Module 5

Waste and Resource Management

Circular Economy in Construction

24 partners

12 countries

Date of Event

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Waste and resource management | Summary

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The aim of this module is to provide the relevant knowledge required to minimise, reuse and repurpose waste through demolition, on and off site

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CONSTRUCTION BLUEPRINT

Waste and resource management | Objectives

1. Understand the **national regulations** for Construction and Demolition Waste (CDWaste) on site
2. Identify and outline the **risks** associated with CDWaste
3. Outline the role of '**End-of-Waste' certification** under EU regulations
4. Outline the circular supply chain: **recovery and recycling**
5. Outline the principles and steps involved in implementing **a Resource and Waste Management Plan (RWMP)** using case studies

Waste and Resource Management | Content

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Topic 1 – Waste Management

Topic 2 – Pre-demolition, pre-development audits

Topic 3 – Demolition, reuse, recycle , repurpose

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1. Waste Management

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EU Waste legislation

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In recent decades, the European Union has developed important legislative work on waste.

The Waste Framework Directive 2008/98/EC, set out what is waste, and established a legal framework on how waste should be managed.
It has 2 key objectives:

1. *to prevent and reduce the negative impacts caused by the generation and management of waste*
2. *to improve resource efficiency.*

The framework imposes labelling, registration, monitoring and control obligations from "cradle to grave", i.e. **from the production of the waste to its final disposal or recovery**.
It also prohibits the mixing of hazardous waste with non-hazardous waste.

Source: CDWaste-ManageVET Project

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What is waste?

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Waste is defined as:

"any substance or object which the holder discards or intends or is required to discard".

Source: CDWaste-ManageVET Project

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Hazardous waste

- Hazardous waste is waste that poses a **threat to human health and the environment.**
- Examples include concrete admixtures, some mastic adhesives and sealants, halogenated flame retardant coatings, asbestos containing materials, tarry emulsions, solvent containers, paints, and adhesives, PBC equipment, etc
- Products with chemical substances and mixtures must be provided with **Safety Data Sheets (SDS).**
- **SDSs** make it possible to assess the risks to which workers are exposed and to establish preventive measures for their handling, including waste

Source: CDWaste-ManageVET Project

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Waste management means**:**

"collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker;

Source: CDWaste-ManageVET Project

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Waste collection

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- **Waste collection** refers to the collection of waste and includes the sorting and initial storage of waste before it is transported to a treatment facility.
- **Separate or selective collection** is the separate collection of waste according to its type and nature to facilitate its subsequent treatment.
- For example, waste can be collected in different containers, each container with a different type of waste such as: wood, plastics, plaster, concrete and stone, metals, hazardous waste etc..

Source: CDWaste-ManageVET Project

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Waste Collection

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Waste separation on site. Source: Ihobe public company for environmental education. Ihobe manual for drafting and implementing a construction and demolition waste management plan and good trade practices. 2012

Separate waste collection on a construction site has many advantages, including reducing the cost of waste management and increasing the chances of transforming waste into quality products through recycling.

Source: CDWaste-ManageVET Project

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Waste Recovery

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Waste recovery means:

"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"

- In construction, recovery means that the waste will be used in some way on or off site and **will not be sent to a landfill.**
- Recovery operations include preparation for re-use and recycling.

Source: CDWaste-ManageVET Project

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Re-use

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Re-use is defined as:

"any operation by which products or components of products which are not waste are re-used for the same purpose for which they were conceived".

Before a demolition material can be reused, it must be prepared for reuse.

Preparing for re-use is defined as:

"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.

Source: CDWaste-ManageVET Project

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Example of reuse:

In construction works, reuse is the use of materials that come from demolition works and are in good condition. These materials are reused without further processing, e.g. masonry, roof tiles, wooden beams, etc. They can be sold on the second-hand market.

Old roof tile for reuse in restoration work. Source:Tejas Gimenez. www.tejavieja.es

Source: CDWaste-ManageVET Project

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Recycling

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Recycling is defined as:

"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".

- To make Construction and Demolition Waste (CDW) recycling possible, it needs to be transported to salvage centres and plants, where it can be sorted and processed for new uses.

Source: CDWaste-ManageVET Project

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Recycling

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Example of recycling

Many construction wastes can be recycled, e.g. :stone and concrete, for the production of aggregates; wood, for the production of wood-based products such as chipboard etc.; glass for the production of glass fibre; metals for the production of metals by remelting; plastics etc.

Derived from wood. CHIPBOARD PANELS. Source: Elke Wetzig (elya), CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons

Source: CDWaste-ManageVET Project

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Backfilling

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Backfilling means

"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;

Backfill can be made up of, or can be a mixture of imported soil, rocks and stones depending on the structural requirements. The need for backfilling will be established during ground investigations which will also be used by the engineers to formulate a design.

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Example of Backfilling

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Concrete waste processed and used as backfilling on a construction site in Romania (taken by Rodica Stanescu, 2021)

Source: CDWaste-ManageVET Project

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Disposal

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Disposal is defined as:

" any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy".

Controlled landfill for non-hazardous waste. Source: Grupotec. www.grupotec.es

Example

The most common disposal operation for construction waste is landfilling.

- Before disposal, waste must be treated, unless this is not technically feasible, or if treatment would be harmful to health or the environment.

Source: CDWaste-ManageVET Project

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Treatment

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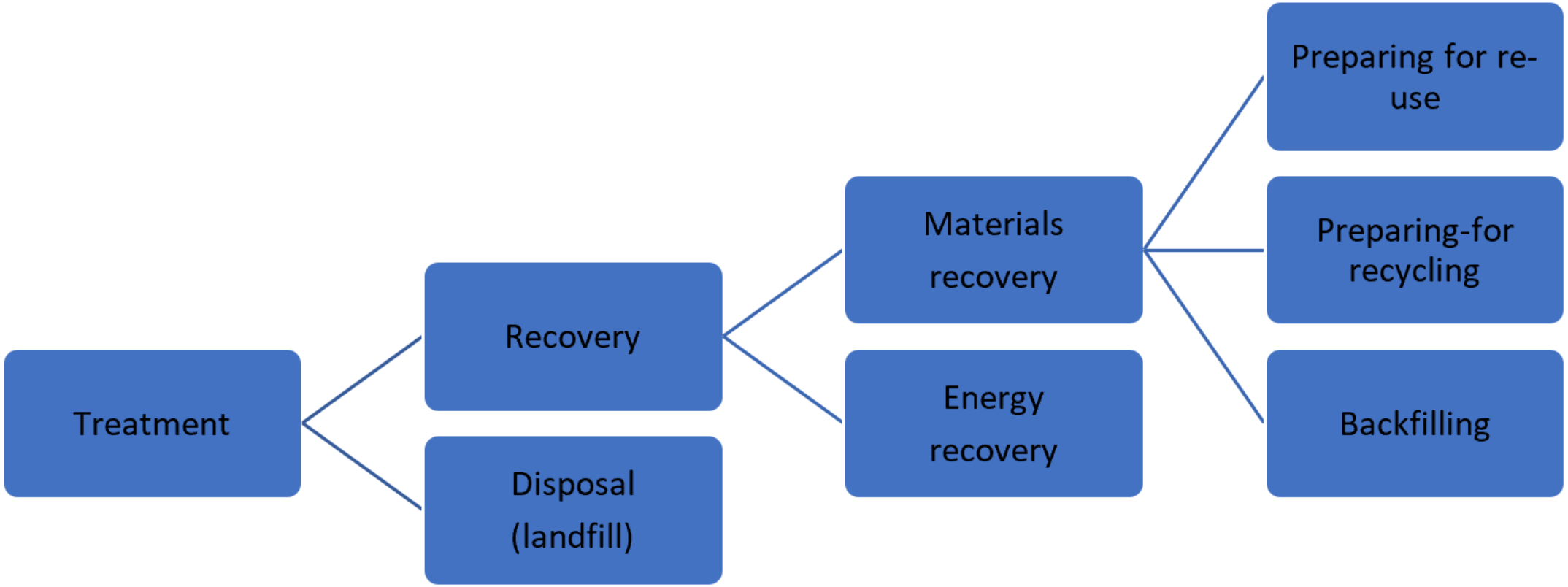
Treatment is defined as:

"recovery or disposal operations, including preparation prior to recovery or disposal".



Outline of waste treatment operations

Source: CDWaste-ManageVET Project

Who is involved in waste management for C&D?

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‘waste producer’ - 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 holder’- a waste producer or a person who is in possession of the waste

"**Waste manager“-** the person or entity who carries out any of the operations that make up waste management, whether or not he is the producer of the waste;

Developer or owner

Contractor or builder (owner of company carrying out the work)

Operator of company that collects, transports and treats the waste

Source: CDWaste-ManageVET Project

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Responsibility for waste management for C&D

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The producer or other initial waste holder has several options to ensure proper treatment of waste, these are:

- Treat the waste yourself.
- To entrust the treatment to a registered dealer, or to an authorised entity or company.
- Hand over the waste to a registered waste collector for treatment.

These operations must be documented.

Source: CDWaste-ManageVET Project

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Waste Hierarchy

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- The objective of waste management is to ensure the protection of the environment and human health.
- Waste should be managed in such a way that it does not cause risks to water, soil, fauna and flora, noise and odour nuisances, or any other environmental impacts.

Source: NegativeSpace

"the best waste is the waste that is not produced".

To achieve this goal, the law establishes the principle of "waste **treatment hierarchy"** which gives priority to "**prevention"**

Source: CDWaste-ManageVET Project

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"the best waste is the waste that is not produced".

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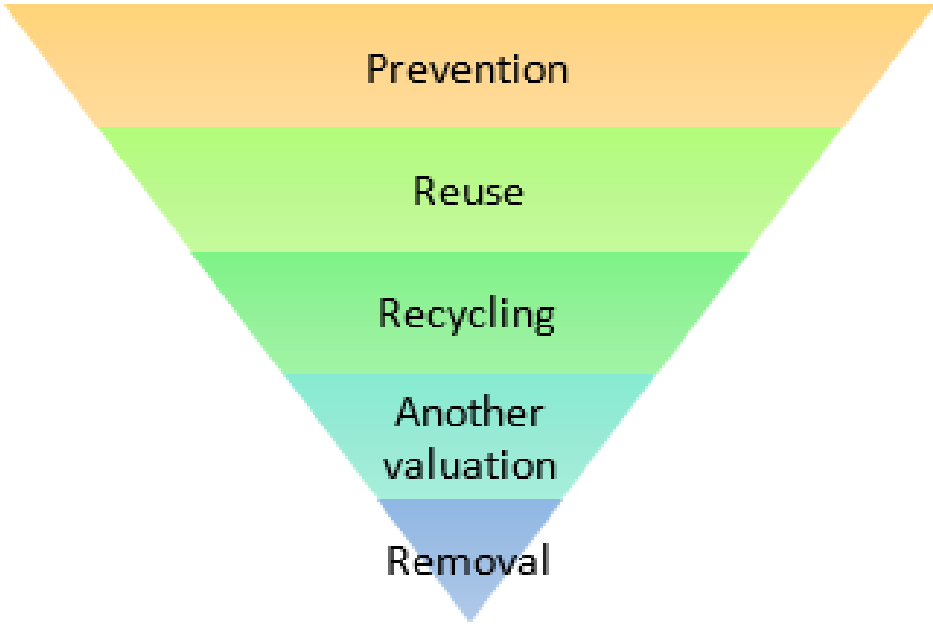
- Ways to **prevent** waste generation on a construction site, include reducing or reusing product containers and packaging, or accurately calculating the amount of materials needed to avoid waste.
- Once waste has been generated, **the order of priority in its treatment** is: recovery through preparation for re-use, recycling, and other forms of recovery, including energy recovery.
- Where recovery is not possible, the waste may be disposed of, mainly through landfilling.

Waste management prioritisation pyramid



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By-products

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For waste to cease to be waste for legal purposes, the law includes two concepts: **"by-product"** and **"end of product status"**. These two figures are key tools to make the circular economy possible.

By-product

A by-product is a leftover material that **comes from an industrial process of production of a product**, that can have a usefulness for a specific legal use that meets all the guarantees of environmental protection and health, and that can be used directly, therefore, it is not considered waste.

The difference between a by-product and a waste is that the by-product has a use, and the waste does not.

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By-products

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Example

For example, the processing of wood generates **by-products** such as bark, chips and sawdust. Bark is used as a decorative element or fertiliser, sawdust for animal bedding and pellets for energy production

By product

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End of Waste Status

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Waste that has been subject to recycling or any other recovery operation ceases to be waste for legal purposes if the product obtained from it meets the following requirements:

- They are used for specific purposes.
- There is demand and a market for the product.
- Meets the technical requirements, legislation, and standards applicable for the intended use.
- Not harmful to human health or the environment

A waste is no longer considered waste, legally, when it is recovered, and the product obtained from it is marketable as a useful and safe product.

Source: CDWaste-ManageVET Project

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End of Waste Status

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Example

When concrete and stone waste is converted into recycled aggregates that meet the requirements for use in the manufacture of concrete, it is no longer considered waste.

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National Waste Management Plans

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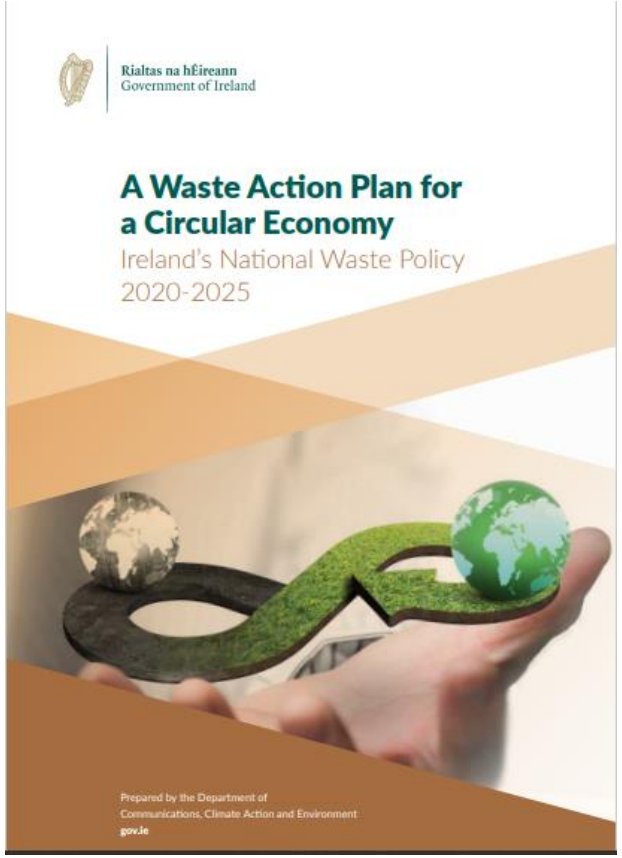
The National Strategies and Plans of waste management, must be in compliance with the **European Framework of the 2020 Strategy**.

View Ireland's 'Waste Action Plan for Circular Economy' here

https://www.gov.ie/en/publication/4221c-waste-action-plan-for-a-circular-economy/



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Types of materials and their properties

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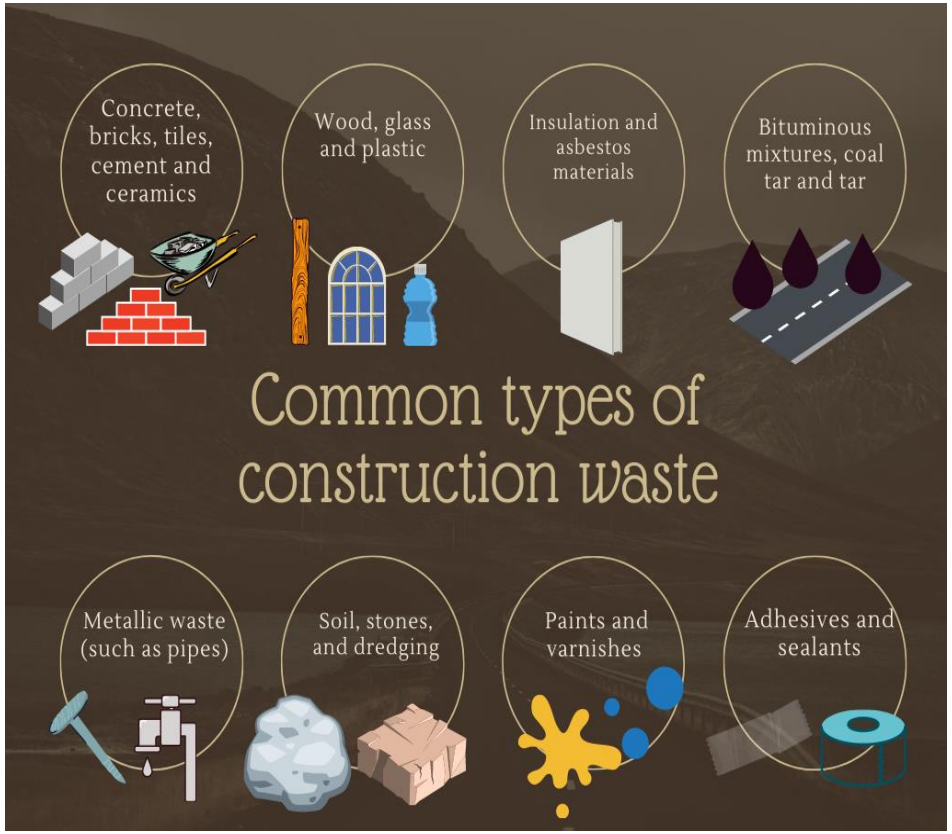
- On a construction site, you should pay careful attention to **how you dispose of all of your waste materials.**
- Some construction waste can be recycled and others must be sent to the landfill. To do so, it is important to know how to **identify the type of waste**, their properties and characteristics.
- Consequently, it will enable the disposal of your waste properly and maximize the construction cost saving and benefit the environment.



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Types of materials and their properties

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The waste generated from the construction industry are for the most part non-biodegradable and inert materials. The C&D waste is classified in three main categories: **inert waste**, **non-hazardous and inert waste** and **hazardous waste**.

Inert waste

- **Inert waste** is waste which is neither chemically nor biologically reactive and **will not decompose** or only very slowly
- Examples: tiles, ceramics, clay, hardcore, bricks and concrete

This type of waste **will not pose a threat** to the environment, animals or human health and will not endanger the quality of water courses.

However, the large amount quantity produced in the industry, means it takes up a lot of space

- inert waste **can be easily recycled** into materials or aggregates.

Source: CDWaste-ManageVET Project

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Types of materials and their properties

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Non-hazardous and non-inert waste

- **The non-hazardous and non-inert waste** are non-inert wastes that do not present any characteristics of "hazardousness" (non-toxic, non-corrosive, non-explosive, etc).
- Examples: packaging, wood, plastics, metal, insulation material, etc
- These waste are made of materials which, **after a potential pre-treatment and/or processing** step, can be used as substitutes of raw material in a production cycle.
- They are **recyclable waste** and the trend is growing- with the emergence of new technologies, more and more materials become recyclable
- The packaging materials must be sorted and directed to be recycled in specified branches adapted for their processing

Source: CDWaste-ManageVET Project

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Types of materials and their properties

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Hazardous waste

- **The hazardous waste** is the waste from industrial activity that presents a **risk for human health or the environment**. They must be managed with specific processes regarding the regulations
- Examples: Aerosol cans, asbestos, batteries, oil and fuels, paints or liquids
- The management of hazardous materials is **regulated by the law** and all the steps are not recommendations but obligations. The owner of the waste must effectively manage them to avoid fines and environmental liability.
- Hazardous waste must be **sorted and stored differently** to general waste, with a focus on safety and security. All risks of contaminating other materials must be avoided

Label describing the hazardous material

Containers of hazardous materials

Source: CDWaste-ManageVET Project

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Material selection methods and/or techniques

Source: CDWaste-ManageVET Project

Possible process of the common waste in the construction site (abstract extracted from

https://www.guidebatimentdurable.brussels/fr/type-de-dechets-de-chantier.html?IDC=8187)

Type of Waste	Recovery			Treatment	
	Reuse	Recycling	Energy recovery	Incineration	Disposal
Treated wood (paint, varnished, ...)					
Tar and bituminous mixtures					
Chipboard wood					
Concrete, mortar additives *recovered by certified collector					
Asbestos					
Concrete and mortar					
Untreated wood Reuse of complete elements, reuse for formwork systems, manufacture of boards, chipboards, sawdust or wood chips					

Recovery/reuse

Satisfying process

Process to be used in last resort

Not a viable option

Types of materials and their properties

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- The best way to ensure that materials are not contaminated with hazardous waste is to segregate the waste in different dumpsters.
- A well-managed segregation of materials/waste including a proper follow-up and a good upstream preparation of the site stakeholders (information, training, …) will enhance the recycling/reuse process and the safety conditions on the site.

Source: CDWaste-ManageVET Project

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Selective demolition

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- A higher level of selective demolition can be achieved by considering the manual dismantling of a wide range of materials to enable C&D reuse.
- Some of the considered techniques are the **stripping** (before demolition) and **scavenging** (after demolition).
- Good examples for reuse include glass, marble fireplaces, precious woods such as walnut and oak, traditional sanitary ware, central heating boilers, water heaters and radiators [6]. Materials such as gypsum, insulation foam, concrete, and mineral wool and glass wool can also be considered for reuse or recycling

Selective demolition example

Removing doors by hand

Removing insulation materials by hand

Removing roofing materials by hand

Source: CDWaste-ManageVET Project

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EU LoW

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In the European List of Waste (LoW), C&D Waste is subdivided into 9 sub-chapters or differentiated groups, these are:

LoW code chapter	Description
17 01	concrete, bricks, tiles and ceramics
17 02	wood, glass and plastics
17 03	bituminous mixtures, tar and tar products
17 04	metals (including their alloys)
17 05	soil (including excavated material from contaminated sites), rocks and dredge spoil
17 06	asbestos-containing insulation materials and building materials
17 08	gypsum-based building materials
17 09	other construction and demolition waste

Source: CDWaste-ManageVET Project

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EU LoW

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Category 17 includes hazardous waste generated during construction and demolition activities:

LoWcode	
17 01 06*	separate mixtures or fractions of concrete, bricks, tiles and ceramics containing dangerous substances
17 02 04*	Glass, plastic and wood containing or contaminated with hazardous substances
17 03 01*	bituminous mixtures containing coal tar
17 03 03*	Coal tar and tarry products
17 04 09*	Metal waste contaminated with hazardous substances
17 04 10*	Cables containing petroleum, coal tar and other dangerous substances
17 05 03*	Soil and stones containing hazardous substances
17 05 05*	Dredging spoil containing dangerous substances
17 05 07*	Railway track ballast containing dangerous substances
17 06 01*	Asbestos-containing insulation materials
17 06 03*	other insulating materials consisting of or containing dangerous substances
17 08 01*	Gypsum-based building materials contaminated with hazardous substances
17 09 01*	Construction and demolition wastes containing mercury
17 09 02*	Polychlorinated biphenyls (PCB) containing construction and demolition wastes (e.g. PCB-containing sealants, PCB-containing resin-based floor coverings, PCB-containing sealed glazing units, PCB-containing capacitors)
17 09 03*	Other construction and demolition wastes (including mixed wastes) containing dangerous substances

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2. Pre-demolition, Pre-development audits

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Introduction

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- The C&D Waste in Construction industry represents the largest waste streams in the European Union. The inert waste in this sector of activity is generally around 70% of the total waste projects and over 90% for public construction.
- However, regarding the characteristics of this material, there is a large potential of recycling/reusing/recovering to be implemented in order to be in line with the Waste Framework Directive 2008/98/EC which established a target of 70% of CDW to be recycled by 2020.
- Consequently, it is important to know how to perform a **Pre-demolition audit**, to enhance the C&D waste management on a construction site including for recycling/reusing/recovering.

Source: CDWaste-ManageVET Project

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Demolition vs Deconstruction

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- In Demolition, the goal of the project is to simply knock down a structure, building or property.
- The Deconstruction purpose is also to tear down the structure, however it aims to salvage whatever parts, components, or materials can be reused and/or recycled.
- Deconstruction requires planning the activity and enables selling materials to specialised buyers and/or reuse them whether directly on site or in other projects

Source: CDWaste-ManageVET Project

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What is a Pre-demolition audit?

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- The pre-demolition audit is an activity organized by the owner of the building or infrastructure resulting in the inventory of materials and components arising from the future demolition, deconstruction or rehabilitation projects, and their management and recovery options.
- Audits are essential since they enable all stakeholders involved to get information on the composition of waste and make it easier to find markets for different waste types.
- Most of the Member States of the European Union have already established at least very basic mechanisms for pre-demolition audits.

Source: CDWaste-ManageVET Project

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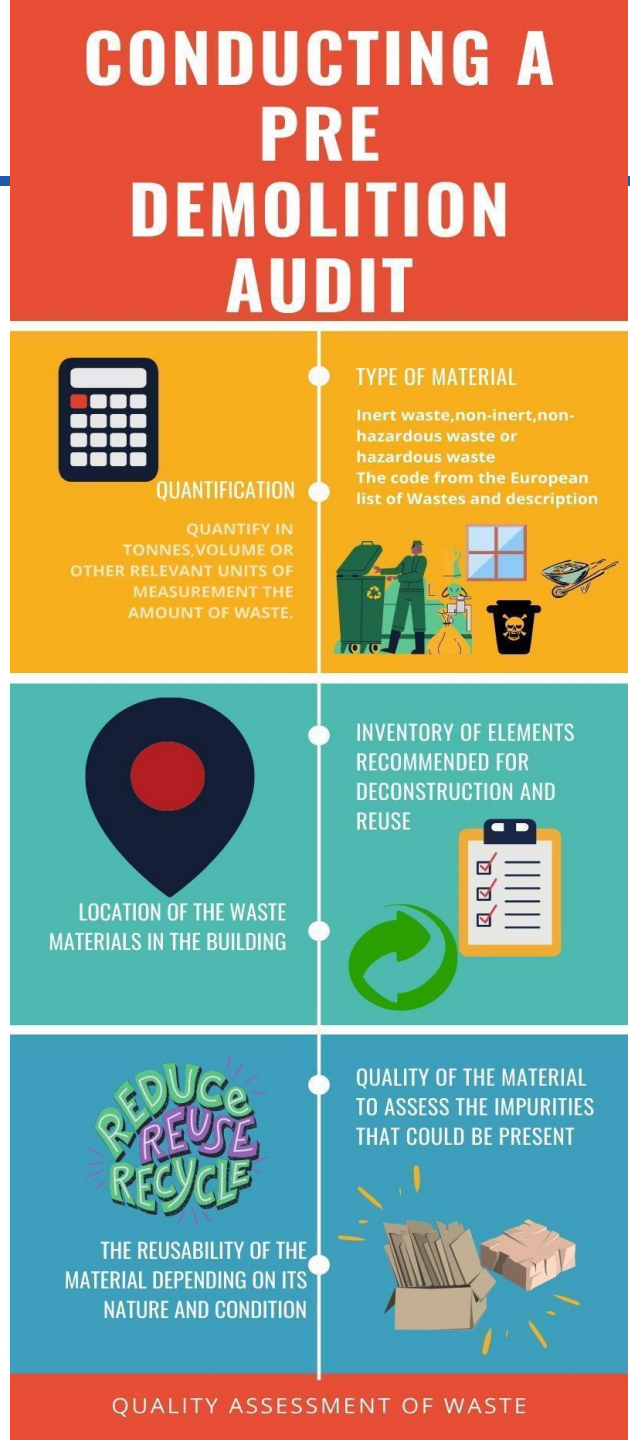
What is a Pre-demolition audit?

- The pre-demolition audit allows professionals to assess the non-hazardous materials that require removal from the structure and calculate their potential value.
- The aim is to facilitate and maximize recovery of materials and components from demolition or renovation of buildings for reuse and recycling purposes without compromising the safety measures and practices outlined in the European Demolition Protocol.



Source: CDWaste-ManageVET Project

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What is a pre-demolition audit?

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A pre-demolition audit consists of two parts:

1) Collecting information: identification, location, quantity and quality of all waste materials generated during the demolition/ deconstruction/ rehabilitation project. This enables having a more precise estimation of the materials on-site and determining which will be done further.

   Information collected provide information about:

   - Which materials are mandatory to separate at source, in particular hazardous waste
   - Which materials are not eligible for reuse or recycling
   - How the waste will be managed and the recycling options

Source: CDWaste-ManageVET Project

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Pre-demolition audit

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2) The audit also needs a waste management plan.
It is crucial that demolition activities must be carried out according to a plan.

The whole process should be monitored by a local authority or by an independent third party (waste management specialized contractor …).
This will enhance the monitoring process by checking:

- How the non-recyclable and reusable materials are processed
- the compliance with regulations (transportation, certification, licence,…)
- assessing the volume of waste excavated

Source: CDWaste-ManageVET Project

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Pre-demolition audit

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The audit is carried out by a qualified expert with good knowledge about construction materials, techniques and the business of the construction industry.

Their expertise will determine the destination of the excavated materials: reuse, recycling, selling, disposal

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Pre-demolition audit- roles and responsibilities

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Participants involved in the waste audit:

- The property owner is responsible for appointing an auditor to develop a waste audit for the identification and classification of waste
- The authority issues demolition or renovation permits and should establish mechanisms to ensure that waste audits are performed including a quality check system and recommendations considered;
- The auditor is responsible for the waste audit
- **The contractor is responsible for demolition/deconstruction/renovation operations defined in the contract with the owner.**
- The waste manager is responsible for the appropriate management and disposal of the waste received from the waste holder or producer.
- The products manufacturer may contribute to the waste audit providing solutions and/or requirements for the reused/recycled materials and components.

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Pre-demolition audit: waste audit

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The waste audit consists of documentation research, a field survey, condition evaluation, and recommendations for the material

1. **Document search:**

This is the first part of the audit.

It aims:

- To provide a first estimation about the materials, their quantities and possible hazardous nature
- To provide an indication on the building or infrastructure
- To investigate the building and its surrounding (practices during its construction, access, management facilities...)

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Pre-demolition audit: waste audit

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2. Field survey

The second part of the audit is the field survey. Its aim is:

- To verify and update the information obtained in the documentation search
- To obtain indications of hazard scenarios and exposure of the building materials and components
- To determine the current condition of the building and its materials
- To identify and indicate the reusable components
- To collect materials for sampling

3. Inventory and reporting

The final report of the audit is prepared and signed by the auditor to validate the accuracy of the content. The report includes the information, the objective, the survey plan i.e all the data, information, documentation concerned by the survey

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Pre-demolition audit: waste audit

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4. Quality Assessment

The quality of the pre-demolition audit depends on the expertise and skills of the auditor and traceability of the information provided by the waste declaration.

The auditor shall have sufficient knowledge, skills and experience to identify hazardous materials and fulfil the legal requirements for the pre-demolition audit. It is recommended that the auditor is independent in all demolition, deconstruction, renovation projects so the audit results are not biased.

5. Traceability of the information

The assessment of the audit shall be performed in three stages:

- Stage1: Initial assessment during the waste audit
- Stage 2: Monitoring after and during works (including decontamination and removal of hazardous wastes, on-site management, comparison between the objectives set and the current amount of waste performed.
- Stage 3: Verification of the off-site management and disposal process considering not only the amount but also the type of waste management performed.

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Pre-demolition audit: report and recommendations

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- Moving forward to the actual auditing report, this is produced following a number of different processes, such as desk study and field survey.

- Via these procedures, the auditor is in the position to identify material sorting operations highlighting **recycling and recovery procedures** and that may involve the **storage, handling, and separation** criteria linked to the overall waste management of the infrastructure.

- In addition, the report assists the auditor to proceed to reuse planning which involves the **inspection, washing or repair of waste products for recovery operations**. Waste, goods or commodity parts could be obtained by an external operator so that they can be reused.

- The waste audit can be completed with recommendations on how to perform waste management on site.

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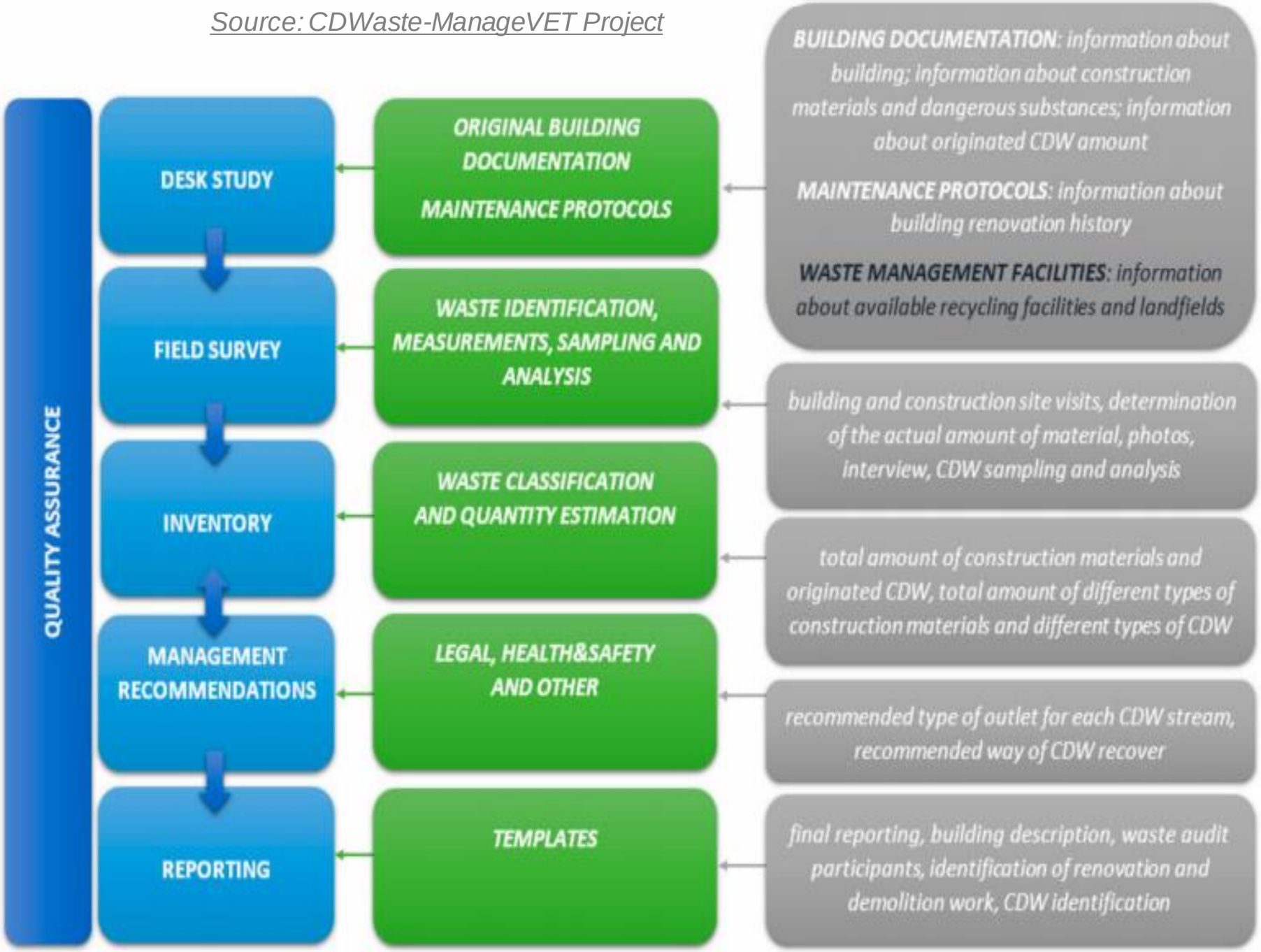
Source: CDWaste-ManageVET Project

An overview of the steps to be followed for an effective pre-demolition audit.



Recommended template for inventory of materials

Type of material	Material Identification	Waste Code (EWC and EURAL)	Location	Quantity	Unit	Observations or other information

Summary table

Building	Type of material	Material Identification	Waste Code (EWC and EURAL)	Quantity	Units	Total quantity
	Inert waste					
	Non-inert, non-hazardous waste					
	Hazardous waste					

(Extracted from "Guidelines for the waste audits before demolition and renovation works of buildings" – others recommended templates are provided in this document available at: ec.europa.eu)

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Learn more!

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- Guidelines for the waste audits before demolition and renovation works of building (EN): https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiw7ev778_uAhWRA2MBHfoHCs0QFjAAegQIARAC&url=https%3A%2F%2Fec.europa.eu%2Fdocsroom%2Fdocuments%2F31521%2Fattachments%2F1%2Ftranslations%2Fen%2Frenditions%2Fnative&usg=AOvVaw2tvcn_NTCNiJ8kmSadDd6k
- Best practice guide to improving waste management on construction sites: https://www.zerowastescotland.org.uk/sites/default/files/Improving%20waste%20management%20on%20construction%20site%20%E2%80%93%20best%20practice%20guide_0.pdf
- Analysis of Best practices to prevent and manage the waste generated in Building Rehabilitation Works (EN): https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwibv9fur9DuAhUM8hoKHe5yBcwQFjARegQIKBAC&url=https%3A%2F%2Fwww.mdpi.com%2F2071-1050%2F11%2F10%2F2796%2Fpdf&usg=AOvVaw0_uLzxL2baMnbQxBUc7c6r
- https://cris.vtt.fi/ws/portalfiles/portal/27438769/EIT_RM_PARADE_Predemolition_audit_overall_guidance_document_Final_2019.pdf

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2. Demolition, reuse, recycle , repurpose

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Waste management planning on site

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Starting from the results of the pre-demolition audit, it is important to identify and **plan** the appropriate demolition techniques and procedures. (selective demolition, strip out, etc.)

- **Planning special treatments** in the case of hazardous waste.
- **Planning recycling** for materials capable of offering performance equivalent to a new material once re-processed.
- **Planning landfill** for materials that cannot be reused either in their original use or after treatment.

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Waste management planning on site

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https://www.youtube.com/watch?v=w_8ByOwjp2U&t=278s

Construction Waste Management System

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- The Construction Waste Management System in any construction company is the **set of internal procedures** which staff must follow to manage the waste produced on every site, in accordance with company policy.
- The Construction Waste Management System, once neglected and even seen as a waste of time, is **now a central part** of doing business for construction companies.
- Planning, and in particular using a site waste management plan, allows to forecast the waste and to anticipate that it will be produced and the materials needed to complete the project.
- It also defines actions to minimise waste and includes the actual measurement of waste, so that forecasts can be compared with actual achievements.
- In most European countries, the Site Waste Management Plan (SWMP), or national equivalent, is **a legal requirement** for some projects. It requires you to forecast and record waste and how it is managed.

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Site Waste Management Plan- 9 steps

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There are **9 steps** for implementation of a Site Waste Management Plan:

Step 1 — Identify who is responsible for producing the plan. The Site Waste Management Plan (SWMP) should be available on site as it could be referred to by the staff, implemented and updated if there are changes.

Step 2 — Identify the different types and quantities of waste.

Step 3 — Identify the waste management options and note any changes in the design and specification that seek to minimize this waste.

Step 4 — Consider how to reuse, recycle or recover the different waste produced by the project.

Step 5 — Identify waste management sites and contractors, for all waste that require the companies to demonstrate that they are complying with the Duty of Care Regime and recording the quantities of waste transported from site for disposal.

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Site Waste Management Plan- 9 steps

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Step 6 — Implement and carry out any necessary training of internal and external staff, to ensure that everyone understands the requirements of the plan.

Step 7 — Plan for efficient materials use, and minimum waste handling and do this early enough, keeping in mind any constraints imposed by the site and its location

Step 8 — Measure the quantity and type of waste produced, comparing this against the SWMP to ensure that the wastes are properly managed and lessons are learned for the next time a SWMP is produced. All should be recorded on the data sheet. Every time a waste is removed from the site, the SWMP must be updated with further information, including: type of waste removed and destination site

Step 9 — Monitor the implementation of the SWMP to ensure that is being followed and be prepared to update plans if circumstances change. Review the success of the SWMP at the end of the project, identifying learning points for future references

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Waste reduction, segregation, reuse on site

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- Managing waste reduction and segregation is the easiest way to maximise the amount of waste that is used and recycled and can make disposing of waste cheaper.
- Several dumpsters must be present on the site in sufficient quantity with clear signage on the waste authorized to be dumped.
- Each container indicates the type of waste that it contains: timber, concrete, solid waste, plastic, hazardous waste, etc… The number of containers depends on the size of the construction site. The waste segregation should be extensive and as accurate as the site permits

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Waste reduction, segregation, reuse on site

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- The waste segregation should be extensive and as accurate as the site permits: we can sort the waste in other categories like battery, paper, organic, etc…In order to facilitate this process, a colour type should be indicated on each container.

- What can also be used are “big bags “. These "big bags" should be coloured according to each category of waste they contain and/or a labelling system should be applied. This practice allows for consistency in waste management, regardless of whether, for example, the project takes place in a multi-storey building, including the basement.

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Waste reduction, segregation, reuse on site

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- When it's possible, the materials present on the site should be reused rather than being transported outside the site.
- When talking about reuse of construction and demolition waste, the term "salvageability "is used.
- The salvageability of a material is defined as its potential to be reused in its current state, minimizing the needs for transport and further processing.

Source: CDWaste-ManageVET Project

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Waste reduction, segregation, reuse on site

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- Keep in mind that a **daily follow up** is essential to maintain an efficient material segregation on site and the engagement of the site players.
- The monitoring should include the checking for contamination, signage and location of containers.
- Moreover, the use of a **tracking software** is the better way to perform this monitoring. It allows you to compare the quantities of waste tracked with the initial estimation and objectives and to make changes as needed to stay on target.
- If the use of digital technology is not possible, the monitoring should be performed through a Recycling Monitoring Form and it will be recorded to demonstrate this process has been done regularly.

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Recycling methods

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Temporary storage, stockpiling

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- An efficient sorting and storage of materials, keeping them separated, is an important factor for proper waste management and to ensure the economic viability of diverting construction debris from disposal.
- The correct separation of inert CDW will promote a more effective recycling process and a higher quality of recycled aggregates and materials
- Materials must follow a differentiated storage according to their treatment options
- Stockpiling can be applied in small projects but is especially beneficial for considerable sized demolition sites, such as airports, industrial plants or housing blocks. Attention must be given to stockpiling timing with a limit of 1 year before disposal and 3 years before recycling

Source: CDWaste-ManageVET Project

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Temporary storage, stockpiling

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- The CDW stockpiling can be harmful for the environment and precautionary measures must be taken to minimise potential risks, such as groundwater contamination by leaching or run-off of contaminants and particulates, heat generation with potential to cause fire, generation of litter, dust, biogas and odour emissions.

- The precautionary measures include waste segregation and disposal in separate dedicated containers.

- Also for reuse, recycling and recovery of C&D materials requires proper stocking. Some materials need to be sorted according to their economic value such as metal that has an established resale value or bricks and tiles that face a significant demand

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Temporary storage, stockpiling

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- To avoid contamination attention must be given during the demolition stage. **Materials that were non-hazardous can become non-reusable/recyclable due to improper procedures.**
- For example - the contamination of inert recyclable waste such as bricks and concrete. If a lead-based paint is mixed in the pile, then it is classed as hazardous waste.
- Therefore, stocking and stockpiling must be undertaken only in suitable circumstances to prevent and minimise any potential harm to human health and the environment

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Reusing

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- **Reusing refers to using an object as it is, without treatment**. This reduces pollution and waste, thus making it a more sustainable process.
- Recycling means turning an item into raw materials which can be used again. This is an energy consuming procedure that can still produce waste and pollution.
- Therefore, **preparing for reuse is to be encouraged** because, in theory, it offers environmental advantages when compared to recycling, since environmental impacts associated with reprocessing do not occur

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Recycling

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- Recycling can take place on-site with materials incorporated as new construction resources or off-site at a recycling plant.
- The most common materials to be recycled from building sites include metal, lumber, asphalt, pavement (from parking lots), concrete and other stony materials, ceramics (e.g. bricks, roof-tiles), roofing materials, corrugated cardboard and wallboard.
- Adequate planning of waste management activities on construction sites is crucial to achieve high recycling rates and high-quality recycling products.

Example of a circular demolition dismantling process. Photo Credit: Erik Boschman

Source: CDWaste-ManageVET Project

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Material and Energy Recovery

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Material Recovery

- Material recovery on-site can occur through **backfilling, which is one way to reuse non-hazardous CDW**. It is a solution applicable in situations such as in public and earthmoving works when reuse or recycling into higher quality applications is not possible
- To avoid a negative environmental impact, such as groundwater contamination, the **CDW should be treated before being backfilled**

Energy Recovery

- **CDW can also be recovered also as substitute fuel**. Such as:
  - contaminated wood and wood-based products that are not suitable for reuse or recycling;
  - plastics;
  - organic insulation (thermal insulation, sound insulation) materials;
  - bitumen based waterproofing membranes

Example of Refuse Derived Fuel

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Transport

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The materials should be transported ideally to a processing plant for further reuse or a final disposal site. Concrete can be reused by crushing it, in order to transform it to be resold either in another size or as backfill.

- The transport of CDW should be performed in a safe and legal manner to prevent any negative impact on the environment and workers' health. Therefore, the contractor should verify if the CDW is hazardous or not and provide the appropriate transport conditions

- it is important to provide a safe storage, separated from other waste, with labelled containers and a restricted access for unauthorised persons. The contractor must ensure and have proof that the hazardous CDW is transferred to an adequate facility authorized to receive the hazardous waste.

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Transport

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- The link between the CDW production location and the final waste disposal facility can be optimized using **waste transfer stations** or collecting boxes.
- All transfer stations serve the same main purpose **to receive CDW from different production points but some also provide waste sorting and recycling services**

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Dutch certification scheme for demolition processes (BRL SVMS-007)

The BRL SVMS-007 is a voluntary certification scheme to encourage a quality demolition process. Customers who prescribe to this certification scheme of procurement and tendering are assured of environmentally and safe demolition on site. The certified demolition process follows four steps:

Step 1 Pre-demolition audit: The demolition contractor carries out an advanced inspection of the demolition project and an inventory of the materials (hazardous and non-hazardous) to get insight into the nature, quantity and any contamination of the extracted demolition materials. An inventory is made of the risks to occupational safety and safety risks to the surroundings.

Step 2 Waste management plan: A waste management plan is drawn up that includes a description of the method of selective demolition and environmentally-friendly demolition, processing and removal of released material flows, safety measures that have to be taken and implementation requirements of the customer.

Case Study continued

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Step 3 Execution: The execution of the demolition occurs in accordance with the waste management plan. Experts in the area of safety and environmentally-friendly demolition are involved and certified demolition contractors work with approved equipment. The demolition contractor must ensure that the demolition location is safe and well organised and that the released material flows do not contaminate the soil and the surroundings.

Step 4 Final report: The delivery of the project takes place in consultation with the involved parties. A final report of the released demolition materials is drawn up by the demolition contractor, and it is supplied to the customer upon request.

https://www.veiligslopen.nl/en/

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Case Study 2

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TRACIMAT, is a non-profit construction and demolition waste (CDW) management organisation.

Tracimat will **certify the selective demolition process and issue a certificate of selective demolition for demolition waste that has been selectively collected and subsequently has gone through a tracing system**.

This tracing system guarantees the selective collection of the demolition waste material, traces it from its point of origin down to the gate of the processing company, assures the processing company of the environmental quality of the input demolition waste.

https://www.tracimat.be/

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Selective Demolition

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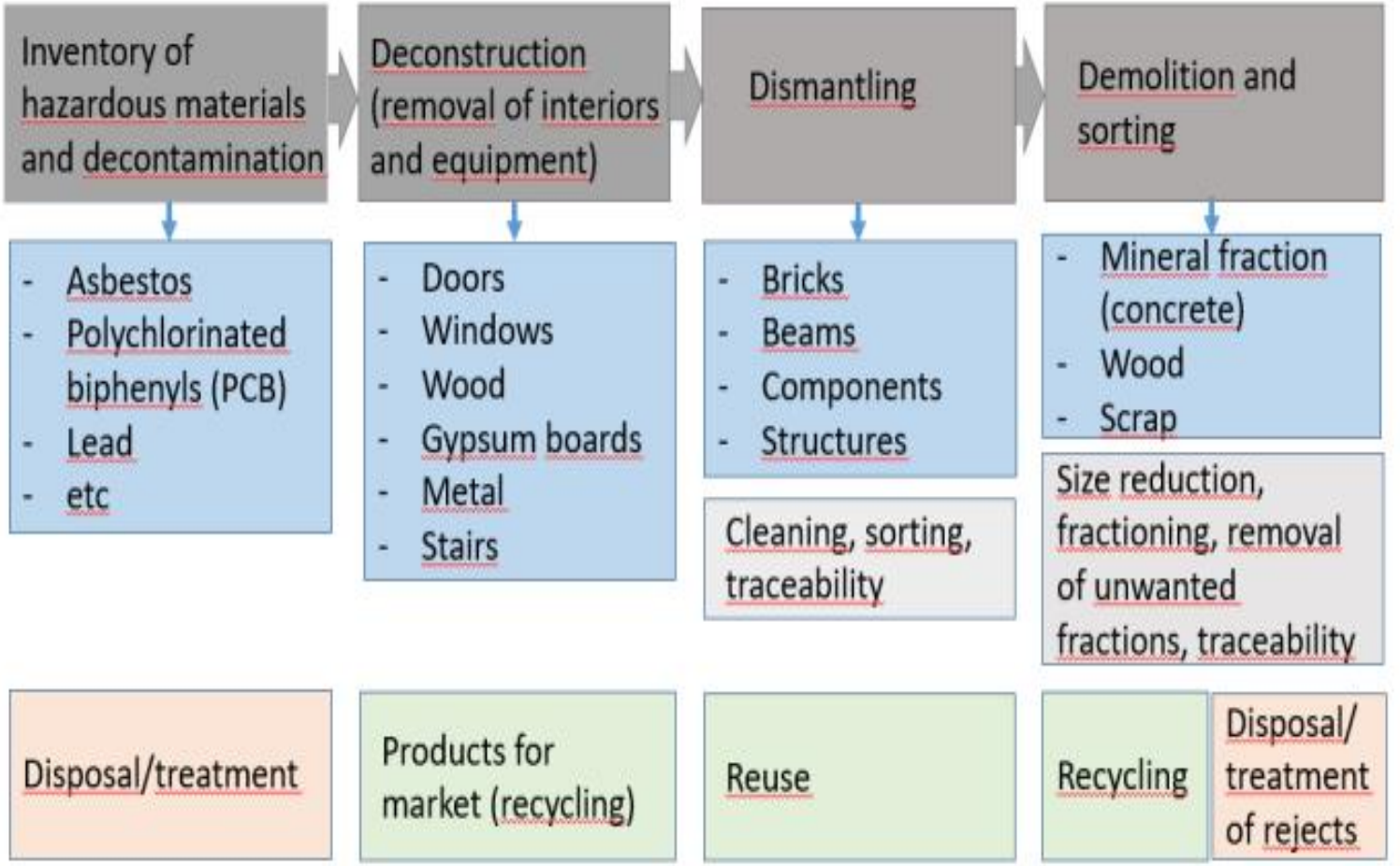
There are three main steps on the quality management of waste identification, source separation and collection:

1. Pre-demolition audit (a/o asbestos detection);
2. Selective demolition;
3. Identification and separation of hazardous waste.



Phases in a selective demolition process Source

Source: CDWaste-ManageVET Project

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Factors affecting material recovery

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The level to which materials may be recovered effectively in the demolition process is strongly dependent on a range of factors that can affect the recovery, mainly the following:

- **Safety**- may increase project costs.
- **Time**. Selective demolition needs more time than traditional demolition, so higher costs are expected.
- **Economic feasibility and market acceptance**. The cost of removing an element (e.g. a roof tile) should be compensated for by its price, while, at the same time, the re-used element should be competitive and accepted by future users.
- **Space**. When there is a space limitation on a site, separation of materials collected should take place in a sorting facility. Space limits specifically require good planning.
- **Location**. The number of recycling facilities in the surroundings of the project site or the local supply waste management services may limit the potential recovery of materials from a deconstruction project.
- **Weather**. Some techniques may be dependent on certain weather conditions that may not coincide with project timing

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Drivers and barriers of selective demolition

Source: CDWaste-ManageVET Project

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Aspect/characteristics	Drivers/benefits	Barriers/challenges
Legislation	Selective demolition is mandatory in many member states. Mandatory decontamination of the construction – removal of hazardous materials.	No demand for selective demolition in some EU Member States. Safety requirements in selective demolition are more demanding.
Market/economics	Higher value for pure C&DW fractions. Treatment costs are lower following selective demolition. Creation of more jobs. If a market for material recovery can be identified and connected prior to demolition, environmental success can accompany financial success.	Selective demolition prolongs demolition time and requires more labour.
Quality	Use of efficient selective dismantling enables the separation of unwanted fractions from recyclable C&DW and improves quality.	Potential presence of hazardous materials. Lack of traceability – limited information on the origin and quality of waste materials.
Local conditions		Low cost of landfill and virgin materials. Neighbourhood – creation of noise pollution and dust, lack of space.

Drivers and barriers of selective demolition- continued

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Typology	Access to BIM data in new buildings. Design for disassembly.	Complex buildings increase costs for selective demolition and material separation. Some construction materials, sandwich elements, are not possible to separate economically. Old buildings are not designed to be deconstructed – from building to components – or disassembled – from components to materials – easily.
Technological development	New techniques for material recognition. Use of robots for demolition work. New recycling technologies for high-grade material fractions.	Material identification not yet available in older buildings.
Actors	Education on the circular economy at different levels in universities.	Several stakeholders involved in the value chain; challenge with communication.

A more selective demolition process will minimise the amount of rejects sent for landfilling, but on the other hand, it is a **more expensive process, more labour intensive and more time consuming**. The selectivity of the demolition process is determined by an economic trade-off but the **future buildings might be constructed to be easier to disassemble**

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Case study 3- *Waste based bricks by Stonecycling*

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Stonecycling is a Dutch company officially launched in 2015 that developed their WasteBasedBricks®. These are interior and exterior bricks made to the requirements of each project from at least 60% waste. Their mission is to move **towards beautiful building materials made from 100% upcycled waste with a positive carbon impact on the planet**. This solution was developed to overcome issues such as:

- Debris from construction, demolition and industrial processes is one of the biggest waste streams in the world;
- The construction industry is responsible for one third of all CO2 emissions in Europe;
- Basic raw materials such as construction sand are becoming increasingly scarce;
- Initiatives for recycling waste materials often lead to downcycling: building products that once had value end up as roadbeds or in one of many landfills;
- Necessity for alternative resources and production methods is a pressing necessity that creates opportunities for the stakeholders in the value chain.

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Waste Hierarchy

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1. Waste prevention (sometimes termed reduction or avoidance or minimisation) (on-site) is the most appropriate waste management option; it excludes the need for any other operation. Prevention should be considered during the **design stage as well as on-site;**

Consider:
How can waste be prevented at

1. **design stage**
2. **construction stage (Check notes for answer)**

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Waste Hierarchy

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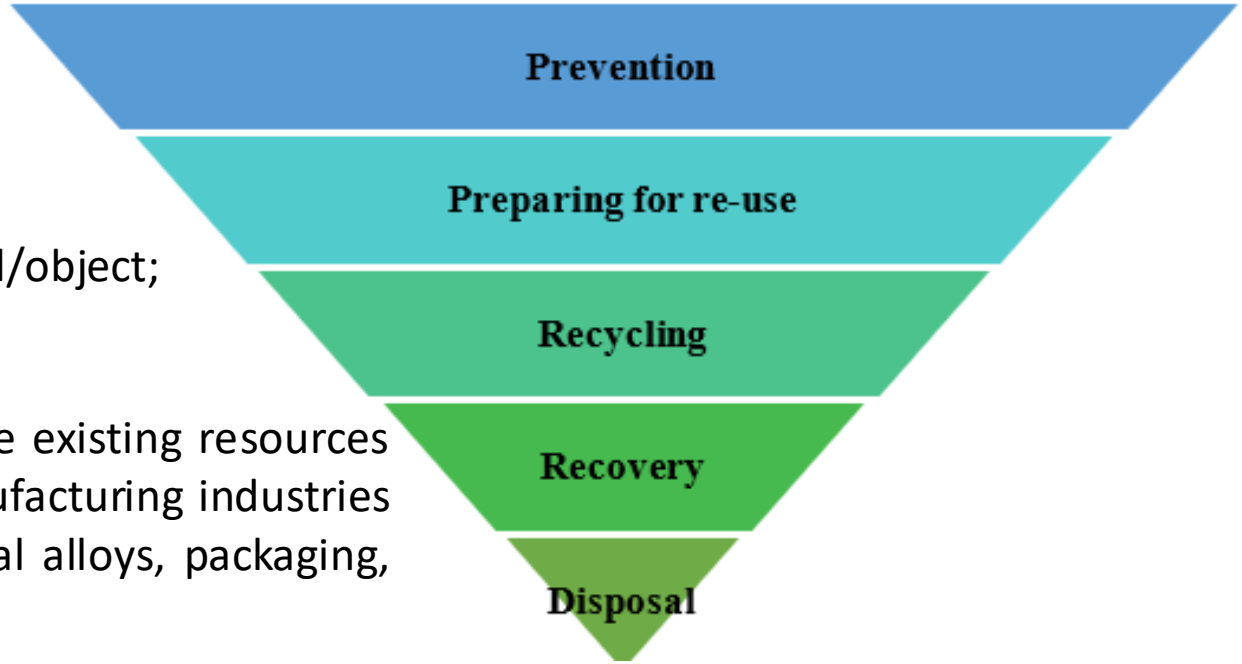
2. Preparing for re-use includes operations that improve the quality of waste before re-use in similar works. These are:

- quality checking;
- the removal of the impurities/ cleaning of the material/object;
- repairing.



3. Recycling - turns waste into new products protecting the existing resources and reducing the environmental impact of mining and manufacturing industries (e.g. tiles, asphalt, concrete, plasterboard, metals and metal alloys, packaging, etc.)

4. Recovery, e.g. material recovery (backfilling, gypsum could be used for the fertilizers and compost production) or energy recovery (wood energy recovery) on- or off-site).

5. Disposal, in a safe manner (off-site) by landfill or incineration of combustible waste.

Source: CDWaste-ManageVET Project

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CONSTRUCTION BLUEPRINT

Summary: Management of C & D waste on site

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On-site waste minimisation operations for construction waste:

- ✓ **reusable and recyclable waste identification**
- ✓ **sorting and storing** – segregation of waste in large containers on –site, based on their subsequent use or type of material;
- ✓ **adequate and safe storage** to minimise the quantity of damaged material on-site;
- ✓ **prevention of materials damage**, mixing or contamination during handling;
- ✓ **processing on-site for waste re-use** – some waste like slabs, tiles, plasterboard;
- ✓ **processing on-site for material recycling** (on-site) or transportation for off-site treatment of some waste like: concrete, plasters, asphalt.
  - size reduction – e.g. by crushing, shredding; size separation - by screening; compaction, using on-site compactors; storing on-site before transportation to an offsite treatment facility;
- ✓ **on-site re-use of materials;**
- ✓ **on-site use of the remaining soil;**
- ✓ **documenting methods** to deal with the specific of wastes.

Source: CDWaste-ManageVET Project

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Summary: Management of C & D waste on site

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On-site waste minimisation operations for demolition waste

- The quantities of waste generated on construction, renovation and rehabilitation-sites are smaller than during demolition, more diverse, but can be managed much easier**. The main operations that are applied in demolition activities are similar with those applied on construction-sites, excepting the main step of dismantling/demolition of construction.**

- Before any preparing for re-use, recycling or recovery, the following operations should be performed:

1. **removal of hazardous waste;**
2. **sorting and storage** of hazardous, reusable and recyclable waste;
3. **processing on-site for material re-use** – e.g., some waste like slabs, tiles, plasterboard;
4. **processing on-site for material recycling or recovery** (e.g. for backfilling) – some waste like concrete, plasters, asphalt, including **size reduction, storing** and **storing**.

Source: CDWaste-ManageVET Project

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Case study 4- *CDW Management in practice*

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Besides from regulations and economic incentives, the successful management of CDW comes down to the actual working practices on the construction site. The following case study reveals details of the daily work in the construction process, which can be improved for a smooth transition toward better collection of CDW.

Swedish construction and property development company NCC

CDW management (CDWM) challenges may range from technological ones to language barriers. The Swedish NCC case shows that the main CDWM practices employed on the construction site are the **use of prefabricated components, the use of color-coded waste containers, the sorting, the recycling of waste and just-in-time (JIT) delivery strategy.** JIT refers to the concept of lean management; materials are delivered just when they are needed and are not stored on site, unnecessarily occupying space.

Source: CDWaste-ManageVET Project

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Case study 4- *CDW Management in practice*

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- Construction workers on site were international and not fluent in the construction management language- difficulties in the instructing regarding waste disposal occurred. The construction company solved this **by distributing small brochures with information in three languages.**

- Additionally, challenges were a general lack of awareness and of understanding on how to sort the wastes and practical issues such as shortage of space, causing the location of waste containers to be too far from the work location on the construction site**. Inadequate space means that there might not be enough space for both recycling equipment and waste containers, which could be the case in densely populated areas.** In such cases, noise levels and dusts caused by the recycling works are challenging issues as well.

Source: CDWaste-ManageVET Project

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Case study 4- *CDW Management in practice*

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- The absence of an **agreement with subcontractors, such as electrical subcontractors, on the construction site regarding waste management** was identified as a hindrance to adequate CDW Management.

- A recycling company subcontractor was engaged for the collection of the waste, but other subcontractors lack incentives to actively participate in the adequate waste management.

- Another on site issue was the **lack of shelters for waste containers, leaving the CDW exposed to various weather conditions.** With certain materials, such as gypsum, this could pose difficulties with the further transportation of the waste, since it absorbs rainwater and becomes heavier to move and manage, which drives up costs of managing.

Source: CDWaste-ManageVET Project

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Learn More!!

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The following link gives access to a video where it is explained how reuse of waste construction components could be made much more common.

Link: https://www.youtube.com/watch?v=r0Ejq_4GXEA

Source: https://www.ucl.ac.uk/circular-economy-lab/affiliated_projects/opportunity_waste

The following link gives access to a video with an example of the C&D Waste recycling process.

Link: https://www.youtube.com/watch?v=nl5_Jx4-gPw

Source: http://www.iconic3d.gr/

Asbestos hazards in renovations, restorations, and demolition https://www.youtube.com/watch?v=PQd_UDBp8nA

Source: CDWaste-ManageVET Project

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Assessment

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