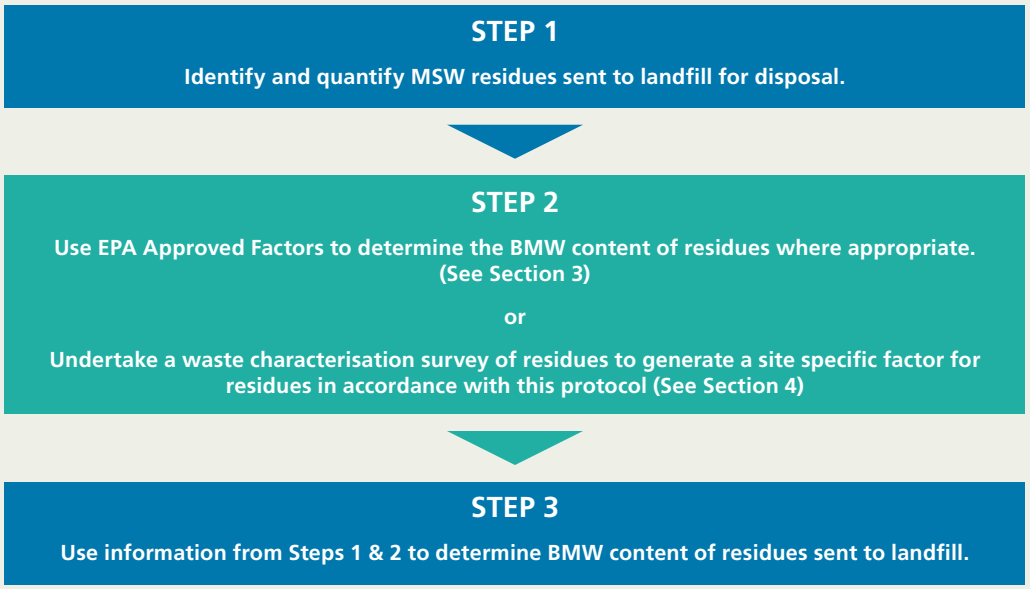

Figure 2. Steps to determine the BMW content of residual waste sent to landfill

2.2.1 MSW Mixed With Non-MSW

Non-MSW such as construction and demolition (C&D) waste, sludges and effluents do not fall under the BMW restrictions or reporting requirements. Landfill operators accepting loads of MSW mixed with non-MSW, such as C&D waste, must be able to determine and report to the EPA the quantity of MSW (and associated BMW) accepted for disposal. Waste streams such as C&D waste should not be included in the tonnages reported.

Residues from the treatment of household and commercial skips should be included in MSW (and associated BMW) tonnages landfilled and reported.

2.2.2 Mixed MSW loads

In order to use the EPA approved factors, the landfill operator needs to understand the waste profile of its customers.

For example, on the same collection route, residual waste from 2 and/or 3 bin household and/or commercial customers may be collected by the same vehicle, which results in the load containing a mixture of these waste types. In such cases, the relative proportions of each of the above waste types in the mixed MSW load must be calculated and reported.

The recorded details of the customers on the route, or pay-by-weight records may be used to calculate the proportions of household and commercial, and associated 2 bin and 3-bin residual wastes, in the load.

The impact of the Waste Management (Food Waste) Regulations 2009 [S.I. No. 508 of 2009] should be considered when profiling waste customers so that the appropriate information is gathered about each load of waste collected.

It is necessary for the landfill operator to have a close working relationship with customers so that the BMW content of the waste accepted at the landfill can be accurately established, tracked and reported.

2.3 REPORTING TO THE EPA

The landfill operator is required to report to the EPA on a quarterly basis in relation to the quantity of MSW and BMW accepted at the landfill.

The EPA has developed a web-based reporting system to streamline the reporting of BMW data and details of this reporting tool have been communicated directly to all relevant landfill operators. The EPA approved BMW factors are incorporated into this reporting system.

2.4 ENFORCEMENT BY THE EPA

The ultimate responsibility for compliance with the landfill BMW limits rests with the landfill operator. The BMW limits in the landfill licence are annual limits and apply to the total quantity of municipal wastes accepted in a calendar year, or part thereof. The quarterly BMW reports required of landfill operators give an indication of how much BMW the landfill has accepted as the year progresses and will facilitate corrective actions to be taken if required.

As pointed out in the 'National Waste Report 2009' (EPA, 2011), it is a national priority that the necessary infrastructure be developed to treat both organic wastes that must be collected separately and the biodegradable portion of residual bins from municipal waste collections. Non-compliance with the BMW limit in the landfill licence undermines this priority.

The EPA will assess and validate the BMW reports. Site inspections and audits will be undertaken to examine documentation and records at waste facilities. Enforcement actions will be decided on a case by case basis and will include actions such as the issue of Notifications of Non-compliance and the use of other enforcement tools in line with the Enforcement Policy of the Office of Environmental Enforcement.

3. EPA APPROVED FACTORS FOR CALCULATION OF BMW CONTENT

3.1 INTRODUCTION

The EPA has developed a list of approved factors to calculate the BMW content of seventeen of the most commonly encountered municipal waste streams. These factors have been derived from studies undertaken by the EPA and will be reviewed and updated as deemed necessary from time to time. The EPA website www.epa.ie and the web-based reporting system for landfill operators will contain any updates to the factors and should be consulted for the current factors in use.

Use of the EPA approved BMW factors is a cost-effective way of calculating and reporting the BMW content of waste accepted at landfills.

3.2 EPA APPROVED BMW CALCULATION FACTORS

Table 2 lists the EPA approved factors for calculating the BMW content of seventeen of the most commonly encountered municipal waste streams. These factors are accurate at the time of publication of this protocol.

Table 2. EPA approved factors to calculate the BMW content of Municipal Waste Streams

Factor No.	Municipal Waste Stream	BMW Factor
1.	Untreated 1-bin household waste	0.65
2.	2-bin residual household waste	0.63
3.	3-bin residual household waste	0.47
4.	Untreated 1-bin commercial waste	0.77
5.	2-bin residual commercial waste	0.75
6.	3-bin residual commercial waste	0.68
7.	Untreated MSW skip waste	0.35
8.	Bulky waste from sorting of MSW skips	0.50
9.	Oversize residues from MSW skips	0.43
10.	Fines residues from MSW skips	0.40
11.	Oversize residues from MSW bin collections (“wet waste”)	0.41
12.	Fines residues from MSW bin collections (“wet waste”)	0.95
13.	Residues from source separated recyclable waste (“clean MRF”)	0.47
14.	Bio-stabilised residual waste	0
15.	Untreated cleansing waste (fly-tipping, street bins, road sweepings etc.)	0.65
16.	Residual MSW from civic amenity facility	0.63
17.	Ash residue from MSW incineration	0

If a waste stream is not listed in Table 2, then the EPA should be consulted and it may be necessary to determine the BMW content by undertaking a waste characterisation survey as set out in Section 4 of this protocol.

The basic method for calculating the BMW tonnage of a municipal waste stream is to multiply the tonnes of that waste stream by the relevant BMW factor:

- MSW tonnes landfilled x BMW factor = BMW tonnes landfilled.

For example, the BMW content of 1,000 tonnes of 2-bin residual household waste is:

- 1,000 tonnes x 0.63 = 630 tonnes of BMW.

Appendix A contains more detailed worked examples.

3.2.1 Untreated waste

As mandated by the Landfill Directive and required by EPA licences, only waste that has been subject to treatment can be accepted for disposal at a landfill. Therefore untreated waste types represented by Factors 1, 4, 7 and 15 should not, unless otherwise agreed by the EPA, be going direct to landfill.

Untreated cleansing waste has been assigned the same factor as untreated 1-bin household waste (BMW factor of 0.65). If the cleansing waste has been treated prior to landfilling, then a waste survey of this stream may need to be undertaken in order to assign an alternative factor to 0.65. Segregation of recyclables such as white goods, metals and plastics, prior to landfill, is considered a treatment process.

3.2.2 Source separate collection systems

Factors 2, 3, 5 and 6 are applicable to residual MSW from source separate collection systems which is either sent directly to landfill by the waste collector or is bulked up at a transfer station without any further treatment of the waste (i.e. the BMW content remains the same for the input and the output MSW from the transfer station).

It is not sufficient to just have a 2 or 3 bin collection system rolled out in order to use the 2-bin or 3-bin factor. The factor used must be appropriate to the circumstances and needs to be justified by the maintenance of records of the amount of waste separately collected and the destinations used for its treatment. These records should be available to the EPA if requested. For example if a 3-bin service is in place and used by just 20% of a collector's route, then it would not be appropriate to apply a 3-bin factor to all of the waste consigned to landfill by that collector. In the scenario presented, a weighted pro-rata calculation should be carried out using records to justify the BMW factor to be applied to the waste stream.

Further information on the development of the household and commercial factors can be found in the report 'Municipal Waste Characterisation Surveys 2008', (EPA, 2009) and 'Surveys of residual waste from businesses provided with organic waste source separated collection systems', (EPA, 2010).

Factor 16 applies to residual waste from a civic amenity facility. It reflects the typical situation at civic amenity facilities where recycling facilities are provided in addition to an area for residual waste disposal. Because of that, it is reasonable to assume that users of the civic amenity facility also use the recycling facilities and that the residual waste has the same profile as 2-bin residual household waste. The civic amenity operator will have to provide evidence that the users of the residual waste disposal area are also using the recyclable bins e.g. by conducting a survey of customers and recording the results.

3.2.3 Mechanical Treatment

Factors 8, 9, 10, 11, 12 and 13 are applied to residual waste outputs from mechanical treatment facilities. These factors were initially developed in June 2010 based on waste characterisation surveys undertaken on behalf of the EPA at "clean" and "dirty" Materials Recovery Facilities (MRFs) around Ireland in winter 2009 and spring 2010. A repeat survey campaign was undertaken at dirty MRFs in autumn 2010 in order to verify the factors. Some minor changes to Factors 7, 9 and 10 were made following the findings of the autumn surveys and have been incorporated into Table 2. Any updates to the factors in Table 2 will be made available on the EPA website www.epa.ie and will be incorporated into the web-based reporting system developed by the EPA for landfill operators.

Factor 8 applies to large and bulky items that are removed from the waste (often known as "pre-sort" waste) and which are sent to landfill for disposal prior to passing the remaining waste through the mechanical processing line.

Typically, mechanical processing involves passing the waste through a trommel (see Figure 3) which produces a residual oversize fraction and a residual fines fraction.

Figure 3. Waste trommel in operation (Photo: courtesy of Spelthorne Borough Council, UK)

Based on the findings of the surveys carried out on behalf of the EPA, two different BMW factors have been generated for the oversize residues, a BMW factor for oversize from trommelled MSW skips (Factor 9) and a BMW factor for oversize from trommelled MSW bin collections (Factor 11). The residual bin from MSW bin collections is commonly referred as to as "wet waste" and is typically trommelled separately to MSW skips.

During the EPA surveys, a factor was derived for the fines residues from trommelled MSW skips (Factor 10) by manual sorting. However, it was found that the fines residues produced from trommelled MSW bin collections were not always suitable for examination by manual sorting. The fines residues from trommelled MSW bin collections were found to be of a wet and fine nature and it proved very difficult to distinguish between materials such as paper, cardboard, plastics, textiles and so on.

A mass balance approach has been used to assign a BMW factor of 0.95 to the fines residues from trommelled MSW bin collections (see Section 4.6 for more information).

3.2.4 Bio-stabilised residual waste

A BMW factor of zero is applied to bio-stabilised residual waste (Factor 14). Stabilisation means the reduction of the decomposition properties of the waste to such an extent that offensive odours are minimised and that the Respiration Activity after four days (AT_4) is <10mg O_2/g DM (until 1st January 2016), and <7mg O_2/g DM thereafter. Section 5 provides more information on this waste stream.

3.2.5 Incineration

A BMW factor of zero is applied to ash residues from MSW incineration (Factor 17).

4. WASTE CHARACTERISATION SURVEYS

4.1 INTRODUCTION

This section outlines how to undertake a waste characterisation survey of the residues from a mechanical treatment facility. It outlines the training and experience required by contractors and personnel that will undertake the waste characterisation survey as well as the health and safety issues which must be taken into consideration.

This section does not go into detail on how to sample a particular collection route. The EPA has published factors for the BMW content of the residual waste bin from household and commercial collections and these factors were developed from studies undertaken on a nationwide basis. The sampling of collection routes is complex and has associated high costs.

Further information on the methodologies for sampling kerbside collections is given in the report 'Programme for Municipal Waste Characterisation Surveys', EPA (2005).

4.2 EPA APPROVED CONTRACTORS

A waste operator wishing to develop a site specific BMW factor for residues from a treatment facility must use, where appropriate, contractors that have been approved by the EPA to undertake the waste characterisation survey.

Generally the EPA, when considering requests to approve contractors, will require such information as the names, training and/or qualifications to be submitted in advance of the sampling.

A summary of the relevant experience of all personnel that will carry out the sampling and interpretation of the results should also be submitted.

4.3 HEALTH AND SAFETY CONSIDERATIONS

All work associated with undertaking waste characterisation surveys must be undertaken in accordance with health and safety legislation.

Undertaking waste characterisation surveys poses a number of hazards to the health, safety and welfare of the personnel involved in the surveys e.g. site vehicle traffic, manual handling, exposure to municipal waste, slip, trip and fall hazards.

All hazards must be addressed in advance by means of a detailed risk assessment, and application of mitigation measures must be undertaken before and during the survey e.g. provision of appropriate training, personal protective equipment (gloves, masks, glasses, disinfectant wipes, high visibility jacket etc.), availability of vaccinations (e.g. hepatitis A, hepatitis B, tetanus and diphtheria or as recommended by a suitably qualified health professional).

4.4 CHARACTERISATION OF OVERSIZE RESIDUES FROM THE MECHANICAL TREATMENT OF MSW BIN COLLECTIONS AND MSW SKIPS

4.4.1 Introduction

Figure 4 outlines the step by step approach to carrying out a waste characterisation survey.

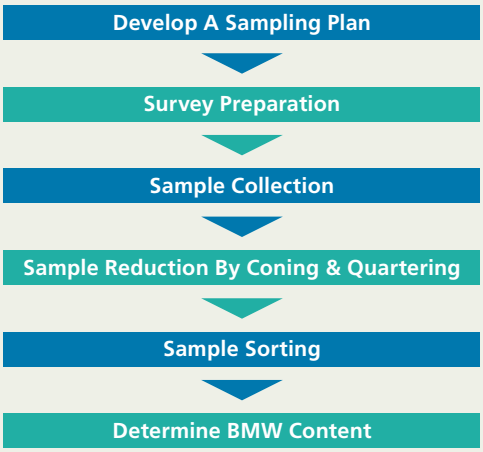

Figure 4. Step by step approach to carrying out a waste characterisation survey

4.4.2 Develop a sampling plan

The sampling plan is an important step of the survey and should be prepared in accordance with *EN 14899:2005 'Characterization of waste - Sampling of waste materials - Framework for the preparation and application of a Sampling Plan.'*

Some of the key steps in developing a sampling plan are as follows:

- Define the objective of the testing programme e.g. to determine the BMW factor of MSW residual outputs to landfill.

- Gather background information such as:
  - Facility waste input profile e.g. household/commercial, 2/3 bin, skips etc.
  - Site details e.g. throughput, operational hours, types of waste accepted.
  - Process flow diagram clearly showing all of the outputs that are produced.
  - Key process parameters such as trommel length and screen size etc.
  - Nature and type of residues e.g. bulky waste, RDF/SRF, oversize, fines etc.
  - Health and safety requirements.

- Develop the sampling approach.
  - Sampling frequency: A waste operator choosing to develop their own specific BMW factor(s) must carry out a minimum of two surveys per year. The composition of MSW residues will vary during the year due to a number of reasons (e.g. seasonal variation in garden waste and ash production, change in customer base, change in treatment processes and roll-out of separate collections).

    A typical survey will last a week. The surveys should take place ideally in March/April and September/October. The two results should be combined to yield an overall figure and agreed with the EPA for subsequent reporting.

    Further information on the variability in waste composition and seasonal variation can be round in the final report 'Programme for Municipal Waste Characterisation Surveys', EPA (2005).

- Composite samples should be used in order to produce as representative a sample as possible. Composite sampling is a type of physical averaging and involves obtaining several increments and mixing them together to make a composite sample. Composite samples can be used for waste characterisation or for the preparation of laboratory samples. When sampling oversize residues, a minimum of 15 increments (e.g. grab samples) of residues must be collected over a typical week of operation.

- Increment size: Each grab sample (increment) of oversize residues that is collected (e.g. using a loading shovel) must have a minimum weight of 200kg.

- Identify the sampling technique and sampling locations. It will be necessary to specify the physical procedure employed in collecting the sample and this will depend on a combination of different characteristics of the materials and circumstances at the sampling location.

- Document the sampling plan prior to implementation. The sampling plan (including any recording sheets) should be made available to the EPA on request.

- For further information on sampling techniques, see the technical report *CEN/TR 15310-2:2006 'Characterisation of Waste - Sampling of waste materials - Part 2: Guidance on sampling techniques.'*

4.4.3 Survey preparation

Adequate time should be allowed for planning the surveys, in order to prepare for and resolve the practical issues involved. Issues to be considered include:

- Space and equipment required at the treatment facility for each stage of the survey.
- The personnel needed to carry out the manual sorting of the waste.
- Health and safety requirements.
- Briefing and training of sorting staff in advance of each sorting event.

Training of Sorting Staff
The staff used for the manual sorting of the residual waste may or may not have had previous waste characterisation survey experience. It is essential that the sorting staff have undergone initial training on the particulars of the specific waste survey being carried out.

The staff will need to be trained to recognise the various waste categories prior to the survey. The waste categories and typical examples listed in Appendix B should be used when training staff. Records of all staff training should be kept.

Equipment
The following list outlines the range of equipment necessary for sorting of municipal waste samples:

- A covered area within the treatment facility. This should be a dry and safe space, with minimal traffic movements, approximately 30m^2 in area.
- Safety tape to cordon off an area of the facility within which the sorting is carried out.
- A loader (or similar vehicle) for mixing and reducing the waste sample.
- A rope for dividing the waste into four quarters for the purposes of reducing the composite sample to the required sub-sample size.
- One sorting table (1.25m length, 1.25m width), the top of which is pierced with a network of holes that are 20mm in diameter for the capturing of < 20mm fines (see Figure 5).
- Containers (typically 140L or 240L wheelie bins or alternatively buckets), clearly labelled as 100% or full-BMW, 50% or part-BMW, 0% or non-BMW or <20mm fines, for separating and weighing the waste fractions.
- One 150kg precision scale (minimum precision 10g) (see Figure 6).

Figure 5. Waste sorting table with a network of 20mm diameter holes

4.4.4 Sample collection of oversize residues

The following points should be taken into consideration during sample collection:

- The type and tonnages of MSW being processed during the week long survey should be noted e.g. 2 or 3 bin MSW bin collections or MSW skips.
- Non-MSW such as C&D wastes should not be processed during the survey.
- Care should be taken to avoid undertaking the survey during phases of start-up or wind-down at a facility.
- Residual waste should be sampled when all recyclables and RDF/SRF have been removed from the waste stream.
- Waste should be sampled when it is loose and prior to baling or compaction.
- Composite samples should be prepared by selecting 15 increments (grab samples), minimum weight of 200kg, of residual waste during a typical working week. The following is an example of the approach to be taken:
  - Residual waste processing time is 10 hours per day and 6 days per week which equals 60 hours per week of operation,
  - Sampling frequency for the working week is determined by 60/15=4. Therefore an increment has to be collected every 4th hour.
  - Assuming increment collection starts 3 hours after the start of operation on Monday, increments will be collected after 3 hours and 7 hours of operation on Monday; after 1 hour, 5 hours and 9 hours after start of operation on Tuesday etc. throughout the week until the 15th increment is selected.
- Residual waste processing time is 10 hours per day and 6 days per week which equals 60 hours per week of operation,
- Sampling frequency for the working week is determined by 60/15=4. Therefore an increment has to be collected every 4th hour.
- Assuming increment collection starts 3 hours after the start of operation on Monday, increments will be collected after 3 hours and 7 hours of operation on Monday; after 1 hour, 5 hours and 9 hours after start of operation on Tuesday etc., throughout the week until the 15th increment is selected.

- The weight of each increment should be recorded (See Appendix C.1 for a sample form for recording the increments collected).
- The 15 increments should not be interfered with during storage and should be stored in an area where they cannot be contaminated (e.g. a covered skip kept indoors).
- Once the 15 increments are collected, the full composite sample should be weighed in order to check that it is close to the sum of the weights of the individual increments.

Figure 6. Weighing scales for weighing of bin with sorted waste

4.4.5 Sample reduction of oversize residues by coning and quartering

The composite sample must be reduced to obtain a more manageable size from approximately 3 tonnes (15 × 200kg) to 200kg. This 200kg fraction is referred to as the sub-sample.

The size reduction should be obtained by the Coning and Quartering technique (see Figure 7). Coning and quartering involves the following:

- The composite sample is placed on the floor and thoroughly mixed (using a manual or mechanical shovel depending on the size of the sample).
- The composite sample is then placed in a single level flattened pile.
- The pile is divided into four quarters using ropes perpendicular to each other.
- Either pair of opposite corners is removed to leave half the original sample. The removed material can be discarded.
- The sample is mixed again and the process is repeated until the desired size of sub-sample is obtained, i.e. 200 kg of waste for sorting.
- Care should be exercised to avoid selection of larger sized particles from the pile since this might introduce sample bias.
- The technical report *CEN/TR 15310-3:2006 'Characterisation of Waste - Sampling of waste materials - Part 3: Guidance on procedures for sub-sampling in the field'* should be referred to for a full description of the Coning and Quartering Technique.

Figure 7. Illustration of coning and quartering technique

4.4.6 Sorting of oversize residues

The following is the procedure to the followed for the sorting of oversize:

- The sorting team generally comprises a supervisor and between three and six sorting staff. The supervisor should be experienced in waste sorting and recording and will have been involved in the training of the sorting staff. The supervisor will ensure the quality control of the sorted material, by checking the material placed in each container.
- The tare weight of each bin is determined and recorded on the survey form (see Appendix C.2 for a sample form).
- For ease of sorting, batches of the sub-sample can be placed on the sorting table one batch at a time.
- The material should be spread out over the entire surface area of the sorting table in order to allow any fines fraction (<20mm) to be separated from the rest and to fall through the holes.
- The 200kg sub-sample is manually sorted into three categories: 100% or full-BMW, 50% or part-BMW and 0% or non-BMW. Appendix B provides the typical waste categories found in municipal waste and the typical examples of waste found in each category. Each waste type is assigned as either 100% BMW, 50% BMW or 0% BMW.
- Food waste, garden waste, papers and cardboard are considered 100% BMW. Textiles (including nappies) and timber are considered 50% BMW. Other categories such as glass, plastics and metals are considered 0% BMW. Sorting staff must be familiar with the list in Appendix B and adhere to it rigidly when sorting waste.
- It is recommended to sort the sub-sample by picking out the larger items first e.g. glass, paper, cardboard, plastics.
- Any remaining material that passes through the 20 mm holes in the sorting table is classified as 'Fines <20mm'. This material should be collected and weighed separately and assigned to the 50% BMW category when sorting oversize residues.
- The weights of each bin with different waste fractions should be recorded.
- By deducting the tare weight, the weight of waste in each bin is calculated.
- The weight of waste in each bin is multiplied by the BMW factor for that waste stream and this gives the weight of BMW in each bin.
- The BMW weights of each bin are summed together.
- The BMW factor is calculated by expressing the BMW weight as a fraction of the MSW weight sorted.

Appendix C.2 provides a sample form with calculations.

4.5 CHARACTERISATION OF FINES RESIDUES FROM THE MECHANICAL TREATMENT OF MSW SKIPS

The approach outlined in Section 4.4 can also be used for the surveying of the fines residues from the mechanical treatment of MSW skips if those fines can be manually sorted and identified by visual examination.

When sampling fines residues from the mechanical treatment of MSW skips, it is recommended that 15 increments of 20kg each are collected and mixed together to form a composite sample of 300kg. This composite sample is then coned and quartered to give a sub-sample of 20kg which is manually sorted.

It is critical that only MSW skips are processed during the survey and that other waste streams such as C&D skips are not processed with the MSW skips.

4.6 CHARACTERISATION OF FINES RESIDUES FROM THE MECHANICAL TREATMENT OF MSW BIN COLLECTIONS

During the surveys undertaken on behalf of the EPA, it was found that the fines residues produced from trommelled MSW bin collections ("wet waste") were not always suitable for visual identification and manual sorting. These fines were of a wet and fine nature and it was very difficult to distinguish between materials such as paper, cardboard, plastics, textiles and so on. Experience from the surveys also showed that when stored over a couple of days, the fines residues started decomposing which made identification even harder.

Three methods are outlined below for deriving a BMW factor for fines residues from the mechanical treatment of MSW bin collections ("wet waste" fines). The three methods are:

- Mass balance,
- Waste characterisation by manual sorting, and
- LOI (loss on ignition) testing.

It is likely that all three methods will be required and consultation should take place with the EPA both prior to and after undertaking any surveys or testing. Operators will be required to undertake two surveys per year as outlined previously in Section 4.4.2.

4.6.1 Mass Balance approach

In situations where a BMW factor is required for only one output, such as the fines, and the BMW content and quantities of all inputs and all other outputs are known, a mass balance approach can be used.

The unknown factor can be determined by calculating the difference between the total quantity of BMW in the inputs and the total quantity of BMW in the known outputs.

Known outputs will include recyclables such as glass, metal, plastics, cardboard and in some situations, RDF/SRF (see Figure 8).

Where RDF/SRF is produced, it will be necessary to undertake a waste characterisation survey of that stream also by following the procedures in Section 4.4. When sampling RDF/SRF, it is recommended that 15 increments of 10kg are collected and mixed together to form a composite sample of 150kg. This composite sample is then coned and quartered to give a sub-sample of 10kg which is manually sorted.

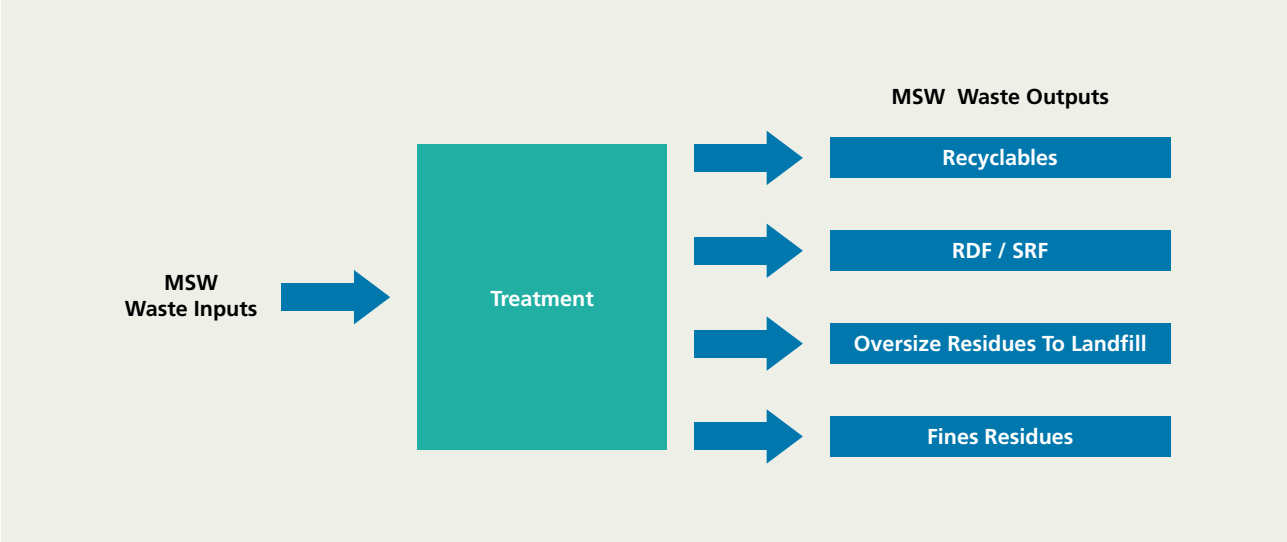

Figure 8. MSW inputs and MSW outputs at a treatment facility

A mass balance approach was used by the EPA in June 2010 to assign a BMW factor of 0.95 to the fines residues from the trommelling of MSW bin collections.

Example 4 in Appendix A provides an example of a mass balance approach for the calculation of the BMW factor of fines residues from trommelled MSW bin collections.

In practice, the mass balance approach is dependent on accurate information being obtained on the types and quantities of inputs and outputs to the waste process over the survey period which is typically of a week's duration. To this end, detailed weighbridge records are required and a full understanding of the inputs to the process must be in place. If this is not possible, then a mass balance approach will not yield reliable results.

4.6.2 Waste characterisation by manual sorting

In general, the same principles are followed when sampling and sorting fines residues from the mechanical treatment of MSW bin collections as are outlined in Section 4.4 for oversize residues. The principal difference is the time period over which the increments are collected and the increment size.

As the fines are likely to degrade if stored over a week long period, the increments should instead be collected over a typical day's production. Fifteen increments of 20kg each should be collected at regular intervals and thoroughly mixed together to make a composite sample of 300kg. The sample should be coned and quartered until 21kg remains.

One kg of this sample should be sent to a laboratory for Loss on Ignition (LOI) testing (see Section 4.6.3 below and Appendix D) and the remaining 20kg should be manually sorted using the procedure described in Section 4.4.6. If the 20kg fines sample cannot be sorted on the same day as sampling, then the sample should be stored at 4°C to slow down degradation and sorting should take place on the following day.

The 20kg fines sample should be sorted into the four categories below using the sorting table with a network of 20mm diameter holes:

- 100% or full BMW: organics, paper and cardboard.
- 50% or part BMW: textiles, wood, unclassified combustibles.
- <20mm fines – assigned 100% BMW to reflect the high biodegradable content of this stream.
- 0% or non-BMW: e.g. plastics, metals, glass.

Appendix B provides the typical waste categories found in municipal waste and the typical examples of waste found in each category.

4.6.3 Loss on Ignition (LOI)

Loss on Ignition (LOI) measures the quantity of organic matter in the sample that can be combusted at 550°C. The loss in weight during combustion equates to the mass of organic matter in the sample.

One kg of the sub-sample should be collected in an airtight container of glass or plastic and sent to the laboratory for testing. The LOI test method as outlined in Appendix D should be followed.

5. BIO-STABILISED RESIDUAL WASTE

5.1 INTRODUCTION

Bio-stabilised residual waste refers to residual biodegradable municipal waste that has been treated to achieve the EPA biodegradability stability standard prior to landfilling or alternative use agreed.

In the case of bio-stabilised residual waste, stabilisation means the reduction of the decomposition properties of the waste to such an extent that offensive odours are minimised and that the Respiration Activity after four days (AT_4) is <10 mg O_2/g DM (until 1st January 2016) and <7mg O_2/g DM thereafter (see Appendix E for the AT_4 test method).

Bio-stabilised residual waste which meets the above EPA standard is assigned a BMW factor of zero. It may be used as landfill cover where:

- it has been stabilised in accordance with the landfill licence; and
- complies with any requirements of the Department of Agriculture, Fisheries and Food relating to the management of animal by-products; and
- has been agreed as cover for the landfill in question by the EPA.

The AT_4 analytical method is only suitable for testing waste that has undergone stabilisation. It cannot be used to determine the BMW content of unstabilised municipal waste streams.

The time it takes to stabilise residual waste is a function of the quality of the feedstock, the biological treatment technology employed and the residence time. Depending on the treatment facility's operational parameters, the operator should be able to determine if the output is likely to meet the EPA stability standard for residual waste sent to landfill.

Figure 9 is based on a graph by Muller (2007). The graph has been amended to show the EPA stability standard. It illustrates the effect of an intensive and highly mechanised composting system, compared to a low-technology system. The graph shows that a minimum of six weeks in a high-technology composting system is necessary to meet an AT_4 <10mg O_2/g DM, whilst it would require a minimum of 11 weeks in a lower-technology system.

The EPA Strive Report "Critical Analysis of the Potential of Mechanical Biological Treatment for Irish Waste Management", (Guinan et al, 2008) also examines the effect of biological treatment technologies on the stabilisation of residual waste, and is a useful reference report.

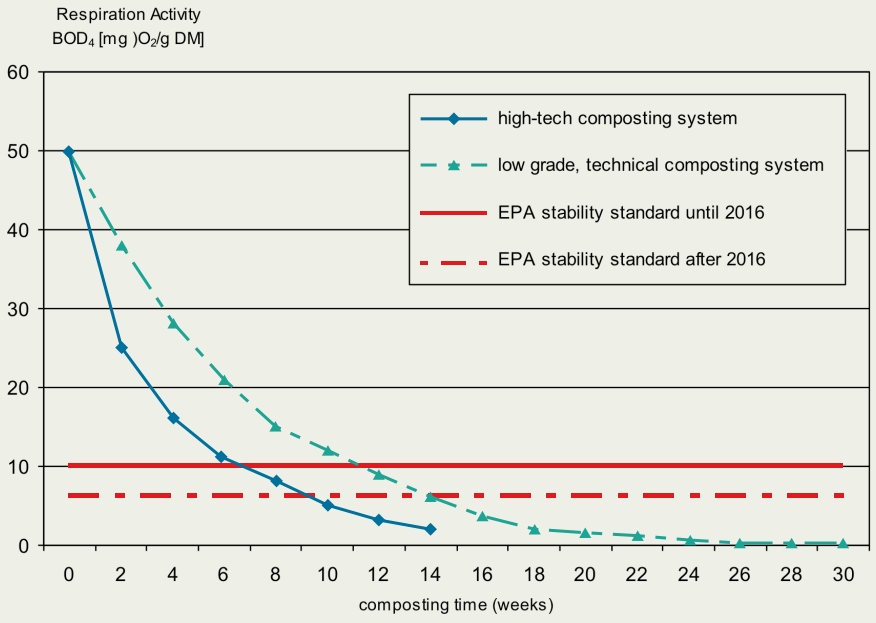

Figure 9. Effect of composting technologies on the rate of bio-stabilisation (adapted from Muller, 2007)

5.2 SAMPLING OF BIO-STABILISED RESIDUAL WASTE

Sampling of bio-stabilised residual waste for AT_4 testing should be undertaken using the following approach:

- Prepare a sampling plan in accordance with *EN 14899:2005 'Characterization of waste - Sampling of waste materials - Framework for the preparation and application of a Sampling Plan.'*
- The residual output from the treatment facility must be sampled at a minimum frequency of every 500 tonnes if going to landfill. For new sources, it is recommended that AT_4 testing is undertaken prior to initial consignment to landfill.
- It should be noted on the sampling plan if there is a sanitation phase in place and when it occurs during the biological treatment cycle. It is important that sampling does not take place immediately after the sanitation phase.
- To produce a representative composite sample from a batch, fifteen 2kg incremental samples should be collected to make a composite sample of 30kg. Increments should be taken so that they represent the whole of the batch. Random samples should be taken along the width and height of the batch.
- Further guidance on sampling techniques may be found in the technical report *CEN/TR 15310-2:2006 'Characterisation of waste – Sampling of waste materials Part 2: Guidance on sampling techniques.'*
- The composite sample should be mixed, coned and quartered to extract a 2 kg sample in accordance with Section 4.4.5. If there is a lot of inorganic material in the sample, then it may be necessary to extract a larger sample of 3-4 kg. The exact sample size should be verified with the laboratory prior to sampling.
- The sample should be packaged, stored and sent to a laboratory for analysis in accordance with the laboratory requirements.
- Analysis should be carried out in accordance with the AT_4 test method in Appendix E.
- Appropriate validation and routine checks on performance should be undertaken and documented by the laboratory to ensure that the procedures and instrumentation used are fit for purpose.
- Personnel undertaking the analysis and calculation of results should have appropriate training.
- Procedures for sample storage, sample preparation and adjustment of water content should be clearly documented and included with the calculations and results submitted to the EPA.

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APPENDIX A: WORKED EXAMPLES

A.1 EXAMPLE 1 - TRANSFER STATION

In 2010, Greentown Transfer Station accepted 50,000 tonnes of MSW. No mechanical treatment of waste took place at Greentown. The waste was bulked up and sent directly to landfill.

The breakdown of the waste accepted was:

2-bin residual household waste:	5,000 tonnes MSW x 0.63 BMW factor =	3,150 tonnes BMW
3-bin residual household waste:	35,000 x 0.47 =	16,450
3-bin residual commercial waste	10,000 x 0.68 =	6,800

What was the % BMW in MSW sent to landfill in 2010?

Total BMW in MSW to landfill = 3,150 + 16,450 + 6,800 = 26,400 tonnes

% BMW in MSW to landfill = (26,400/50,000) x 100 = 53%

A.2 EXAMPLE 2 - MBT FACILITY

Eastgrange MBT plant accepted 39,000 tonnes of 2 bin residual household waste in 2010. Eastgrange operate a mechanical treatment line to separate recyclables from the waste, produce oversize residues for disposal to landfill and fines residues which go for further biological treatment on-site.

20,000 tonnes of recyclables were sent to off-site processing facilities.

12,000 tonnes of oversize residues were sent to Ballyvale Landfill. The EPA approved BMW factor for this residual stream is 0.41.

7,000 tonnes of fines residues were treated at the on-site biological treatment plant. The output from biological treatment was tested and had an AT_4 value of 8.5mg O_2/g DM. This material was sent to landfill but had a zero BMW value as it had passed the AT_4 standard.

What was the % BMW in MSW sent to landfill in 2010?

% BMW in MSW to landfill =

$$\frac{(12{,}000 \times 0.41) + (7{,}000 \times 0)}{19{,}000} \times 100 = 26\%$$

A.3 EXAMPLE 3 - LANDFILL

In 2010, Ballyvale landfill accepted MSW from Greentown Transfer Station and Eastgrange MBT facility.

Greentown Transfer station sent 50,000 tonnes MSW of which 26,400 tonnes was BMW.

Eastgrange MBT facility sent 19,000 tonnes MSW of which 4,920 tonnes was BMW.

What was the % BMW in MSW accepted by the landfill in 2010?

Total MSW accepted by the landfill was 50,000 + 19,000 = 69,000 tonnes

Total BMW accepted by the landfill was 26,400 + 4,920 = 31,320 tonnes

% BMW in MSW accepted = 31,320/69,000 x 100 = 45%

A.4 EXAMPLE 4 - MASS BALANCE APPROACH

A facility accepts 250 tonnes of 2-bin residual commercial waste with a BMW factor of 0.75 and 250 tonnes of 2-bin residual household waste with a BMW factor of 0.63 each week. The waste is trommelled using a 50mm screen size and recyclables are removed.

Table A.1 shows how the BMW input to the facility is calculated

Table A.1 Calculation of BMW input

	MSW (Tonnes)	BMW Factor	BMW (Tonnes)*
2-Bin Residual Commercial	250	0.75	187.5
2-Bin Residual Household	250	0.63	157.5
Total Input	500		345

* Tonnes of BMW input is calculated by multiplying MSW (tonnes) by the BMW factor.
The facility has a weekly input of 345 tonnes of BMW.

A waste characterisation survey is undertaken of the outputs from the facility and details of these are shown in Table A.2.

Table A.2 Calculation of BMW Outputs

	MSW (Tonnes)	BMW Factor	BMW (Tonnes)
Pre-sort	0	0.5	0
Metal	20	0.0	0
Timber	0	0.5	0
Plastics	20	0.0	0
Cardboard & Paper	40	1.0	40
Oversize Residues	175	0.41*	72
<50mm Fines Residues	245	?	?
Total Output	500		

* EPA approved factor

The quantity of BMW in the <50mm fines residues is the difference between the total BMW input and the total BMW output of the other waste streams which equals:

345 tonnes (BMW input) – 112 tonnes (BMW output: 40 tonnes cardboard & paper + 72 tonnes oversize residues)
= 233 tonnes of BMW in <50mm fines residues

Therefore the BMW factor for the <50mm fines residues is 233/245 = 0.95

APPENDIX B: WASTE CATEGORIES AND TYPICAL EXAMPLES

Table B.1 below provides a breakdown of the typical waste categories found in municipal waste and examples of types of waste found in each category. A total of 61 sub-categories of municipal waste are listed below. These are grouped into 13 primary categories e.g. organic waste, papers etc.

With respect to the biodegradable content of municipal waste, these 61 sub-categories are grouped into three main categories: 100% or full-BMW, 50% or part-BMW and 0% or non-BMW and are colour-coded below.

Table B.1 should be used as the point of reference when training sorting staff and when undertaking the manual sorting and visual identification of the waste.

Table B.1 Waste Categories and Typical Examples

Legend	100 % BMW	50% BMW	0% BMW

EWC Codes	Waste Categories	Typical Examples
Organic Waste		
20 01 08	Edible kitchen & canteen waste	Unused or partially used packaged food that can't easily be separated from packaging, e.g. jar of honey, tub of soft cheese. Vegetables, fruit, cheese or sausages removed from packaging.
20 01 08	Inedible kitchen & canteen waste	Vegetable peelings, tea bags, meat carcasses
21 01 08	Liquid fit for human consumption	Liquid contained in drink or milk containers
20 02 01	Biodegradable waste from garden & park	Grass and bush cutting, twigs, soil, flowers, leaves, tree branches, weeds
20 01 25	Vegetable oil	Waste cooking oil
Papers		
15 01 01	Paper Packaging	Brown or white paper bags, fast food wrapping paper, egg cartons, bread wrappers. Curried fast food packaging, meat wrapping.
20 01 01	Newspapers	Local and national newspapers, newsprint-type advertising publications, other newsprint
20 01 01	Magazines & glossy paper	Magazines and ads on glossy paper, shop catalogues
20 01 01	Office papers	Office type envelopes, letters, print outs
21 01 01	Tissue Paper/ Kitchen Roll	Tissue Paper/ Kitchen Roll
20 01 01	Other papers	Till receipts, books, telephone directories, non-glossy junk mail, loose leaf paper, non-glossy brochures and catalogues, notebooks, envelopes
Cardboards		
15 01 06	Flat Card Packaging	Cereal boxes, toy boxes, washing powder containers. Ready packed meats.
15 01 06	Corrugated Cardboard (Packaging)	Corrugated packaging cardboard used for household items packaging (TV, PC, furniture etc). Contaminated pizza box.
20 01	Other Cardboards (Non Packaging)	Greeting cards, postcards, files and folders, tickets

EWC Codes	Waste Categories	Typical Examples
Composites		
15 01 05	Beverage Carton (Packaging)	Beverage/juice cartons (Tetrapak)
15 01 05	Other Composite Packaging	Tablets packaging (blister packets), potato crisps tubes, paper and foil bag (hot food)
Textiles		
15 01 09	Textiles Packaging	Some types of potato sacks
20 01 11	Textiles Non-Packaging	Rags, household soft furnishings (cushions) and upholstery, blankets, towels, carpets, curtains, ruck-sacks,
20 01 10	Clothes	Clothes
	Nappies	Nappies
18 01 04	Healthcare Textiles	Dressings, plasters, linen, disposable clothing, sanitary towels, bandages
Plastics		
20 01 39	PET (Packaging)	Soft drinks bottles, water bottles
20 01 39	PE (Packaging)	Milk bottles, detergent/shampoo bottles, bottle caps, yoghurt drink bottles
21 01 39	PP (Packaging)	Microwaveable meal trays, butter tubs, dessert containers, disposable drink cups, yoghurt pots, ice cream containers, rashers trays
22 01 39	Styrofoam (EPS) (Packaging)	EPS foam - electronic goods packaging, burger boxes, some meat trays, some vegetable trays
15 01 02	Supermarkets Bags and Films (Packaging)	Shopping bags, fertiliser bags, cling film, compost/peat-moss bags, sandwich bags, cereal packets (inside box), biscuit wrappers, pallet wrap.
15 01 02	Other Plastic (Packaging)	Toothpaste tubes, cosmetics tubes, CD/DVD/tape covers. Meat containers, contaminated film packaging etc.
20 01 39	Other Plastic Waste (Non Packaging)	Refuse bags, clothes hangers, toys, air freshener holders, plant pots, seed trays, video cassettes, CDs, DVDs. tapes, washing up bowls, racks, CDs, gardening equipment, lighters, rulers, shoes (plastic only), plastic frames, babies bottle.
Glass		
15 0107	Green Glass (Packaging)	Red wine bottles, beer bottles
15 0107	Clear Glass (Packaging)	White/Rosé wine and water bottles, jam jars
15 0107	Brown Glass (Packaging)	Beer Bottles (e.g. Budweiser), medicine bottles
15 0107	Glass Other Colours (Packaging)	Blue water bottles, medicine bottles
20 01 02	Non Packaging Glass	Mirrors, plate glass, flat glass, cookware (Pyrex), mixed broken glass, drinking glasses.

EWC Codes	Waste Categories	Typical Examples
Metals		
15 01 04	Ferrous Metal (Packaging)	Food cans, can lids, beer bottle lids, biscuit tins, polish tins, lids from glass jars
20 01 40	Other Ferrous Metal Waste	Keys, nails, cutlery, paper clips, building/DIY materials, screws, tools, safety pins, metal shelves, radiators, pots and pans, locks, wire hanger
15 01 04	Aluminium Cans (Packaging)	Beverage cans - soft drinks, beer
	Aluminium foil (packaging)	Foil sheets, foil trays, some toothpaste/cosmetic products tubes, wine bottle screw caps, chocolate bar foil wrapper, foil yoghurt lids, stock cube wrapper.
20 01 40	Other Aluminium Waste	
15 01 04	Other Metal (Packaging)	
20 01 40	Other Metal Waste	Copper wiring
Wood		
15 01 03	Wood Packaging	Bottle corks, cork packaging, pallets, ice-cream sticks
20 01 37	Non-Packaging Natural Wood	Wood fencing (unpainted/unvarnished), some wood from DIY
20 01 37* / 20 01 38	Treated/ composite woods (e.g. MDF/chipboard)	Kitchen units, particle wood, toilet seats, skirting (chipboard, plywood, mdf), baskets.
Hazardous Municipal Waste		
20 01 27* / 20 01 28	Paint and associated products	Paint tins, heavily soiled paint brushes
20 01 33*/34	Batteries & Accumulators	Lead acid, nickel cadmium, other car and household batteries and accumulators (including rechargeable batteries)
20 01 21*	Fluorescent tubes	Fluorescent tubes and other mercury containing wastes
20 01 99	Aerosols	Deodorant, perfume, hairspray
21 01 35*/36	Electronic equipment	Household appliances (toasters etc), electronic toys, remote controls, phone chargers.
20 01 31*/32	Medicines and drugs	Out of date antibiotics, steroids, tablets, etc separated from packaging, inhaler
20 01 29*/30	Detergents	Laundry detergents separated from packaging i.e. the liquid or powder only
20 01 99	Waste oil and oil filters	Automobile engine oil and filters
20 02 03	Garden chemicals	Sprays, feeds
20 01 99	Ink cartridges and toner	From office, household printers.
20 01 99	Healthcare risk waste	Sharps, vials
20 03 99	Other (hazardous) municipal waste	Any other items - Description to be provided during survey e.g. hair dye
20 03 99	Other (hazardous) municipal waste	Any other items - Description to be provided during survey

EWC Codes	Waste Categories	Typical Examples
Unclassified Combustibles		
20 03 99	Unclassified combustibles packaging	
20 03 99	Other unclassified combustibles	Animal hair, linoleum (lino), rubber/latex gloves, cigarette butts, candles, full tube body lotion, paint brush
Unclassified Incombustibles		
20 03 99	Unclassified incombustibles packaging	
20 03 99	Other unclassified incombustibles	Inert waste e.g. ceramics, crockery, stone/ceramic floor and wall tiles, vases, stones, bricks, non-mercury containing light bulbs.
Components Smaller Than 20mm Round Mesh		
20 03 99	Fines smaller than 20mm round	Any items going through the 20mm mesh

APPENDIX C: SAMPLE FORMS

C.1 SAMPLE FORM FOR RECORDING WASTE INCREMENTS

Name & Address Of Facility		**Waste Licence Or Permit No.**	
Treatment Process (e.g. shredder, trommel, 50mm screen)		**Type Of Waste Being Processed** (e.g. 2-bin residual household)	
Residual Waste Stream Being Sampled (e.g. > 50mm oversize residues to landfill)		**Sampling Location** (e.g. loose pile on floor, prior to loading to lorry)	
Details Of Photos Taken			

	Date	Time	Weight
Sample Increment 1			
Sample Increment 2			
Sample increment 3			
Sample increment 4			
Sample increment 5			
Sample increment 6			
Sample increment 7			
Sample increment 8			
Sample increment 9			
Sample increment 10			
Sample increment 11			
Sample increment 12			
Sample increment 13			
Sample increment 14			
Sample increment 15			

Weight Of Composite Sample	
Weight Of Sub-Sample (after coning & quartering)	

Signed:_____ **(Supervisor)**	**Date:**_____

C.2 SAMPLE FORM FOR RECORDING WEIGHTS & CALCULATION OF BMW CONTENT

Type Of Residue		e.g. >50mm oversize residues from trommelling of 2-bin residual household	
Weight Of Sub-Sample To Be Sorted		185kg	
Date Of Sorting	15/09/10	**Date Of Sorting**	2-5pm

	Bin 1 **100% or Full BMW**	**Bin 2** **50% or Part BMW**	**Bin 3** **0% or Non-BMW**	**Bin 4** **Fines < 20mm**
	Kg	**Kg**	**Kg**	**Kg**
Tare Weight **(weight of empty bin)**	10	10	10	10
Gross weight **(waste plus tare weight)**	54	50	101	20
Net weight **(gross minus tare weight)**	44	40	91	10
BMW Factor	1	0.5	0	0.5
BMW weight **(net weight x BMW factor)**	44	20	0	5

BMW Weight	44 + 20 + 0 + 5 = 69 kg
BMW Factor Of >50mm Oversize Residues	69/185 = 0.37

Signed:_____ **(Supervisor)**	**Date:**_____

APPENDIX D: LOI TEST METHOD

D.1 LOI METHOD FOR THE TESTING OF FINES RESIDUES FROM THE MECHANICAL TREATMENT OF MSW BIN COLLECTIONS "WET WASTE"

Reference: Amended from the European Standards EN 15169:2007 Characterization of waste - Determination of loss on ignition in waste, sludge and sediments and EN 14346:2006, Characterization of waste - Calculation of dry matter by determination of dry residue or water content.

1. **Transport Conditions:**
   Dark and cool.

2. **Sample Storage And Preservation:**
   Airtight container of amber glass or plastic with no migration of constituents e.g. PP or PE. As the sample is biologically active, if the sample is not processed within 24 hours, the sample should be made inactive by cold storage at 4°C in the dark not longer than 3 days; longer storage at about -18°C.

3. **Sample Preparation:**
   Record the weight of the sample received by the laboratory (the sample received should be approximately 1kg in weight). Homogenise the sample thoroughly by manual mixing. The bigger pieces should be broken up by hand or cut up using a scissors or secateurs. No sieving should be carried out on the sample.

4. **Removal Of Foreign Bodies Or Non-comminutable Inert Materials:**
   Foreign bodies or non comminutable inert material (e.g. plastic, metal, stones, glass, ceramics) should be separated from the sample. Record the weight and nature of the foreign bodies or non comminutable inert material removed and retain in a clear plastic bag. The remaining sample should be manually mixed again to ensure the sample is homogeneous. Particle size of the sample should be <10mm and any remaining large pieces should be cut up using a scissors or secateurs.

5. **DM And LOI Testing:**
   DM and LOI testing should be carried out in successive operations on the same test portion in the same crucible according to EN 14346:2006 and EN 15169:2007. Dry a representative weighed portion of the sample at 105°C until no further weight loss, cool and weigh to provide the dry matter value. This sample is then heated slowly to 550°C and held at that temperature until all organic matter is completely combusted. The sample is then cooled in a dessicator and re-weighed. The loss in weight on heating to 550°C is calculated and the loss on ignition is determined.

   5.1 Dry Matter: Test run on five replicate samples, drying at 105°C +/- 3°C. Five replicates of 50g or larger are removed from the homogenised sample. The crucible volume and the bulk density of the sample may affect the weight of the test portion used but it should be as close to 50g as possible.

   5.2 Loss on ignition. The test portion size is determined by the output from the dry matter test. Test run on five replicate samples, drying at 550°C +/- 25°C.

6. The weights for the sample received, foreign bodies or non-comminutable inert material removed, moisture loss during the dry matter test, loss on ignition and ash should be reported. The result for each of the five replicates should be reported with standard deviation.

7. The BMW factor for the sample is estimated using the calculations illustrated in the worked example in section D.2.

D.2 WORKED EXAMPLE

Figure 10 illustrates the composition of the sample during the various stages of the analytical process. A start sample weight of 1,000g is used for illustrative purposes.

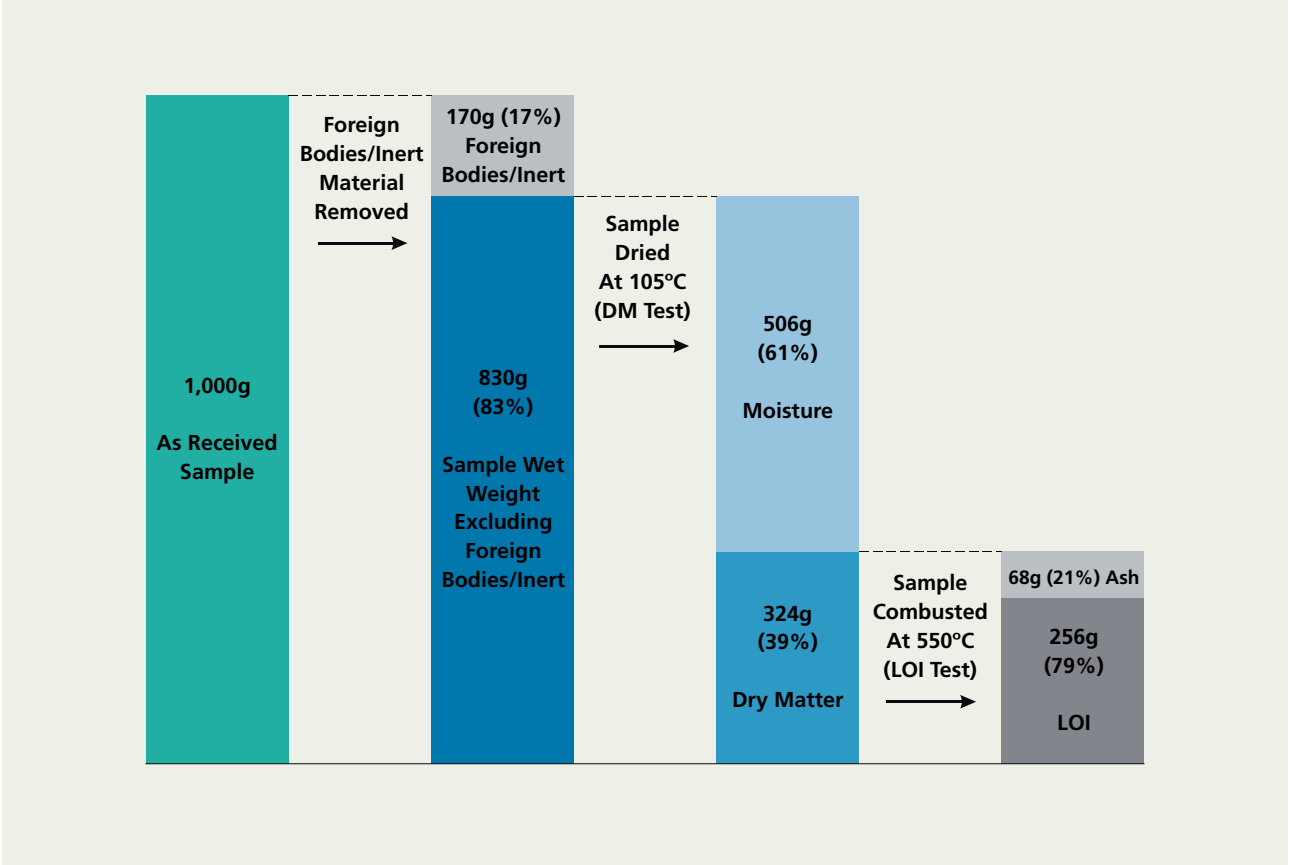


Figure 10. Illustration of the LOI analytical process

All moisture loss is assumed to come from the biodegradable fraction of the sample.
The calculation of the BMW factor is as follows:

$$\frac{\text{256g (LOI) + 506g (moisture)}}{\text{1000g (as received sample)}} = 0.76$$

APPENDIX E: AT_4 TEST METHOD

According to Annex 2.5 of German Ordinance on Environmentally Compatible Storage of Waste from Human Settlements and on Biological Waste Treatment Facilities of 2001.

http://www.bmu.de/files/pdfs/allgemein/application/pdf/ablagerungsverordnung.pdf

E.1 BIOLOGICAL DEGRADABILITY OF DRY RESIDUE IN ORIGINAL SUBSTANCE BREATHING ACTIVITY (AT_4) (ANNEX 2 NO. 5)

1. **Test apparatus:**
   AT_4 shall be determined using a Sapromat, Respiromat or equivalent apparatus. All departures from the method listed below shall be documented.

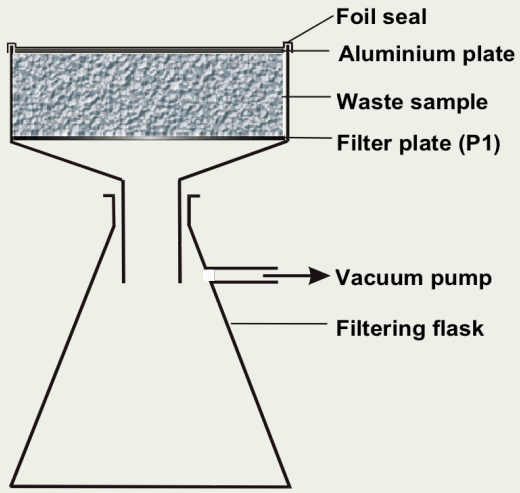
2. **Temperature:**
   20 ± 1°C in a temperature-controlled water bath or conditioned room.

3. **Sample Storage:**
   Sample preparation must be completed, and the test started, within 48h following sampling. During this period temperatures over 4°C are permissible for no more than 24h. If it is not possible to ensure compliance with this procedure, the sample shall be frozen, within 24h after sampling, at -18 to -20°C. Freezing of samples shall be documented in connection with evaluation. Thawing of samples must be gentle, and must last no longer than 24h; during thawing, the temperature must not exceed 20°C.

4. **Sample Preparation:**
   The original sample, in its entirety, must be wet-crushed to < 10mm. If necessary, interfering substances (glass, stones and metals) may be discharged prior to crushing. Their weight components must be taken into account in evaluation of the test.

5. **Adjustment Of The Water Content:**
   Moisten 300g of the prepared sample with 300ml of tap water and place the wet mixture in the apparatus described in Figure 11. After covering and sealing, apply an underpressure of ca. 100,000 Pa (water-jet vacuum) and maintain for a period of 30 minutes. Determine the volume of the filtered-off water and subtract this from the added 300 ml of tap water. The amount of water determined in this manner is to be added to that part of the sample placed in the test apparatus.

   If the water content of the sample to be used is larger than the determined water content, then transfer the sample, without further moistening, into the apparatus described in Figure 11, expose it for 30 minutes to the underpressure in the vacuum nutsch and then place it in the test apparatus.



Apparatus:
filtering flask, vacuum-proof, volume 1 to 2 litres, with rubber plug
filter nutsch, diameter 120 mm, filter plate (P1), volume 1 litre,
should have vertical side walls
aluminium plate, diameter the same as the inside diameter of the nutsch
vacuum pump and underpressure manometer

Figure 11. Apparatus for adjusting the water content

6. **Sample Amount:**
A 40g sample, adjusted to the water content determined as described above, is to be used.

7. **Number Of Parallel Batches:**
Samples are to be tested in three parallel batches.

8. **Test Duration And Evaluation:**
The evaluation period is 4 days, and it begins following the initial lag phase. The lag phase has ended when the mean oxygen consumption, expressed as a 3-hour mean, reaches 25% of the value that results as the 3-hour mean in the region of the largest increase in the oxygen consumption within the first 4 days.

The weight of the oxygen consumed during the lag phase is subtracted from the weight of the oxygen consumed throughout the entire test (lag phase + 4 days), and it must not be more than 10% of the overall value. If this condition is not fulfilled, determination may not be carried out.

Measurements must be recorded on an hourly basis.

The analysis function and the 3-hour means are shown by entering the test duration (in hours) on the x-axis and the summed oxygen weights (in mg O_2 per g dry weight) on the y-axis.

9. **Listing Of The Result:**
The result is listed with two significant places, in mg O_2 per g dry weight. Both the mean and the standard deviation are to be listed. If one of the values of the triple determination deviates from the mean by more than 20%, then this value is to be thrown out as an outlier. In such cases, the new mean is then calculated from the 2 remaining values.

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