JRC TECHNICAL REPORTS

Level(s) indicator 2.2: Construction and Demolition waste and materials

User manual: overview, guidance and instructions
(Publication version 1.0)

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Title
Level(s) indicator 2.2: Construction and Demolition waste and materials User manual: overview, guidance and instructions (Publication version 1.0)

Abstract
Developed as a common EU framework of core indicators for the sustainability of office and residential buildings, Level(s) provides a set of indicators and common metrics for measuring the performance of buildings along their life cycle. As well as environmental performance, which is the main focus, it also enables other important related performance aspects to be assessed using indicators and tools for health and comfort, life cycle cost and potential future risks to performance.

Level(s) aims to provide a common language of sustainability for buildings. This common language should enable actions to be taken at building level that can make a clear contribution to broader European environmental policy objectives. It is structured as follows:

1. Macro-objectives: An overarching set of six macro-objectives for the Level(s) framework that contribute to EU and Member State policy objectives in areas such as energy, material use and waste, water and indoor air quality.

2. Core Indicators: A set of 16 common indicators, together with a simplified Life Cycle Assessment (LCA) methodology, that can be used to measure the performance of buildings and their contribution to each macro-objective.

In addition, the Level(s) framework aims to promote life cycle thinking. It guides users from an initial focus on individual aspects of building performance towards a more holistic perspective, with the aim of wider European use of Life Cycle Assessment (LCA) and Life Cycle Cost Assessment (LCCA) methods.
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# The Level(s) documentation structure

## User manual 1: Introduction to the common framework
- Orientation and learning for potential users of Level(s)

## User manual 2: Setting up a project
- Plan the use of Level(s) on your project and complete the building description.

## User manual 3: Indicator user manuals
- Detailed instructions and guidance on how to use each indicator

### 1. How can Level(s) be used

### 2. The common language of sustainability
- Briefing notes: Thinking sustainability
  - Whole life cycle and circular thinking
  - Closing the performance gap
  - How to achieve sustainable renovation
  - How sustainability can influence value

### 3. How Level(s) works

#### 1. Establish a project plan

#### 2. Complete the building description

| 1.1 Use stage energy performance |
| 1.2 Life cycle Global Warming Potential |
| 2.1 Bill of quantities, materials and lifespans |
| 2.2 Construction & demolition waste and materials |
| 2.3 Design for adaptability and renovation |
| 2.4 Design for deconstruction, reuse and recycling |
| 3.1 Use stage water consumption |
| 4.1 Indoor air quality |
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| 4.3 Lighting and visual comfort |
| 4.4 Acoustics and protection against noise |
| 5.1 Protection of occupier health and thermal comfort |
| 5.2 Increased risk of extreme weather events |
| 5.3 Increased risk of flood events |
| 6.1 Life cycle costs |
| 6.2 Value creation and risk exposure |
How this indicator user manual works

Level(s) is a framework of core indicators of sustainability that can be applied to building projects in order to report on and improve their performance. The supporting documentation has been designed to be accessible to all the actors that may be involved in this process.

If you are new to the assessment of a building’s sustainability, we recommend reading the first part of the Level(s) user manual. This will provide you with an introduction to the basic concepts behind Level(s) and how you can apply it to a building project.

If you haven’t yet set up your building project to use Level(s), including completing the project plan and the building description, then we recommend reading the second part of the Level(s) user manual.

This indicator user manual forms the third part of the Level(s) user manual where you will find instructions on how to use the indicators themselves. It is designed to help you apply your chosen indicator to a building project. It will help you to do this in the following way:

- **Introductory briefing**: This section provides an overview of the indicator, including:
  - why you may wish to measure performance with it,
  - what it measures,
  - at which stages in a project it can be used,
  - the unit of measurement, and
  - the relevant calculation method and reference standards.

- **Instructions on how to use the indicators at each level**: This section provides:
  - step by step instructions for each level,
  - what is needed to make an assessment,
  - a design concept checklist (at Level 1), and
  - the reporting formats.

The instructions often refer to the guidance and further information which can be found after the instructions.

- **Guidance and further information for using the indicator**: This section provides more background information and guidance to support you in following specific steps in the instructions, including the design concepts introduced at Level 1 and the practical steps to calculate or measure performance at Levels 2 and 3. They are all cross-referenced to specific instruction steps at either level 1, 2 or 3.

This indicator user manual is structured so that once you are familiar with using the indicator and you know how to work with it, you may no longer need to refer to the guidance and background information, but only work directly with the instructions at the level of your choice.
Technical terms and definitions used

“Auditor” means, according to the 2018 guidelines for waste audits before demolition and renovation works of buildings, the expert or the team of experts (auditing team) performing the waste audit. It can be represented by the building owner or consultant (e.g. an architect or structural engineer) acting on behalf of the owner.

“Backfilling” means, according to the EU Waste Framework Directive, any recovery operation where suitable non-hazardous waste is used for purposes of reclamation in excavated areas or for engineering purposes in landscaping. Waste used for backfilling must substitute non-waste materials, be suitable for the aforementioned purposes, and be limited to the amount strictly necessary to achieve those purposes;

“Construction and demolition waste” means, according to the EU Waste Framework Directive, waste generated by construction and demolition activities. The 2016 EU Construction & Demolition waste management protocol further defines this term as waste generated at sites where construction, renovation or demolition takes place, and included in category 17 of the European List of Wastes (note: indicator 2.2 reports excavation wastes (category 17 05) separately to other codes under category 17).

“Decontamination” means, according to the 2016 EU Construction & Demolition waste management protocol, the reduction or removal of chemical agents.


“Disassembly” means, according to ISO/FDIS 20887:2020, the non-destructive taking-apart of a construction works or constructed asset into constituent materials or components (note: the term disassembly should be considered as synonymous with “deconstruction”, which is defined as the “removal of building elements from a demolition site in order to maximise their recovery and reuse” in the 2018 Guidelines for waste audits before demolition and renovation works of buildings.).

“Hazardous waste” means, according to the EU Waste Framework Directive, waste which displays one or more of the hazardous properties listed in Annex III (to the same Directive). The 2016 EU Construction & Demolition waste management protocol, further defines hazardous CDW as debris that has hazardous properties and that may prove to be harmful to human health or the environment. This comprises contaminated soil and dredging spoil, materials and substances that may include adhesives, sealants and mastic (flammable, toxic or irritant), tar (toxic, carcinogenic), asbestos-based materials in the form of respirable fibre (toxic, carcinogenic), wood treated with fungicides, pesticides etc. (toxic, ecotoxic, flammable), coatings of halogenated flame retardants (ecotoxic, toxic, carcinogenic), equipment with PCBs (ecotoxic, carcinogenic), mercury lighting (toxic, ecotoxic), systems with CFCs, insulation containing CFCs, containers for hazardous substances (solvents, paints, adhesives, etc.) and the packaging of likely contaminated waste.

“Inert waste” means, according to the 2016 EU Construction & Demolition waste management protocol, waste that does not undergo any significant physical, chemical or biological transformations (e.g. concrete, bricks, masonry, tiles). Inert waste will not dissolve, burn or otherwise react physically or chemically, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health.

“Non-hazardous waste” means, according to the Waste Framework Directive, a waste that does not display one or more of the hazardous properties listed in Annex III (to the same Directive).

“Preparing for re-use” means, according to the Waste Framework Directive, checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing.

“Recovery” means, according to the Waste Framework Directive, any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Annex II (to the same Directive) sets out a non-exhaustive list of recovery operations.
“Recycling” means, according to the Waste Framework Directive, any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations;

“Renovation” means, according to the 2016 EU Construction & Demolition waste management protocol, work that involves the structural alteration of buildings, the substantial replacement of main services or finishes and/or the substantial changed use of floor space whilst at the same time including associated redecoration and repair works on the one hand and related to the new building on the other. Renovation covers all the work done to existing buildings as the four R’s: renovation, rehabilitation, restoration and remodelling. Renovation is addressed from a broad perspective, including residential, historical and commercial buildings owned and managed by private/public companies or authorities.

“Re-use” means, according to the Waste Framework Directive, any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.

“Scavenging” means, according to the 2016 EU Construction & Demolition waste management protocol, the activity of identifying usable materials that takes place after demolition; in this context, particularly re-usable and recyclable materials.

“Selective deconstruction”, means the systematic disassembly of buildings in order to maximise the reuse and recycling of recovered materials.

“Selective demolition” means, according to the 2016 EU Construction & Demolition waste management protocol, the activity of removing valuable materials from a site, installation or building that takes place before demolition.

“Waste” means, according to the EU Waste Framework Directive, any substance or object that the holder discards or is required to be discarded. Notable exemptions to the scope of the Waste Framework Directive set in Article 2 are: (i) land (in situ) including unexcavated contaminated soil and buildings permanently connected with land; and (ii) uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is guaranteed that the material will be used for the purposes of construction in its natural state on the site from which it was excavated.

“Waste audit” means, according to the 2018 EU Guidelines for waste audits before demolition and renovation works of buildings, a qualitative and quantitative assessment of waste that will be produced from the construction, demolition/deconstruction or refurbishment activities including residual waste that is not part of the building. An important part of the waste audit is also the identification and removal of materials/components containing hazardous substances (note: the same principles can be applied to estimating waste generated during construction activities).

“Waste holder” means, according to the EU Waste Framework Directive, the waste producer or the natural or legal person who is in possession of the waste.

“Waste management plan”, according to the 2016 EU Construction & Demolition waste management protocol, means a plan that contains information about how the different steps of the demolition/renovation/construction will be performed, by whom they will be performed, which materials will be collected selectively at source, where and how they will be transported, what will be the recycled, re-use of final treatment and how to follow up.

“Waste producer” means, according to the EU Waste Framework Directive, anyone whose activities produce waste (original waste producer) or anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of this waste.
“Waste transfer station”, according to the 2016 EU Construction & Demolition waste management protocol, means any site, location, tract of land, installation or building that is used or intended to be used primarily for the purpose of transferring solid wastes.

Introductory briefing

Why measure performance with this indicator?

Construction and demolition waste (CDW) is one of the largest waste streams generated in the EU, accounting for approximately 25-30% of all EU waste. The vast majority of CDW is inert, so construction and demolition activities present opportunities to divert CDW away from landfill and back into the construction material loop. Legal requirements to report on CDW show that average recovery rates for CDW across the EU (excluding excavation waste) are only 50%, even though some Member States have achieved rates >90%.

The aim of this indicator is therefore to promote and allow users to systematically plan for the reuse, recycling or recovery of elements, materials and wastes via the segregated collection of CDW during construction, renovation and demolition activities.

What does it measure?

Levels 2 and 3 of this indicator estimate and measure the overall quantity of waste generated by construction, renovation and demolition activities (in kg). This quantity is disaggregated into the main types of CDW as per the European List of Waste entries. Final outcomes for each waste type (e.g. recycling, landfill etc.) are also recommended (Level 2) and later recorded during the project (Level 3).

At what stage of a project

The stages at which an assessment can be made reflect the three ‘levels’:

- Level 1: In the conceptual design, information is provided to prompt discussion and decision making for the project about aspects that will directly or indirectly shape the outline Waste Management Plan (WMP) and thus the quantities of CDW generated and their possible reuse, recycling and recovery.
- Level 2: During the detailed design and prior to construction/demolition activity, estimates of CDW can be compiled in an inventory following the Level(s) excel template, which in turn will inform a more detailed WMP for the project.
- Level 3: During and after the construction/demolition activity, actual data can validate performance when compared to estimates and project targets, both for quantities and outcomes for different types of CDW.

Unit of measurement

Data is reported in kg and shall later be normalised to the useful internal floor area of the building in question. In this way, a comparable unit of measurement is generated (kg/m²).

System boundary

In the context of the Module A-D life cycle stages set out in EN 15978, the indicator is generally focussed on the A5 stage (construction process) of the building life cycle. However, any reduction in CDW generation or any onsite recycling or recovery would be indirectly reflected in A1-A4 stages (due to less waste meaning fewer materials needed to do the job). Any future estimates for the fate of building elements and materials at the End
of Life of the new building would affect results in module C (End of Life stage) and module D (benefits/loads beyond the system boundary).

Scope
The scope includes data for all building elements, materials and wastes generated by construction, renovation and/or demolition activities. Data may include Waste Electronic and Electrical Equipment (WEEE)\textsuperscript{1} and excavation waste (EW), although these are reported separately from CDW. Indicator 2.2 reports on all final outcomes for CDW. The relationship between these outcomes, the WMP and demolition or construction activities is illustrated below.

![Figure 1. Relationship between the WMP, construction activities, demolition activities and outcomes for CDW](image)

Calculation method and reference standards
The calculation used for Levels 2 and 3 is based on the European list of waste codes and consists of either an estimation (Level 2) or the recording (Level 3) of the different flows of waste by category and their ultimate destination. The Level(s) excel reporting templates for CDW generally follow the EU CDW management guidelines for waste audits, published in 2018 in 15 EU languages [here](link).

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\textsuperscript{1} Only materials falling within the scope of the WEEE Directive (2012/19/EU) as set out Annexes III and IV to the Directive and not including other types of electrical equipment that are permanently installed in the building should be reported as WEEE.
Instructions on how to use the indicators at each level

Instructions for Level 1

L1.1. The purpose of Level 1

The focus of Level 1 is to make the reader aware of highly relevant aspects for reducing CDW and optimising its management, regardless of whether they intend to compile inventories at Level 2 or 3. Users of Level(s) should then briefly describe how these aspects were considered (or not) during discussions and decision-making at the concept design stage in a summary table.

L1.2. Step-by-step instructions

These instructions should be read in conjunction with the accompanying Level 1 technical guidance and supporting information (see page 19).

1. Consult the checklist under L1.4 of design concepts relating to CDW and read the background descriptions in the Level 1 technical guidance.

2. Within the design team, review and identify how CDW-related design concepts can be introduced into the design process and building project.

3. Once the conceptual design is finalised with the client, record the CDW-related design concepts that were taken into account using the L1 reporting format (in L1.5).

L1.3. Who should be involved and when?

At the concept design stage, the main actors would be the concept architect, the building owner and the relevant building authority that grants the permit for the construction, renovation or demolition activity. In cases where BAM principles are to be incorporated, particular emphasis is placed on the expertise of the concept architect/consultant. In cases where demolition activities are involved, early dialogue with demolition specialists and salvage operators is strongly encouraged.

Later in the project, the contractor, specialist sub-contractors, waste managers, product manufacturers and possibly an auditor will become involved. For further details about the roles and interactions of different actors, see the technical guidance.

L1.4. Checklist

The following design concepts have been identified from best practice and literature reviewed by the Joint Research Centre as proxies for achieving better performance.

Table 1. Level 1 checklist for design concepts relevant to CDW

<table>
<thead>
<tr>
<th>Level 1 design concept</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Setting of relevant targets or Key Performance Indicators (KPIs)</td>
<td>When considering setting any ambition levels or targets for waste management and outcomes in the project, they should be set in the proper context of the EU waste hierarchy and the EU List of Wastes.</td>
</tr>
<tr>
<td>2. The influence of project type on CDW generation and management.</td>
<td>Different projects (e.g. new construction on greenfield sites, renovation projects or demolition projects) will generate different quantities of waste. Time, labour and space constraints will also vary with each project site and budget, having an influence on the CDW management.</td>
</tr>
<tr>
<td>3. Pre-demolition auditing (if demolition activities take place).</td>
<td>With the aim of identifying the different elements, materials and potential wastes and how they could potentially be dealt with by decontamination, stripping, selective deconstruction and sorting techniques – within the time,</td>
</tr>
</tbody>
</table>
space and labour constraints of the project and the regionally available options for these elements, materials and wastes.

4. Good construction practice

Identify good practices that can reduce onsite waste (e.g. via the increased use of prefabricated elements) and procurement arrangements that may incentivize the reduction of over-ordered materials.

5. Outline Waste Management Plan (WMP)

Establish an outline WMP to explain (i) how environmental and health impacts from CDW can be reduced; (ii) how cost benefits can be maximised (i.e. increased revenues and avoided costs) and (iii) how the segregated collection of onsite waste can be optimised based on the different possible end market, storage, processing and disposal options.

6. “Buildings As Material Banks” (BAMB) principles.

Consider how BAMB concepts could be applied to the conceptual design of the building (e.g. design for disassembly and reuse of prefabricated elements at the End of Life).

L1.5. Reporting format

Table 2. Level 1 reporting format for indicator 2.2 (with example answers provided)

<table>
<thead>
<tr>
<th>Construction and Demolition Waste design concept</th>
<th>Addressed? (yes/no)</th>
<th>How has it been incorporated into the building project? (provide a brief description)</th>
</tr>
</thead>
</table>
| 1. Target setting and KPIs in line with the EU waste hierarchy and the European LoW | Yes | The material provided in the Level 1 technical guidance has been consulted and targets of:  
- ≤10% landfill disposal for non-haz waste,  
- ≥40% recycling+reuse of all inert waste and  
- ≥95% material recovery+recycling+reuse for separately collected inert waste fractions. |
| 2. Project type and influence on CDW constraints | Yes | The project will be a new-building construction on a cleared brownfield site. Excavations of existing backfill and contaminated soil will be required in order to construct basement car parking. A preliminary cost comparison of offsite remediation and storage of contaminated soil compared to disposal to hazardous waste landfill will be conducted before deciding on which option to choose. |
| 3. Pre-demolition audit | No | Not relevant to this project since no demolition activity is required. |
| 4. Good construction practice | Yes | Over-ordered materials will be a KPI for the project and the contractor will be encouraged to try to negotiate buy-back options with suppliers for over-ordered materials for a fixed % of the original purchase price. |
| 5. Site Waste Management Plan (SWMP) | Yes | A consultant with in-depth knowledge of the regional processing options and end-markets for CDW will be contracted to help optimise the outline WMP. |
| 6. Buildings as Material Banks (BAMB) principles in concept design | No | Initial decision taken not to incorporate these concepts into the building design as it would require additional expertise in the project team and dialogue with suppliers about building material passports. |
Instructions for Level 2

Important note: The exact steps to follow will be influenced by the scope of the building project (e.g. is a pre-demolition audit relevant or not).

L2.1. The purpose of Level 2

The purpose of Level 2 is to allow users to report on and to make reliable quantitative estimates of CDW using the Level(s) inventory template(s) for CW and/or DW estimation. In cases where demolition activities are involved, the 5 stages below are required. Only the last 3 stages are required for construction activities.

Figure 2. The 5 key steps for reporting on DW

Source: Adapted from the 2018 EU Guidelines for waste audits before demolition and renovation works of buildings.

L2.2. Step-by-step instructions for demolition activities

These instructions should be read in conjunction with the accompanying Level 2 technical guidance and supporting information (see page 26).

When estimating the DW for a project, steps 1-4 below should be followed to carry out a pre-demolition audit and this audit should then shape the waste management plan (WMP) in step 5:

1. Carry out a desk study, collecting and reviewing original building documentation to make an initial estimate of the materials present.
2. Conduct a field survey to identify materials present and to estimate quantities, consider involving specialist contractors with knowledge of regional reuse markets.
3. Download the Level(s) template for DW estimates.
4. Follow the instructions embedded in the Level(s) inventory template and use the information from steps 1-3 to create an inventory of material/waste estimates related to demolition/renovation activities.
5. (Further step beyond the scope of Level(s) reporting) Prepare a WMP that explains how data on the waste arising on the site will be monitored and tracked, as well as how the elements, materials and wastes arising from the demolition activity should be collected, stored, treated and transported.

L2.3. Step-by-step instructions for construction activities

Estimating CW is generally much simpler than DW because the estimates are directly linked to the Bill of Materials (BoM) and Bill of Quantities (BoQ) for the project. In the Level(s) template, BoM is
considered as defined material fractions that are derived from the BoQ (which may contain entries that consist of multiple material fractions together).

Step-by-step instructions for developing a CW inventory and WMP

1. Prepare an approximate BoM based on the scope of the detailed design documentation available (if also reporting on indicator 2.1, Bill of Quantities, data from the Level(s) indicator 2.1 template could be used directly).
2. Download the Level(s) template for CW estimates.
3. Insert BoM values into the Level(s) template for CW estimates and follow the instructions embedded in each column heading where data needs to be entered.
4. Select the nature of the waste material (e.g. inert, non-hazardous or hazardous) and the appropriate waste code.
5. Consider the best processes and systems offered by waste contractors for specific material/waste streams and recommend the end-market destination (based on the regional situation) for each entry in order to complete the CW inventory.
6. Based on steps 3, 4 and 5, an outline WMP should be prepared that would explain how the elements, materials and wastes arising from construction activities should be collected, stored, treated and transported.

L2.4. What do you need to make an assessment?

The main items needed are as follows:

- A completed Level(s) building description.
- For demolition activities, a desk study, field survey and completed Level(s) DW estimate inventory.
- For construction activities, the Level(s) CW estimate inventory (this could be based on a draft Bill of Quantities and Bill of Materials filled out in the Level(s) indicator 2.1 template).

L2.5. Who should be involved and when?

Demolition projects (referring to steps in L2.2): The auditor is the most important actor in steps 1-4 and may also be responsible for step 5, or perhaps work together with a waste manager. The auditor must prepare a pre-demolition audit that meets any requirements set by the building authority and forms the basis for an outline WMP. The waste manager must have an input to or control of the outline WMP and product manufacturers may also be involved.

Once a permit has been granted by the building authority (i.e. beyond step 5) and the contract for the demolition works has been awarded, the contractor will most likely make their own in-house pre-demolition audit, and compare this to the results of the auditor.

Construction projects (referring to steps in L2.3): The architect/consultant, and possibly a separately contracted quantity surveyor, should work on steps 1-3 in accordance with the detailed design approved by the building owner. If indicator 2.1 is also reported on, then the person/team responsible for this should be closely involved in indicator 2.2 reporting for the sake of consistency. The waste manager needs to be involved in steps 4-6.

Once a permit has been granted by the building authority (i.e. beyond step 6) and the contract for the construction works has been awarded, the contractor will need to start with the outline WMP and adapt it to any additional specificities and developments in the project.
L2.6. Ensuring the comparability of results

At the individual project level, CDW estimates and estimated fractions of diversion from landfill should be considered in the context of national and European targets (e.g. see the BIOS report\(^2\)) or typical wastage rates (e.g. see Resource Efficient Scotland paper\(^3\)).

In terms of comparing projects, the normalisation of data into kg/m\(^2\) and expressing outcomes as a % of total flows allows for better comparison amongst a broad range of project types.

L2.7. Going a step further

The Level(s) inventory templates have further functionality that can be used at the Level 2 stage and that may inform specific project KPIs.

- **Reporting by different waste types**: Estimates for DW and CW are also automatically disaggregated into different waste streams as a function of the LoW code used for each entry to the inventory. This allows for specific reuse, recycling or material recovery targets to be set for specific waste fractions as well. More specific targets link to the consideration of end-markets that only accept certain types of waste and should be reflected in the WMP for the project so that collection systems ensure the level of quality and segregation required.

- **Avoided landfill cost estimation**: The spreadsheet estimator allows for the costs of hazardous, non-hazardous and inert landfill to be estimated in a scenario where all CDW was sent to landfill. These avoided costs are important to consider when assessing any additional costs associated with actions required to improve material recovery, recycling and reuse rates.

L2.8. Format for reporting the results of an assessment

The reporting format below applies for DW estimates. The exact same format applies for CW estimates except that it also can include estimates of over-ordered materials in the total.

The indicator results provide information on much waste is estimated to be generated in total, plus a breakdown of the waste by outcome. The outcomes follow the EU waste hierarchy and disposed waste is further split by waste type. The results are normalised to the internal floor area of the building. Optional additional reporting on additional sources of waste can be made for WEEE, earthworks and the over ordering of materials to site.

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\(^3\) An average figure of 13% was stated in: “Best practice guide to improving waste management on construction sites”, published by Resource efficient Scotland.
Table 3. Headline results to be reported for indicator 2.2, Level 2 estimates of CDW

<table>
<thead>
<tr>
<th>Sum of material sub-chapters</th>
<th>Mass (kg)</th>
<th>Mass (kg/m²)</th>
<th>Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuse of materials</td>
<td>4500</td>
<td>1.96</td>
<td>0.4%</td>
</tr>
<tr>
<td>Recycling of DW</td>
<td>640773</td>
<td>256</td>
<td>36.9%</td>
</tr>
<tr>
<td>Material recovery (backfill)</td>
<td>301000</td>
<td>144</td>
<td>32.0%</td>
</tr>
<tr>
<td>Energy recovery</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Disposal</td>
<td>22400</td>
<td>9</td>
<td>2.0%</td>
</tr>
<tr>
<td>of which: Inert</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Non-haze</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hazardous</td>
<td>22400</td>
<td>8.96</td>
<td></td>
</tr>
<tr>
<td>Total (kg)</td>
<td>1126573</td>
<td>451</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

| Building GFA (m²)                     | 2500      |              |
| Normalised DW (kg/m²)                 | 450.6     |              |
Instructions for Level 3

Important note: The exact steps to follow will be influenced by the scope of the building project (e.g. is a pre-demolition audit relevant or not).

L3.1. The purpose of Level 3

The focus of Level 3 is to guide the reader through the steps necessary to actually measure the quantities of CDW in their project, using the Level(s) excel templates for CW and DW reporting to collate data. Level 2 provides a basis for working with Level 3 and allows a comparison of estimates with actual data. However, using level 2 is not essential prior to using level 3 unless demolition is carried out.

L3.2. Step-by-step instructions

These instructions should be read in conjunction with the accompanying Level 3 technical guidance and supporting information (see page 39).

When estimating DW for a project, steps 1-4 should be followed to create a pre-demolition audit and this audit should then shape the WMP in step 5:

1. In cases where demolition activities take place, download the Level(s) template for DW estimation and prepare a demolition waste inventory prior to demolition activity taking place.
2. Download the Level(s) template for CW reporting and DW reporting and consult with project team to be sure that all parties agree on how it should be filled out.
3. Develop a WMP or refine an outline WMP with clearly defined roles and responsibilities and that has considered potential end-markets and material logistics.
4. Agree among the project team on a tracking system to log site and logistical data.
5. Add new entries to the inventory with each movement of building elements, materials or waste offsite for reuse, recycling, recovery or disposal.
6. At the end of the project, assess the total quantities of over-ordered construction products and materials and extract final results for CDW from the relevant inventory.

L3.3. What do you need to make an assessment?

The main items needed are as follows:

- A completed Level(s) building description
- A detailed waste management plan.
- An agreed method of recording waste shipment data (an excel-based Level(s) template is available).
- A tracking and tracing system to collate and update waste movement data.

L3.4. Who should be involved and when?

The contractor and any relevant sub-contractors should be involved in steps 1-6. A specialist demolition auditor should be involved in carrying out the work or at least overseeing the work of the contractor in step 1.

Where relevant and required under the law, the building authorities should be involved in steps 1 and 3 to check and approve the pre-demolition audit and the SWMP prior to the granting of any permit for relevant demolition and construction activities.
L3.5. Ensuring the comparability of results
At the individual project level, CDW generation and fractions diverted from landfill should be considered in the context of national and European targets (e.g. see the BIOS report\textsuperscript{4}) or typical wastage rates (e.g. see Resource Efficient Scotland paper\textsuperscript{5}).

In terms of comparing projects, the normalisation of data into kg/m\textsuperscript{2} and expressing outcomes as a % of total flows allows for better comparison amongst a broad range of project types.

L3.6. Going a step further
The Level(s) inventory templates have further functionality that can be used at the Level 3 stage and that reflect project KPIs.

- **Reporting by different waste types**: Estimates for CDW are also automatically disaggregated into different waste streams as a function of the LoW code used for each entry to the inventory. This allows for specific reuse, recycling or material recovery targets to be set for specific waste fractions as well. More specific targets link to the consideration of end-markets that only accept certain types of waste and should be reflected in the WMP for the project so that collection systems ensure the level of quality and segregation required.

- **Avoided landfill cost estimation**: The spreadsheet estimator allows for the costs of hazardous, non-hazardous and inert landfill to be estimated in a scenario where all CDW was sent to landfill. These avoided costs are important to consider when assessing any additional costs or revenues associated with actions required to improve material recovery, recycling and reuse rates.

L3.7. Format for reporting the results of an assessment
The reporting format below applies for DW estimates. The exact same format applies for CW estimates except that it also can include estimates of over-ordered materials in the total.

The indicator results provide information on much waste is estimated to be generated in total, plus a breakdown of the waste by outcome. The outcomes follow the EU waste hierarchy and disposed waste is further split by waste type. The results are normalised to the internal floor area of the building.

Optional additional reporting on additional sources of waste can be made for WEEE, earthworks and the over ordering of materials to site.

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\textsuperscript{5} An average figure of 13% was stated in: “Best practice guide to improving waste management on construction sites”, published by Resource efficient Scotland.
Table 4. Headline results to be reported for indicator 2.2, Level 3 measurements of CDW

<table>
<thead>
<tr>
<th>Sub-chapter</th>
<th>Sum of sub-chapters</th>
<th>Mass (kg)</th>
<th>Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuse</td>
<td>Reuse</td>
<td>6352</td>
<td>1.1%</td>
</tr>
<tr>
<td>Recycling</td>
<td>Recycling</td>
<td>520321</td>
<td>92.7%</td>
</tr>
<tr>
<td>Recovery</td>
<td>Material (backfill)</td>
<td>30197</td>
<td>5.4%</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>2788</td>
<td>0.5%</td>
</tr>
<tr>
<td>Disposal</td>
<td>Disposal</td>
<td>1452</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>Inert</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-hazard</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hazardous</td>
<td>1452</td>
<td></td>
</tr>
<tr>
<td><strong>Total (kg)</strong></td>
<td></td>
<td>561110</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Normalised CDW (kg/m²)</strong></td>
<td></td>
<td>224.4</td>
<td></td>
</tr>
</tbody>
</table>
Guidance and information for using the indicator

Guidance and information for Level 1

The guidance supports the six Level 1 aspects and provides further details about roles and responsibilities of the main actors:

L1.3 – Further details about relevant roles and responsibilities
L1.4 concept 1 – The EU waste hierarchy and List of Wastes (LoW)
L1.4 concept 2 – Project type and influence on CDW constraints
L1.4 concept 3 – Pre-demolition audit
L1.4 concept 4 – Good construction practice
L1.4 concept 5 – Site Waste Management Plans (SWMPs)
L1.4 concept 6 – Buildings As Material Banks (BAMB) concept

L1.3 Further details about roles and responsibilities

The main different actors that play relevant roles for indicator 2.2 are described briefly below:

- **Property owner** is responsible for the identification and classification of waste as well as preliminary planning of handling of it;
- **Contractor** is responsible for demolition/deconstruction/renovation operations defined in the contract with the owner. The contractor should contribute to the traceability aspects of waste. Additionally, the contractor could play a key role in securing buy-back options for over-ordered construction materials/products;
- **National administration** is usually responsible for the waste legislation and waste management planning, it will have an obligation to collect the data about the CDW generated and its treatment;
- **Local administration (building authority)** issues demolition or renovation permits and should establish mechanisms to ascertain (directly or with the intervention of third parties) that waste audits are performed and their recommendations followed;
- **Auditor** (or auditing team) is responsible for performing the waste audit. The auditor needs to be a qualified expert with appropriate knowledge about building materials (including hazardous materials), building techniques and building history. A qualified expert needs to be familiar with demolition techniques, waste treatment and processing as well as with (local) markets;
- **Waste manager** is responsible that the waste received from the waste holder or producer will be managed and/or disposed adequately. The waste manager should also contribute to the traceability aspects of waste;
- **Products manager/manufacturer** may contribute to the waste audit by providing solutions and/or requirements for the reused/recycled materials and components.
- **Designer/consultant planning the demolition or renovation works** is typically contracted by the property owner to prepare the necessary documentation for the building authority to obtain the relevant permit.
- **Designer/consultant planning new buildings or infrastructures** is (together with the new property owner) deciding about the use of recycled/reused products or materials. He can be involved in the demolition/renovation planning to specify and supervise the extraction of their

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6 Taken from a report produced by VTT for DG GROW in 2016: Technical and Economic Study with regard to the Development of Specific Tools and/or Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures
products and materials. Additionally, this particular actor could play a prominent role in embracing any BAMB principles in design for disassembly.

Due to the number of actors involved, it is highly recommended that a clear workflow be defined and the roles and responsibilities be allocated accordingly, especially when sub-contractors will later be involved. The flow diagram below shows how the main actors in demolition, renovation and construction projects interact via different aspects of the building project.

![Flow diagram of roles and responsibilities in building projects](image)

*Figure 3. Overview of roles and responsibilities relating to CDW in building projects, with Level 1 parts in orange/light orange (adapted from 2018 EU Guidelines for waste audits before demolition and renovation works of buildings)*

An auditor would normally only be involved if a pre-demolition audit will be necessary. In such cases, the independence of the auditor from the future contractor is clear to see.

The actors highlighted in orange are those that are of relevance to discussions during the concept design stage that will influence possible quantities of CDW generated and their outcomes. The expertise of the auditor and the designer/consultant are crucial for ensuring that suitably ambitious targets can be set for reducing CDW and its disposal to landfill.

The building authority is only highlighted in light orange because they will only set broad boundaries on the building project at the concept design stage. Later on, the building authority will become more involved once a more detailed design is available and Level 2 estimates of CDW are made as part of the permitting process.

### L1.4 concept 1 – The EU waste hierarchy and List of Wastes (LoW)

Before considering any targets or KPIs to set for the building project, it is essential to understand how the EU waste hierarchy (Article 4 of the WFD\(^7\)) can be applied to construction, renovation and demolition activities and the associated elements, materials and wastes that can arise from these activities:

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The design team should also be aware of many specific references to CDW that are made throughout the WFD and their significance when deciding how to report on CDW, namely:

- Article 9(1d) of the WFD about measures that Member States shall take to encourage the re-use of products and to set up systems for promoting repair and re-use activities for CDW. Significance for Level(s) and Article 9(1f) of the WFD about measures that Member States shall take to reduce CDW generation. **Significance for Level(s): Member State level promotion of end-markets that allow for the reuse of elements, materials and CDW.**

- The promotion of selective demolition, the safe removal of hazardous substances to facilitate reuse and high-quality recycling and sorting of CDW into defined fractions (at least wood, mineral fractions, metal, glass, plastic and plaster), is specifically mentioned in Article 11(1) of the WFD about measures Member States shall take to prepare for reuse and recycling. **Significance for Level(s): use the in-built Level(s) inventory template functionality to report on these specific fractions.**

- Article 11(2) sets a target of 70% of reuse/recycling/material recovery of non-hazardous CDW was set for 2020. **Significance for Level(s): A logical minimum target for Level(s) reporting at the individual project level would therefore be at least the same as the overall EU 2020 target. Targets can be more ambitious in terms of a higher % and/or in terms of linking %’s to the higher outcomes of recycling and reuse.**

- Article 11(6) states that the Commission shall consider setting minimum recycling targets and minimum reuse targets for CDW as well as targets for individual CDW material fractions before 2025. **Significance for Level(s): use the in-built Level(s) reporting template functionality to report on different waste fractions and also on outcome (% reuse, % recycling, % material recovery etc.).**

- Article 37(2) requires that Member States shall report separately on material recovery of CDW compared to the quantities of waste prepared for reuse or recycled. **Significance for Level(s): That Member State competent authorities should accept real data in a consistent format from different projects that plan to use the Level 3 reporting template.**

- Annex II states that energy recovery generally means the principal use of the waste stream as a fuel or some other means in order to generate energy and where facilities comply with defined minimum energy efficiencies. **Significance for Level(s): That any CDW waste stream that has no net calorific value should not be considered as contributing to energy recovery in Level(s) reporting.**

Any CDW targets need to also respect the different types of CDW that can occur, as defined in chapter 17 of the LoW. The relevant sub-chapters are as follows:

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8 Excluding non-hazardous excavation waste, which have list of waste entries beginning with 17 05.
9 List of Wastes, as defined in Commission Decision 2014/955/EU
- 17: CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
  - 17 01: concrete, bricks, tiles and ceramics.
  - 17 02: wood, glass and plastics.
  - 17 03: bituminous mixtures, coal tar and tarred products.
  - 17 04: metals (including their alloys).
  - 17 05: soil (including excavated soil from contaminated sites), stones and dredging spoil.
  - 17 06: insulation materials and asbestos-containing construction materials.
  - 17 08: gypsum-based construction material.
  - 17 09: other construction and demolition wastes.

The full list of entry codes (6 digit level), are included as a separate excel worksheet in the Level(s) template for CDW estimation/reporting. It is worth noting that all entries beginning with 17 05 correspond to excavation waste (EW) and not CDW. However, the Level(s) inventory template makes provision for estimating and collecting data on EW, and reports it separately.

Other relevant codes for Waste Electrical and Electronic Equipment (WEEE) arising at demolition sites are also included in the list in the Level(s) inventory template in case these waste streams are significant in demolition or renovation projects.

Next to each entry in the excel is an annotated assumption of whether the waste should be considered as hazardous or non-hazardous\textsuperscript{10} and a further consideration of which waste fractions can be considered as inert\textsuperscript{11}.

Such basic knowledge about the waste hierarchy and the type of waste streams involved underpins all of the other Level 1 aspects and should support any project targets or KPIs that might be chosen for the project.

L1.4 concept 2 – Project type and influence on CDW constraints

The optimum reuse, recycling and recovery of CDW requires the allocation of sufficient time, space, labour and expertise. However, time and space constraints in particular can be locked into a project simply depending on the nature of the project itself or external factors. The significance of different waste streams (CW, DW and EW) for several different project types is shown in the table below.

\textit{Table 5. Influence of project type and location on CDW}

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Construction waste (CW)</th>
<th>Demolition waste (DW)</th>
<th>Excavation waste (EW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New construction in rural area</td>
<td>Normal levels (e.g. 48-135 kg/m\textsuperscript{2})</td>
<td>Low or zero. Nothing to demolish.</td>
<td>Can be high due to need to clear and level site, connect utilities and put foundations in place.</td>
</tr>
<tr>
<td>New construction in sub-urban area</td>
<td></td>
<td></td>
<td>Same as above, plus a higher risk of contaminated soil.</td>
</tr>
<tr>
<td>New construction in urban area</td>
<td>Very high (e.g. 664-1637 kg/m\textsuperscript{2}). Pre-demolition audit highly recommended in all cases.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demolition and new construction in any area</td>
<td></td>
<td></td>
<td>Can vary significantly depending on the differences between the old and the new building and factors such as basements and underground parking.</td>
</tr>
<tr>
<td>Renovation in any area</td>
<td>Low to normal levels (e.g. 20-326 kg/m\textsuperscript{2}) but, depending on nature of renovation, this can be high.</td>
<td>Low or zero. Nothing to excavate normally.</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{10} As per Commission Notice on technical guidance on the classification of waste (2018/C 124/01)
\textsuperscript{11} As per the EU Construction & Demolition Management Protocol (September 2016)
Space constraints: Projects involving demolition activities not only produce the largest quantities of CDW, but also tend to have the greatest constraints on space for storage. Consequently, an accurate estimate of DW via a pre-demolition audit is essential, enabling the elaboration of a robust WMP that will make provision for the possible stockpiling of building elements, materials and wastes offsite.

If excavation is significant, EW (even if planned to be reincorporated back onsite later) can dominate possible onsite storage capacity and so offsite storage may need to be considered.

In major renovation projects, even though the quantities of CDW are lower than for demolition, the space constraints may still be significant if the building has to remain in use.

Time/labour constraints: In cases where demolition activities are carried out, there are many opportunities to maximise the reuse of building elements and the recycling or the recovery of materials. However, to do this properly, time is required to contract the necessary expertise, conduct a detailed pre-demolition audit and to carry out the relevant pre-demolition activities (namely decontamination, stripping, selective deconstruction and selection demolition).

L1.4 concept 3 – Pre-demolition audit

When demolition or renovation activity is required in a building project, the relevant EU guidance document should be consulted. The text here is a condensed selection of the most relevant points to be aware of at the concept design stage so that the project team is prepared for any reporting under Level 2 or 3.

A pre-demolition audit:
- can be carried out for any demolition or renovation project, but is only mandatory for projects above a minimum threshold (this threshold will vary across the EU);
- must (if legally required) be completed prior to applying for the demolition or renovation permit;
- should provide all relevant documents required for the permit application;
- must, after a desk study and field survey, locate and identify construction elements and materials in the old building/infrastructure, especially hazardous materials, and compile this into an inventory (a common Level(s) template is provided for the inventory);
- recommend how these materials can be removed in a safe and environmentally sound manner with minimal compromise of technical quality for future reuse, recycling or recovery;
- recommend the final end-market for each separated element, material or waste (i.e. reuse, recycling, recovery or disposal) based on local and regional knowledge.

If the pre-demolition audit is completed by an independent expert auditor (or auditing team) even before the publication of the call for tender for the demolition or renovation works, the audit will provide a common basis for cost-estimates in offers from different tenderers.

L1.4 concept 4 – Good construction practice

The same principles about what to do with demolition wastes arising onsite (i.e. identify type and consider treatment/disposal options) can be applied to CW. The type of CW can be precisely known in advance by the contractor because it will arise from the same construction elements, materials and products that they need to procure.

Certain decisions can be made at the early planning stages which can reduce or prevent the generation of CW in the first place. For example:
- greater use of modular design principles with prefabricated elements;

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incorporation of a waste expert into the project team to set-up an induction and training programme for the project (linked to the WMP);

- provision of onsite training to contractors and sub-contractors;
- planning for ongoing monitoring and progress meetings about site waste during the execution phase of the project;
- reducing the risk of damage to delivered materials by reducing the time they sit idle onsite (i.e. using just-in-time delivery programming that is aligned with construction project stages) or exposed to weather (i.e. using covered storage onsite);
- consider possible ways to incentivise the contractor to minimise over-ordered material (e.g. via specific KPIs and contractual clauses).

L1.4 concept 5 – Waste Management Plans (WMPs)

Prior to the awarding of a permit for a construction, renovation or demolition project, an outline WMP will be required. In demolition and major renovation projects, the outline WMP will be closely linked to the pre-demolition audit. Put simply, a pre-demolition audit can be considered as “the what”, and the WMP as “the how”. A good WMP contains information about:

- how the different steps of the demolition will be performed;
- by whom they will be performed;
- which materials will be collected selectively at source;
- where and how they will be transported;
- approximate per tonne disposal costs (e.g. landfill gate fees and taxes), treatment costs (e.g. €/tonne to crush and grade concrete) and avoided material costs (e.g. €/tonne virgin aggregate for backfill);
- what will be the final outcome for each waste stream and how to follow up.

Final outcomes for waste streams will depend on regionally available facilities and processing equipment, which in turn will be influenced by national and regional WMPs that Member State competent authorities have established. Such national/regional WMPs are required by Article 28 of the Waste Framework Directive (2008/98/EC). Consulting the relevant national/regional WMP and related competent authority is therefore a logical starting point to understand what options are likely to be available for waste streams.

The project WMP should identify and address how to deal with safety, security and environmental issues. As a minimum, a distinction about how to deal with hazardous and non-hazardous wastes on site must be included. Ideally, the WMP makes provision for the separate collection of different types of CDW and EW as a function of planned treatment options. The main different treatment options are:

- cleaning for reuse (e.g. contaminated soil);
- reuse (e.g. structural steel, metal sheet, bricks and roof tiles);
- recycling in the same application (e.g. metals, paper, glass, asphalt);
- recycling/material recovery in another application (e.g. bricks to aggregates, wood to particleboard);
- energy recovery (e.g. wood, plastics, certain insulation materials);
- disposal (e.g. landfill or thermal destruction without energy recovery).

Measures taken to limit environmental impacts during the waste generating activities, waste storage and waste transport (e.g. including leaching and dust) shall be described. In the plan it should be stated how both the non-hazardous and hazardous waste will be managed.
L1.4 concept 6 – Buildings As Material Banks (BAMB) principles

Buildings have traditionally been valued based on their floor area, the location and land area they sit on, architectural features and the use that can be made of the building. However, there is also a residual value that is locked into a building via the components and materials it is made of. This locked-in value (often viewed solely as a future demolition and disposal cost) is maximised when these components and materials can be adequately retrieved at the End of Life of the building for reuse.

This BAMB concept is relevant to all buildings but can be especially incorporated into the design of new buildings or in the definition of major renovation activities. By choosing elements and components that can be disassembled, and by providing clear instructions about their correct disassembly via building material passports, the possibility to reuse that material or element is maximised. The level of information for each product could include the product features, reuse/recycling potential and visual details of the building element or material. This principle can underpin the “circularity” of the whole building as well.

![Figure 5. Example of a building material passport (left) and how this information can be structured for a whole building. Source: BAMP project (2019)](https://www.bamb2020.eu/library/overview-reports-and-publications)

Input from architects and/or consultants with expert knowledge of the BAMB principles and of the availability of materials and elements with BAMB-type passports is crucial at the concept design stage if these principles are to be embraced. The BAMB approach is complimentary with Building Information Modelling (BIM) and can slot into the building model and related documentation.

While the Level(s) inventory template for indicator 2.2 for use at Levels 2 and 3 is set up to estimate and record DW from demolition projects for old buildings. However, the exact same format can be applied to the hypothetical future demolition of the new building in the future (i.e. “module D” of the building life cycle).

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Guidance and information for Level 2

The guidance supports the following Level 2 instruction steps:

- L2.2 – General guidance for instructions for demolition activities
- L2.2 step 1 – Further details about the desk study
- L2.2 step 2 – Further details about the field study
- L2.2 step 4a – Further details about filling out the Level(s) DW inventory template
- L2.2 step 4b – Additional features in the Level(s) DW inventory template
- L2.3 – Who is involved and when
- L2.4 step 1 – Scope for BoM for construction activities
- L2.4 step 3 – Entering data in the Level(s) CW estimate inventory
- L2.4 step 4 – Deciding upon the nature of waste for entries in the Level(s) CW estimate inventory
- L2.5 step 5 – Considering possibilities for reuse, recycling and recovery of different waste fractions
- L2.4 step 6 – Further considerations about and outline WMP

L2.2 – General guidance for instructions for demolition activities

**Important general points to bear in mind:** The potential for reuse or recycling can be greatly increased if time is taken beforehand to consult with experts and representatives of relevant end markets when assessing the materials and building elements present in the building to be demolished or renovated. Prior to demolition commencing, the following actions should be fully considered:

- **Identification of elements for reuse onsite:** a visual examination for elements that can reused onsite. This would require active involvement of the owner of the new building and possibly the planning authorities if the old building has interesting heritage features in its architecture (e.g. facades). Any elements for re-use offsite would come under the stripping action described below.

- **Decontamination:** the selective removal of hazardous materials in order to prevent the contamination of other waste streams that would otherwise be inert or non-hazardous. The source separation of certain hazardous materials may be mandatory and require special handling procedures, depending on national legislation.

- **Stripping:** the selective removal, using basic techniques, of higher value materials (e.g. cabling) or elements (e.g. marble fireplace) in pure streams for their re-use offsite, limiting the quantity of waste generated and preventing their added value from being lost altogether in mixed waste streams.

- **Disassembly (or deconstruction):** the non-destructive taking-apart of a building or structure into constituent materials (e.g. plasterboard) or elements (e.g. windows and frames). This action could be to physically recover elements identified for onsite or offsite reuse. Special equipment or techniques may be required to deconstruct (e.g. pre-tensioned structures).

- **Selective demolition:** the sequencing of demolition in order to maximize the recycling and recovery potential of the DW in subsequent sorting operations (e.g. removing the roof first for the optimum recovery of slate roof tiles for crushing into slate aggregate).

It is important to note that this will also depend on the local market and the relevant technical and quality requirements for DW, which can be a major market barrier if waste segregation is insufficient.

L2.2 step 1 – Further details about the desk study:

Ideally original design documents such as architectural plans and technical drawings are available. If not, then general information about the age of the building, the type of materials used and construction techniques applied may be helpful.
Documentation regarding the history of use or access to previous users of the building may offer clues to the potential presence of hazardous substances (e.g. construction when PCB sealants where widely used) and hazardous materials (e.g. renovation when asbestos was widely used) or contaminated soil (e.g. previous industrial activity on the site or in the surrounding area).

**L2.2 step 2 – Further details about the field survey**

The survey should be tailored to the building in question but should normally include the following main steps:

- Site visit and general analysis of the building (checking what was learned during the desk study)
- General audit and inventory. The general audit and inventory is to have an idea (for every part of the building) about which materials occur and to collect the necessary information to identify, quantify and localize them in the building.
- Detailed audit and inventory. The different rooms are inventoried in detail (floor coverings, lighting units, interior walls, false ceilings, etc.)
- Sample taking and analysis (not all materials can be visually identified, and so suspect materials need to be sampled and analysed).

**L2.2 step 4a - Further details about filling out the Level(s) DW inventory template:**

Some screenshots from the L2 DW inventory-estimate worksheet in the Level(s) inventory template excel are shown below to walk users through how to fill it out. Up to 12 pieces of information can be inserted for each entry to the pre-demolition inventory. The screenshot below looks at the first 8 columns.

![Screenshot of the first 8 columns (of 12) for input data for the pre-demolition inventory.](image)

In each column heading there is an embedded comment which provides details about the type of information that can be inserted and how it is related to other columns. One row of example data has been entered in the Figure above. The entry refers to lamps that are to be removed separately during the decontamination stage because they may contain mercury and thus would contaminate other DW. Consulting the List of Waste (LoW) codes provided in another tab of the worksheet (titled "L1 LoW info"), it is clear that these lamps are an example of WEEE and should
have the code “20 01 21*” (select it from dropdown in column D). This code means it is a hazardous waste (select from dropdown in column C). The field survey identified these lamps throughout the building (column E) and a total of 65 were counted (column F). Some lamps were removed and an average weight per lamp of 750g was determined (column G). Multiplying F and G together gives the result in column H.

The last 4 columns for each pre-demolition audit are shown below. Each column heading has an embedded comment.

![Figure 7. Screenshot of the last 4 columns (of 12) for input data for the pre-demolition inventory.](image)

The same drop-down menu appears for columns I and J. The full list of options for columns I and J are as follows:

![Figure 8. Screenshot of the pre-defined dropdown list for entries under column I and J.](image)

For clarity, in cases of any excavation of contaminated soil during demolition projects (strictly speaking EW rather than DW) if it is remediated, it can be considered as recycled onsite (if remediation is in-situ) or recycled offsite (if remediation is ex-situ).

In column I, the best possible outcome (i.e. the highest in the waste hierarchy) for the element, DW, EW or WEEE is selected. In column J, the probable outcome is chosen based on knowledge about local/regional end-markets and project constraints. When all entries are totalled, any differences in the “best” and “probable” outcomes for DW can be compared side by side in an automatically generated graph on the spreadsheet (an extra output, not forming part of the core Level(s) reporting format).
Figure 9. Automatically generated comparison of “best possible” and “probable” outcomes for Level 2 estimates of DW (note: not part of the core reporting format for Level(s)).

The last two columns (K and L) refer to specific comments, notes, warnings and additional information that is not practical to literally type or copy-paste in, but which could be inserted as an embedded comment to relevant cells or simply as a link to more detailed information elsewhere online. For example, column K could refer to “see section 4.1 of health and safety plan”.

L2.2 step 4b - Additional features in the Level(s) DW inventory template

Several other additional features of the Level(s) inventory template for demolition projects are also worth mentioning.

Further breakdown of outcomes for specific CDW sub-chapters (e.g. concrete, wood, plastic, glass, etc.):

Figure 10. Automatically generated totals of different waste fractions (see columns S-AB) for Level 2 estimates of DW (note: not part of the core reporting format for Level(s)).
Each entry to the DW inventory has to have a LoW code assigned to it. If dealing with complex elements made of multiple materials, one of the 17 09 codes should be used if it is definitely not WEEE. Each LoW code informs about the characteristics of the material/waste fraction (e.g. inert, demand for recycling, potential for energy recovery), so it makes sense to collect them separately and to see how their outcomes add up compared to other waste streams with different properties. Such a breakdown also allows users to set material specific targets for their projects.

**Estimating the baseline cost of 100% landfill disposal:**

Landfill costs can be significant, especially in countries where landfill taxes have been imposed and where landfill capacity is limited, especially for hazardous waste landfill. In cases where recycling or preparing for reuse may imply net costs, it is most appropriate that avoided landfill costs are also factored into the real cost calculation.

**Separate reporting on WEEE and EW:**

Reporting on WEEE can lead to widely variable results depending on the nature and the history of use of the building to be demolished or renovated. There are only two outcomes possible, its reuse/refurbishment or its arrival at a WEEE facility. The potential to report on WEEE is included here but should be considered as purely optional because the List of Waste (LoW) codes are in different chapters to those for DW. If WEEE is to be reported, it is important that it is done correctly. This would mean not counting cables throughout the building infrastructure as WEEE (these would fall under the CDW codes 17 04 10* or 17 04 11). It would also mean not counting any other parts of the permanent electrical installations in the building as WEEE (as per Article 2).

Separate reporting on EW is of interest because this number can, depending on the nature of the project, be much higher than CDW. Even though EW has specific entry codes under chapter 17 of the LoW (i.e. 17 05 XX) it is generally
very easy to re-use or recycle. Consequently, it should not be mixed up with reporting on other DW streams that are more difficult to re-use or recycle, as it could skew overall results.

**L2.3 Who is involved and when**

The flow diagram below shows how the main actors in demolition, renovation and construction projects interact via different aspects of the building project, with the main project aspects and actors for Level 2 in orange or light orange.

![Flow diagram](image)

*Figure 13. Overview of roles and responsibilities relating to CDW in building projects, with Level 2 parts in orange/light orange (adapted from the 2018 EU Guidelines for waste audits before demolition and renovation works of buildings)*

Unlike Level 1, all of the main actors are involved to some extent in Level 2. A specialist and independent demolition auditor (or auditing team) should be contracted to carry out the pre-demolition audit. This contract should be a separate process to the actual demolition works. The auditor must report to the building owner and (optionally) the architect/consultant. The auditor is responsible for ensuring that the pre-demolition audit meets any relevant requirements set by the building authority for granting the demolition permit. The pre-demolition audit also forms the basis for the contractual obligations of the contractor.

The pre-demolition audit forms the basis for an outline WMP, which is where the waste manager will have input about available storage, processing and end markets in the region. Product manufacturers may also influence the outline WMP with regards to quality or technical requirements for different recycling and material recovery processes. Each element or material identified in the pre-demolition audit should be passed through the following logic.
Figure 14. Decision-making process in the pre-demolition inventory formation and management recommendations (adapted from EC, 2018)

Once a permit has been granted, the selected contractor will start with the pre-demolition audit and outline WMP and make their own assessment as well. Any significant differences identified at this point (e.g. additional hazardous materials) must be communicated to the building owner and consultant as soon as possible.

A very similar situation applies for construction projects with the main differences being that an auditor will not tend to be considered necessary. Instead, a quantity surveyor would draw estimate a Bill of Materials (BoM) and a certain % of waste be estimated from the BoM. General rules of thumb would be applied here based on previous experience with similar materials/products and building projects. An average figure of 13% of raw materials ordered are discarded as unused.

L2.4 step 1 – Scope for BoM for construction activities

The BoM will begin as an approximate estimate and become more detailed as the building design evolves and matures. At Level 2, it is possible that a BoM of several of the aspects above may not be accurately known. Users should therefore define the scope of the BoM, stating which of the above aspects are covered in entries to the CW estimate inventory.

It is also possible that users are reporting on BoQ in indicator 2.1. In such cases, the same scope for BoM should be used for any Level 2 estimates of CDW under indicator 2.2. The suggested scope for the BoQ in indicator 2.1 is as follows:

Table 6. Hierarchical framework for reporting Bill of Quantities and Materials in indicator 2.1.

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
</tr>
</thead>
</table>


15 Best practice guide to improving waste management on construction sites. Resource efficient Scotland.
## Shell

<table>
<thead>
<tr>
<th>Foundations (substructure)</th>
<th>(i) Piles; (ii) Basements; (iii) Retaining walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loadbearing structural frame</td>
<td>(i) Frame (beams, columns and slabs); (ii) Upper floors; (iii) External walls; (iv) Balconies</td>
</tr>
<tr>
<td>Non-load bearing elements</td>
<td>(i) Ground floor slab; (ii) Internal walls; (iii) partitions and doors; (iv) Stairs and ramps</td>
</tr>
<tr>
<td>Facades</td>
<td>(i) External wall systems; (ii) cladding and shading devices; (iii) Façade openings (including windows and external doors); (iv) External paints, coatings and renders</td>
</tr>
<tr>
<td>Roof</td>
<td>(i) Structure; (ii) Weatherproofing</td>
</tr>
<tr>
<td>Parking facilities</td>
<td>(i) Above ground and underground (within the curtilage of the building and servicing the building occupiers)</td>
</tr>
</tbody>
</table>

## Core

<table>
<thead>
<tr>
<th>Fittings and furnishings</th>
<th>(i) Sanitary fittings; (ii) Cupboards, wardrobes and worktops (where provided in residential property); (iii) Ceilings; (iv) Wall and ceiling finishes; (v) Floor coverings and finishes</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-built lighting system</td>
<td>(i) Light fittings; (ii) Control systems and sensors</td>
</tr>
<tr>
<td>Energy system</td>
<td>(i) Heating plant and distribution; (ii) Cooling plant and distribution; (iii) Electricity generation and distribution</td>
</tr>
<tr>
<td>Ventilation system</td>
<td>(i) Air handling units; (ii) Ductwork and distribution</td>
</tr>
<tr>
<td>Sanitary systems</td>
<td>(i) Cold water distribution; (ii) Hot water distribution; (iii) Water treatment systems; (iv) Drainage system</td>
</tr>
<tr>
<td>Other systems</td>
<td>(i) Lifts and escalators; (ii) Firefighting installations; (iii) Communication and security installations; (iv) Telecoms and data installations</td>
</tr>
</tbody>
</table>

## External works

<table>
<thead>
<tr>
<th>Utilities</th>
<th>(i) Connections and diversions; (ii) Substations and equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscaping</td>
<td>(i) Paving and other hard surfacing; (ii) Fencing, railings and walls; (iii) Drainage system</td>
</tr>
</tbody>
</table>

Matching the scope for estimates of BoM ensures:
- better comparability with other projects, and
- a comparison of Level 2 estimates with Level 3 real data for the same project.

The largest mass of materials will normally be associated with the “shell” elements and so users should always try to report in more detail here. Shell elements also need to be carefully considered and agreed at the design stage and are less likely to change, unlike fittings and furnishings for example, which could change from one day to the next if the client decides to.

### L2.4 step 3 – Entering data in the Level(s) CW estimate inventory

There are a total of 19 columns where data can be entered for each entry to the CW estimate inventory. The first 10 relate to direct estimates of the quantity of CW and, if desired, over-ordered materials (OO). Only 6 of these columns require a definite input.

The next 3 columns relate to the cost of the materials and only require input into 1 column. The cost data is purely optional.

The next 2 columns are extremely important and relate to relevant List of Waste code and whether that waste should be considered as inert, non-hazardous or hazardous.

The last 4 columns relate to the expected fate of the waste, specifically to the best outcome and the probable outcome for CW and for OO. If no estimates are made for quantities of OO materials, it will not be necessary to select options for the last 2 columns.
Screenshots of the different columns are provided below, together with the embedded comments at the top of each column.

Figure 15. Screenshot of the first 10 columns (of 19) for input data for the CW+OO estimate inventory.

The example entry shown (poured concrete for the foundations) is a relatively complex material for which to estimate wastage rates or over-ordering rates. It is delivered in batches via ready mix lorries and there are different sources of waste possible here (excess concrete returning in the ready mix lorry to the supplier) and accidental spills, skimmings and reject batches remaining onsite. Normally ready mix concrete trucks always carry extra material for a safety margin to ensure that the pour does not fall short of the target (e.g. 10% excess in the truck). So there is a deliberate element of material over-ordering combined with possible onsite waste.

If both CW and OO have the same fate, there is no need to distinguish between them and a combined % rate can be inserted in Column G (e.g. 20% for the screenshot example). However, if they have different fates, the user is recommended to make 2 entries for the same material (e.g. 7% CW and 13% OO for the screenshot example). This is why titles in Columns G and I refer to Construction Waste (CW) and the titles in Columns H and J refer to Over-Ordered material (OO) so that users can distinguish between the two if they wish.

The other main material involved in concrete is the reinforcement bar (rebar), so any wastage there should also be reported as a separate entry in the inventory, even if it is for the same “foundations” as the poured concrete.

It is especially important here to highlight that BoQ, in Column F, is to be considered as the quantity of materials needed in the building plus any foreseen wastage or deliberate over-ordering.

In column G, a percentage wastage rate is entered that is multiplied by the actual BoQ. As per the poured concrete example above, the need for 600 000 kg of concrete with a wastage rate of 7% would result in an estimated 42 000 kg of waste concrete.

One example where it is definitely worth distinguishing between CW and OO would be with ceramic tiles. For example, if 200m² of ceramic floor tiles were needed, an estimated wastage rate of 15% was assumed (i.e. 30m²) and the most economical order volume is in batches of 50m², a total of 250m² would be inserted in the BoQ. This would lead to an estimate of 30m² waste (12%) and 20m² (8%) over-ordered materials. If the OO ceramic tiles are reused in the building as and when needed and the CW ceramic tiles are crushed for inert aggregate, then separate %’s need to be defined in the same row.
The entry to Column K is purely optional and the automatic output in Columns L and M is dependent on it. The Column L costs estimate the “cost” of each kg of CW as its direct impact on the need to buy more of the original material in the BoQ. The same logic applies to any estimates of over-ordered materials. Although poured concrete cannot be stored for future reuse, other construction materials/elements can, for example roof, wall and floor tiles. Especially when these tiles are niche products or personalised for the particular building project, it may be considered reasonable to deliberately over-order to account for future repair and replacement needs.

In Columns N and O, the nature of the waste and the most relevant List of Waste (LoW) code are chosen from drop-down menus. Any entries for WEEE should start with “16” or “20” and any entries for excavation waste must start with 17 05. For construction elements/products that are composed of multiple different types of potential waste material (e.g. doors and windows), the mixed waste entries (i.e. starting 17 09) should be used if the elements/products will not be separated into constituent materials onsite. All entries must be classified as “inert”, “non-hazardous” or “hazardous” in Column N. This is definitely important if trying to set a baseline cost for a scenario where all CW was to be sent to landfill. If in doubt about which classification is most appropriate, consult the guidance in the LoW worksheet in the same Level(s) excel file.

The final columns (Columns P, Q, R and S) represent the best and probable outcomes for each CW entry to the inventory (Columns P and Q) and for each OO entry (Columns R and S). The main reasons for differences between the best and probable outcomes would be due to:

- Time, space or labour constraints in the project (e.g. separate waste streams for plaster and wall tiles could not be established, so now the mixture of inert ceramic tile and non-hazardous gypsum cannot be recycled as inert aggregates for concrete).
- Limited availability of recycling facilities/equipment in the region (e.g. nearest glass producer that would accept broken glazed windows for recycling into new glass was 500km away, much cheaper to simply crush onsite and use in backfill).

The dropdown options for Columns P, Q, R and S are:
The options are very similar to those for Level 2 estimates of DW, except that there is less scope for re-use since there are no old materials and elements that could be reused and anything unbroken and unused that could effectively be reused is counted separately as “over-ordered materials”.

**L2.4 step 4 – Deciding upon the nature of waste for entries in the Level(s) CW estimate inventory:**

Users are referred to the “L1 LoW” worksheet in the Level(s) CDW template for indicator 2.2 if they are uncertain about whether to consider the entry as inert, non-hazardous or hazardous.

In the “L1 LoW” worksheet, there are three pages, the 1st page (columns A-C) is basically an introduction to how wastes should be classified.

The 2nd page (Columns D-M) contains the full list of waste codes for all the wastes covered in chapter 17 of the European List of Wastes. Next to each code, specifically in Column M, an assumed nature of the waste is provided.

On the 3rd page, the list of relevant codes for WEEE is provided.

These assumptions are fine to use as a basis for making Level 2 estimates. However, when it comes to actually handling the waste during the project (i.e. Level 3 reporting), it may be necessary to carry out a leaching test prior to the waste being accepted at either the landfill or by a recycler/product manufacturer.

**L2.4 step 5 – Considering possibilities for reuse, recycling and recovery of different waste fractions**

Each of the main CDW fractions are listed below, with the different alternatives to disposal, with an approximate estimate of the potential for these routes to accept all of these wastes (at the EU level) and the related environmental benefits. The alternatives are in order of decreasing environmental benefit moving from left to right in the table.
### Table 7. Possible end-markets for the reuse or recycling of materials recovered

<table>
<thead>
<tr>
<th>Material</th>
<th>Alternative 1 (preparing for re-use)</th>
<th>Alternative 2 (recycling)</th>
<th>Alternative 3 (recovery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete (more details here)</td>
<td>Reuse of precast concrete blocks. Large environmental benefit especially due to avoided need for cement.</td>
<td>Crushing for use in concrete production, ideally onsite (recycling). Could accept 40-50% of waste concrete (uncertain for bricks etc.). Main benefit is avoided demand on virgin material quarries.</td>
<td>Crushing for use in road construction or backfill (recovery). Could accept up to 75% of waste concrete (uncertain about bricks etc.). Main benefit is avoided demand on virgin material quarries.</td>
</tr>
<tr>
<td>Bricks, tiles and ceramic (more details here)</td>
<td>Reuse of bricks, tiles and ceramic. Large environmental benefit due to avoided need for firing.</td>
<td>Recycling in a stationary plant. Could accept 30-80% of waste asphalt. Main benefits are reduced need for bitumen binder and virgin material quarries.</td>
<td>Material recovering as aggregates. Could accept up to 41% of waste asphalt. Main benefit is the reduced need for virgin material quarries.</td>
</tr>
<tr>
<td>Bituminous materials (more details here)</td>
<td>In-situ recycling. Could accept up to 100% of waste asphalt. Main benefits are reduced need for bitumen binder, virgin material quarries and transport.</td>
<td>Recycling into derived timber products. Could accept around 33% of waste wood. Benefits of prolonging the presence of wood in the value chain and reducing demand for virgin wood and avoided CH4 emissions in landfill.</td>
<td>Energy recovery. Could accept up to 100% of waste wood. Benefits of “renewable” electricity and heat destruction of any harmful organic compounds present, and avoided CH4 emissions in landfill.</td>
</tr>
<tr>
<td>Wood (more details here)</td>
<td>(Only applicable to solid wood). Pieces of solid wood (e.g. floorboards, vigas etc.) to be manually removed, sanded, cut to size if necessary and varnished accordingly.</td>
<td>Use in manufacture of plasterboards. Could accept up to 30% of gypsum waste. Benefits are avoided need to quarry virgin gypsum and avoided H2S emissions from landfill.</td>
<td>Use as an additive in cement. Uncertain how much waste gypsum could be used this way. Avoids the need to quarry virgin gypsum and H2S emissions from landfill.</td>
</tr>
<tr>
<td>Gypsum (competes with flue gas gypsum from power plants) (more details here)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### L2.4 step 6 – Further considerations about an outline WMP

The site waste management plan should define how:
- different elements, materials and wastes are to be collected and stored onsite,
- where they should be taken to and
- specify the destination of the element/material/wastes that are diverted from landfill.

The outline WMP should consider all the possible flows of CW and OO material and consider how best to monitor, record and track these flows. Some examples of flows are illustrated below.
The different material/waste activities are highlighted in grey (for CDW generated), burgundy (for EW generated), green (for reuse or recycling), orange (for recovery), red (for disposal) and black (for WEEE). The blue arrows are intermediate flows and when the arrows are dashed, this indicates that the actual traceability of material/waste from the project may be lost if combined with material from other companies and projects.

From the diagram above, the importance of material/waste tracing and tracking is clear to see. The time-frame of a building project also has to be considered. It is possible that elements and materials are sent to salvage yards but are not necessarily reused before the building project is completed. The same can apply to waste materials that are processed for subsequent recycling or recovery operations. Consequently, there need to be some assumptions made when elements, materials and wastes are sent offsite to 3rd parties simply based on the normal practice of those 3rd parties.
Guidance and information for Level 3

The guidance supports the following Level 2 instruction steps:

L3.2 step 1 – Preparing a DW inventory (see earlier guidance for L2.2, steps 1 and 2).
L3.2 step 2 – Entering data in the Level(s) CDW inventory.
L3.2 step 3 – Define/refine a WMP with clearly defined roles and responsibilities (see earlier guidance in L1.2 step 5 and L1.3) and consider possible end-markets for CDW (see earlier guidance in L2.4 step 5).
L3.2 step 4 – Defining a tracking and tracing system for CDW.
L3.3 – Who is involved and when.
L3.6 – Going further (see earlier guidance for L2.2, step 4b).

L3.2 step 2 – Entering data in the Level(s) CDW inventory

There are a total of 10 columns where data can be entered for each entry to the CDW estimate inventory.

Screenshots of the different columns are provided below, together with the embedded comments at the top of each column.

![Figure 19. Screenshot of all 10 columns for input data for the CDW monitoring](image)

The first 4 columns relate to the source and nature of the waste.

The next 3 columns relate to the quantification of the CDW but if the shipments are weighed directly, input into 1 column of is required (Column G).

The last 3 columns relate to the fate of the CDW. Unlike Level 2 reporting, there is no need to consider the best and probable outcomes. Instead, the actual outcome only is chosen. Two of the last 3 columns are optional and the type of information to enter should depend entirely on what type of documentation and record-keeping system is to be used for the project.

When looking at actual CDW data, it is not necessary to estimate over ordered (OO) material, this will be evident at the end of the project so long as materials are stored in a well-managed way. Any over-ordered material can be inserted as a separate entry (a separate row) if the fate of the OO is different to that of the same CW.
Another difference with Level 2 reporting is that both DW and CW can be reported together in the same excel sheet. This is necessary to allow for renovation projects to be covered, where both demolition and construction activities occur.

**L3.2 step 4 – Defining a tracking and tracing system for CDW**

*Table 8. Examples of relevant traceability systems in the sector*

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral waste traceability in the French construction industry.</td>
<td>France, any waste producer or waste holder is responsible for waste management until its disposal or final recovery, even when waste is transported to a specialised facility in order to be treated. The French regulation requires that waste producers provide a document specifying the transportation of waste from their production site and the nature of the waste. This document must be provided before it can enter waste treatment facilities that accept non-hazardous inert waste. Producers of recycled aggregates choose to implement a waste traceability system at their treatment facilities. This traceability ensures the quality of treatment and enables users to be informed of possible uses of recycled aggregates from waste, taking into account environmental and geotechnical criteria.</td>
</tr>
<tr>
<td>Source: Cerema, 2016</td>
<td></td>
</tr>
<tr>
<td>French electronic traceability system (see <a href="http://www.investigo.fr/">www.investigo.fr/</a>).</td>
<td>Ivestigo is a traceability software for C&amp;D waste. Launched by the French Demolition Association (SNED), this online platform aims to ease traceability work and respect the French wastes regulations for companies. More specifically, a user can create, edit and print waste tracking forms for all C&amp;D waste (inert, non-hazardous, hazardous and asbestos), and keep a waste register for each demolition works according to French regulations. A dashboard and several indicators allow companies to follow thoroughly the wastes they produce and improve communication with clients. Finally, Ivestigo is free of charge for the French Demolition Association’s members.</td>
</tr>
<tr>
<td>Tracimat – a Belgian example of a C&amp;D waste tracking</td>
<td>Tracimat is a non-profit, independent demolition management organization recognized by the Belgian public authorities that issue a &quot;certificate of selective demolition&quot; for a specific C&amp;D material that has been collected selectively at the demolition site and subsequently gone through a tracing system. The demolition certificate shows the processor whether the C&amp;D material can be accepted as &quot;low environmental risk material&quot; which means that the purchaser (recycling plant) can be quite sure that the C&amp;D material meets the quality standards for processing at the recycling plant. Therefore the “low environmental risk material” can be processed separately from “the high environmental risk material”. Because of the unknown origin and/or the unknown quality the “high environmental risk material” must be controlled more stringently than the “low environmental risk material” so the processing will be more expensive. All this will boost trust in the demolishing contractors and the recycled product, resulting in improved and more widespread marketing of recycled C&amp;D materials. In the future, other demolition waste management organizations could be recognized by the relevant public authorities. Tracimat does not issue a certificate of selective demolition until the waste has gone through the traceability system. The tracing process starts with the preparation of a demolition inventory and waste management plan prepared by an expert prior to the selective demolition and dismantling work. To guarantee the quality of the demolition inventory and waste management plan, they must be prepared according to a specific procedure. Tracimat will check the quality of the demolition inventory and waste management plan and issue a declaration on its conformity. Tracimat checks whether both the hazardous waste and the non-hazardous waste that complicates the recycling of the specific demolition C&amp;D material, have been selectively and properly disposed of. Tracimat initially focused on the stony fraction, which in terms of weight by far represents the greatest portion of the construction and demolition waste and will deal with other C&amp;D materials at a later stage. The 'eenheidsreglement' is a certification regulation for recycled aggregates that consist of an internal control and an external control by an accredited certification organisation. 'Clean input gives clean output' is the general motto of this policy. It also explains the distinction between streams with a Low Environmental Risk Profile (LERP) and streams with a High Environmental Risk Profile (HERP). In fact the Tracimat-system is one way for the crusher to accept debris as LERP,</td>
</tr>
</tbody>
</table>
beside other possibilities. So the 'eenheidsreglement' stands on its own and is a management system and certification regulation for recycled aggregates. Tracimat is a type of tracing system for debris derived from selective demolition.

| SmartWaste – developed by BRE (UK) | This tool provides the opportunity for all waste movements to be recorded and detailed information to be uploaded in real time via an authenticated spreadsheet or via an Application Programming Interface. The tool also provides a breakdown of waste materials and links to Key Performance Indicators, making it a possible complement or alternative to Level(s) reporting. |

**L3.3 – Who is involved and when**

The flow diagram below shows how the main actors in demolition, renovation and construction projects interact via different aspects of the building project, with the main project aspects and actors for Level 2 in orange or light orange.

As with Level 2, all of the main actors are involved to some extent in Level 3. The only actor not involved is the auditor, unless random audits are programmed during the project to ensure that the detailed WMP is appropriate and/or that the plan is being implemented correctly.

The waste manager plays a central role in Level 3 and needs to co-ordinate closely with the site manager from the consultant. Depending on the outcomes for the waste, products managers will need to be engaged when considering any technical or aesthetic requirements for waste shipments.