EU Construction & Demolition Waste Management Protocol

including guidelines for pre-demolition and pre-renovation audits of construction works

Updated edition 2024

Updated by
Anke Oberender, Thilde,Fruergaard Astrup, Sofie Frydkjær Witte (Danish Technological Institute)
Marco Camboni, Francesca Chiabrando, Monika Hayleck, Rūta Akelytė (RPA Europe)
August – 2024

EUROPEAN COMMISSION

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW)
Directorate H (Ecosystems III: Construction, Machinery & Standardisation)
Unit H.1 Construction
Contact: GROW CONSTRUCTION
E-mail: GROW-CONSTRUCTION@ec.europa.eu
European Commission
B-1049 Brussels

EU Construction & Demolition Waste Management Protocol

including guidelines for pre-demolition and pre-renovation audits of construction works

Updated edition 2024

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

2024 EN

Manuscript completed in August 2024

Revised 2024 edition, first published 2016

LEGAL NOTICE

PDF	ISBN 978-92-68-18900-9	doi: 10.2873/77980	ET-02-24-753-EN-N

Luxembourg: Publications Office of the European Union, 2024

Table of Contents

Table of Contents ..... **v**

List of abbreviations ..... **viii**

Glossary ..... **x**

Summary and main recommendations ..... **xiv**

1. Introduction **1**

1.1. Aim, scope and target of the Protocol 1
1.2. Principles of the Protocol 4
1.3. Revision and update of the Protocol and its structure 5
1.4. Terms and definitions 7

2. Renovation or demolition? **8**

3. Identification of CDW and construction products through pre-demolition and pre-renovation audits **11**

3.1. What is a pre-demolition or pre-renovation audit? 11
3.2. What are the benefits of an audit? 12
3.3. When is an audit carried out? 13
3.4. What is the threshold for carrying out an audit? 13
3.5. Who participates in the audit process? 14
3.6. What are the steps of an audit? 15
3.6.1. How to scope the audit? 16
3.6.2. Desk study 17
3.6.3. Field survey 19
3.6.4. Inventory of materials and construction products 23
3.6.5. Resource management recommendations 25
3.6.6. Reporting 26
3.7. Quality assessment of audits 28
3.7.1. Requirements for auditors 28
3.7.2. Traceability 29

4. Selective demolition **31**

4.1. Improve source separation 32
4.2. Removal of hazardous substances and materials 34
4.3. Selective demolition and dismantling 37
4.3.1. Onsite operations 38
4.3.2. Packaging waste 39

4.3.3. Documentation is essential....39

5. Waste logistics 41

5.1. Transparency, tracking and tracing 41

5.2. Improve logistics 41

5.3. Stockpiling potential and proper stocking 42

6. Waste processing and treatment 44

6.1. A variety of waste processing and treatment options 44

6.1.1. Hazardous waste should be kept separate from non-hazardous waste 44

6.2. Examples of onsite and non-onsite re-use 44

6.3. Preparing for re-use 46

6.4. Recycling 47

6.5. Other recovery 47

6.5.1. Other material recovery 47

6.5.2. Energy recovery 48

6.6. Disposal 48

7. Quality management and assurance 49

7.1. Quality of the primary process 49

7.1.1. Quality management at the waste identification, source separation and collection stages 52

7.1.2. Quality management during CDW transport 53

7.1.3. Quality management during CDW processing and treatment 53

7.2. Quality of products and product standards 54

8. Policy and framework conditions 55

8.1. An appropriate regulatory framework 55

8.1.1. Circularity and harmonisation with EU initiatives in the regulatory framework 55

8.1.2. Facilitating Re-use 56

8.1.3. Demolition and renovation permits and licenses 56

8.1.4. Integrated waste management strategies 56

8.1.5. Allow space for storage and recycling in public planning 58

8.2. Enforcement is key 59

8.2.1. Enforcement of landfill and incineration restrictions 59

8.2.2. A special word about enforcement of hazardous waste 59

8.2.3. Documentation is essential 60

8.3. Public procurement 60

8.4. Awareness, public perception and acceptance 60

Annex A Contributors 62

Annex B Hazardous substances and materials in construction works, hazardous properties and hazardous waste 65

Annex C Recommended templates for inventory of materials and elements and management recommendations 69

Annex D European list of waste 76

Annex E Overview of available treatment options 81

Annex F Checklist 83

Annex G References 86

List of abbreviations

ACW	Asbestos containing waste
BEMPs	Best Environmental Management Practices
BIM	Building Information Modelling
BMP	Building material passports
BREF	Best available techniques reference document
BRP	Building renovation passports
CDW	Construction & demolition waste
CFC	Chlorofluorocarbon
CLP	Regulation on the classification, labelling and packaging of chemical substances and mixtures
COEs	Organotin compounds
CPR	Construction Products Regulation
DBL	Digital building logbooks
DoP	Declaration of Performance
DPP	Digital Product Passports
EADs	European Assessment Documents
EC	European Commission
ECHA	European Chemicals Agency
EMAS	EU Eco-management and Audit Scheme
EPBD	Energy Performance of Building Directive
EPR	Extended Producer Responsibility
EPS	Expanded Polystyrene
ETA	European Technical Assessments
EU	European Union
EWC-stat code	Code following the statistical waste nomenclature EWC-stat
GHG	Greenhouse gas
GPP	Green Public Procurement
HCFC	Hydrochlorofluorocarbons
HDPE	High Density Poly Ethylene
hENs	Harmonised European Standards
HFC	Hydrofluorocarbon
HFRs	Halogenated organophosphate flame retardants
IT	Information technology
JRC	Joint Research Centre
LIDAR	Light Detection and Ranging
LoW-code	European List of Waste (LoW) Code
MFSU	Manufacture, formulation, supply and use
NGOs	Non-governmental Organisations
NIMBY	Not in my Backyard
NIR	Near-Infrared
PAH	Polycyclic aromatic hydrocarbon
PCBs	Polychlorinated biphenyls
PFAS	Perfluorinated and polyfluorinated alkyl substances
PFCs	Perfluorinated compounds
POPs	Persistent Organic Pollutants
PP	Polypropylene
PPE	Personal Protective Equipment
PS	Polystyrene
PU	Polyurethane
PVC	Polyvinyl chloride
RDF	Refuse-Derived Fuels
RDI	Relationship Development Intervention

SMEs	Small and medium-sized enterprises
SRDs	Sectoral Reference Documents
SRF	Solid Recovered Fuel
STOT	Specific Target Organ Toxicity
TRL	Technology Readiness Level
VOC	Volatile organic compounds
WFD	Waste Framework Directive
XRF	X-ray fluorescence

Glossary

Accreditation means an attestation by a national accreditation body that a conformity assessment body meets the requirements set by harmonised standards and, where applicable, any additional requirements including those set out in relevant sectoral schemes, to carry out a specific conformity assessment activity. [1]

Audit refers to pre-demolition audit and pre-renovation audit**.**

Auditor means the expert or the team of experts (auditors´ team) performing the audit. The auditor or the team of auditors can be appointed by the owner of the construction works or consultant (e.g. an architect or structure engineer) acting on behalf of the owner.

Authority means the national or regional administration responsible for granting the demolition or renovation permits and supervision of the demolition or renovation process.

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. [2]

CE Marking for construction products indicates that manufacturers take responsibility for the conformity of their products with the declared performance as well as the compliance with all applicable requirements of Regulation (EU) No 305/2011 or with Regulation (EU) 2024/… of the European Parliament and of the Council laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011 and in other relevant Union harmonisation legislation providing for its affixing. CE marking should be affixed to all construction products for which the manufacturer has drawn up a declaration of performance and conformity in accordance with the Construction Products Regulation. [3]

Certification is a procedure by which a third party gives written assurance that a product, process or service is in conformity with certain standards.

Construction and Demolition waste (CDW) means waste generated by construction and demolition activities, [2] with the following exceptions: (a) 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 and (b) waste waters (such as trade effluent disposed of via tankers, foul sewers, surface water drains, water courses, etc.).

Construction product means any formed or formless physical item, including 3D-printed products, or a kit that is placed on the market, including by means of supply to the construction site, for incorporation in a permanent manner in construction works or parts thereof, with the exception of items necessarily first integrated into a kit or another construction product prior to being incorporated in a permanent manner in construction works.[3]

Construction works means buildings and civil engineering works that may both be over or in the ground or water, including but not limited to roads, bridges, tunnels, pylons and other facilities for transport of electricity, communication cables, pipelines, aqueducts, dams, airports, ports, waterways, and installations which are the basis for rails of railways. [3]

Collection of waste means the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility. [2]

Deconstruction means the process of selectively and systematically dismantling construction works to reduce the amount of waste created and generate a supply of secondary materials that are suitable for reuse and recycling. [4]

Decontamination is the removal of hazardous substances and materials.

Elements means a physical part of a building or structure which can be removed as a whole for re-use, such as bricks, windows, doors, beams, installations, columns etc.

End-of-waste status is achieved when waste which has undergone a recycling or other recovery operation complies with the following conditions:

(a) the substance or object is to be used for specific purposes;

(b) a market or demand exists for such a substance or object;

(c) the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and

(d) the use of the substance or object will not lead to overall adverse environmental or human health impacts.

Compliance with these conditions is assessed on the basis of national or Union-wide end-of-waste criteria. [2]

Extended Producer Responsibility (EPR) scheme means a set of measures taken by Member States to ensure that producers of products bear financial responsibility or financial and organisational responsibility for the management of the waste stage of a product's life cycle. [2]

Hazardous CDW means CDW which displays one or more of the hazardous properties listed in Annex III of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste.[2] Wastes listed as hazardous in the European List of Waste [5] are marked with and asterisk (*).

Hazardous substance or mixture means a substance or a mixture meeting the criteria for classification as hazardous in accordance with Regulation (EC) No 1272/2008. [6]

Inert waste means waste that does not undergo any significant physical, chemical or biological transformations. 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. [7]

Integrated waste management plans and strategies means a geographically based plan that promotes and supports the CDW management.

Inventory means the list of types and quantities of materials, construction products with potential for re-use, and CDW materials.

Labelling means affixation of a label or symbol indicating that compliance with standards has been verified. Use of the label is usually controlled by the standard-setting body. Where certification bodies certify against their own specific standards, the label can be owned by the certification body.

Landfill means a waste disposal site for the deposit of the waste onto or into land (for instance underground), including:

- internal waste disposal sites (for instance own waste disposal carried out by the producer of waste at the place of production), and
- a permanent site (older than one year) which is used for temporary storage of waste, but excluding:
    - facilities where waste is unloaded in order to permit its preparation for further transport for recovery, treatment or disposal elsewhere, and

- storage of waste prior to recovery or treatment for a period less than 3 years as a general rule,
- storage of waste prior to disposal for a period less than 1 year. [7]

Material recovery means any recovery operation, other than energy recovery and the reprocessing into materials that are to be used as fuels or other means to generate energy. It includes, *inter alia*, preparing for re-use, recycling and backfilling. [2]

Owner of the construction works means the owner of the buildings or civil engineering works, the developer or the party identified by the national legislation as the original waste holder.

Pre-demolition audit means a preparatory activity with the purpose of (1) collecting and assessing information about the qualities and quantities of construction products for re-use, CDW materials with the potential for preparing for re-use and recycling as well as other types of CDW materials that will be released during the demolition works; and (2) giving general and site-specific recommendations regarding the demolition process. An important part of the pre-demolition audit is also the identification of materials containing hazardous substances or mixtures and those that might hinder re-use or recycling.

Preparing for re-use means 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. [2]

Pre-renovation audit means a preparatory activity with the purpose of (1) collecting and assessing information about the qualities and quantities of construction products for re-use, CDW materials with the potential for preparing for re-use and recycling as well as other types of CDW materials that will be released during the renovation works and (2) giving general and site-specific recommendations regarding the renovation process. An important part of the pre-renovation audit is also the identification of materials containing hazardous substances and those that might hinder re-use or recycling.

Primary processes refer to the steps from the audit process to selective demolition, waste logistics and waste processing.

Quality assessment means the collection and analysis of data to determine the degree of conformity with predefined criteria or objectives.

Quality assurance is part of quality management focused on providing confidence that quality requirements will be fulfilled. [8]

Quality management can include establishing quality policies and quality objectives, and processes to achieve these quality objectives through quality planning, quality assurance, quality control, and quality improvement. [8]

Re-use means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived. [2]

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. [2]

Recycling means 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. [2]

Refuse-Derived Fuels means waste that is used entirely or to a large extent for the purpose of energy generation. Waste materials which are generally reusable as RDF include tyres, rubber, paper, textiles, exhausted oils, wood, plastics, industrial waste, hazardous waste and municipal solid waste.

Renovation means modification and improvements to an existing plant, building, or civil engineering works in order to bring it up to an acceptable condition. [9]

Resource management plan sets out the approach to demolition or renovation, the treatment and logistics of the materials identified in the pre-demolition or pre-renovation audit.

Scavenging is the activity of identifying usable materials that takes place after demolition; in this context, particularly re-usable products and recyclable materials.

Selective demolition means removal of materials from a demolition site in a pre-defined sequence in order to maximise recovery and recycling performance. It involves sequencing the demolition activities to allow the separation and sorting of building materials and products. Selective demolition ensures the removal and safe handling of hazardous substances and mixtures and facilitates re-use and high-quality recycling by selective removal of materials and products in a pre-defined sequence. [2]

Separated collection means collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment. [2]

Stockpiling location is a platform for storing waste that can be moved.

Stripping-out is the activity of removing all materials from construction works that takes place before demolition.

Third party means a person or organisation that is not direct part of an activity or contract or transaction.

Traceability means the tracking and documentation of the movement and management of (waste) materials. To ensure compliance with rules and encourage transparency, it requires tracking information about origin, transit, treatment and final disposal.

Waste means any substance or object that the holder discards or intends or is required to discard. [2]

Waste holder means the waste producer or the natural or legal person who is in possession of the waste. [2]

Waste management means the collection, transport, recovery (including sorting), 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. [2]

Waste producer means anyone whose activities produce waste (original waste producer) or anyone who carries out preprocessing, mixing or other operations resulting in a change in the nature or composition of this waste. [2]

Waste transfer station is 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. [10]

Waste treatment means recovery or disposal operations, including preparation prior to recovery or disposal.

Summary and main recommendations

The EU Construction & Demolition Waste Management Protocol aims to enhance confidence in CDW management processes and increase trust in re-used products and recycled materials. As CDW is the largest waste stream in the EU, better CDW management can deliver significant environmental, economic and social benefits.

The Protocol covers the full CDW management process, providing guidance on:

- **Waste identification through pre-demolition and pre-renovation audits.** Audits before demolition or renovation are crucial for identifying re-use potentials, hazardous substances and mixtures, waste quantities and streams. Audits involve desk studies of building documentation, site surveys, sampling/testing, and recommendations on waste management options. Auditor competence and traceability are important for quality assurance.
- **Selective demolition.** Selective dismantling enables safe removal of hazardous substances, mixtures and materials (e.g. asbestos) and improves source separation for re-use, recycling and recovery. The starting point of selective demolition is the preparation of a demolition plan detailing the sequence, roles, logistics and documentation. Selective demolition ensures the segregation of hazardous wastes from non-hazardous wastes.
- **Waste logistics.** Documentation ensures transparency and traceability which are key for CDW management. Logistics should minimise transportation distances, use transfer stations efficiently, and ensure proper stockpiling to maintain material quality and mitigate environmental risks such as dust and run-offs.
- **Waste processing and treatment.** The waste hierarchy (prevent, reduce, prepare for re-use and re-use, recycle, and recover) is the compass for CDW management. The Protocol covers available treatment options for various waste streams - concrete, plastic, metal, glass, wood, gypsum, insulation etc. It highlights options for re-use on- and off-site, preparing for re-use through cleaning and repairing, recycling, and other recovery.
- **Quality management**. Ensuring quality at all stages - audits, demolition, logistics and treatment - is crucial for building confidence in re-used products and recycled materials. This involves monitoring, documentation, certification schemes, product standards and end-of-waste criteria where applicable.
- **Policy framework.** The Protocol provides recommendations for authorities on developing conducive regulations, strategies and enforcement mechanisms.

Overcoming regulatory, economic, technical and social barriers requires concerted efforts and cooperation between industry, authorities and society. The Protocol emphasises shared responsibility, from identifying re-use opportunities to ensuring quality recycled materials, to facilitate circularity in construction and demolition activities across the EU.

Main Recommendations:

For industry practitioners:

- Conduct pre-demolition/pre-renovation audits to identify re-use potential, hazardous materials, and waste streams.

- Implement selective demolition to enable safe removal of hazardous materials and improve source separation.
- Ensure proper waste logistics - tracking, transportation, stockpiling to maintain material quality.
- Prioritise waste treatment options following the hierarchy - re-use, preparing for re-use, recycling, other recovery, disposal.
- Implement quality management through monitoring, documentation and certification along the value chain.

For public authorities:

- Develop regulatory frameworks promoting circularity, extended producer responsibility and proper hazardous waste management.
- Facilitate re-use markets through platforms, standards and reducing legislative obstacles.
- Include re-use, recycling and circularity requirements in demolition/renovation permits.
- Implement integrated waste management strategies with economic instruments such as landfill taxes.
- Enforce landfill/incineration restrictions and regulations on hazardous substances.
- Allocate space for CDW storage/recycling facilities through urban planning.
- Raise awareness, provide training and develop skills for circular construction practices.
- Lead by example through green public procurement criteria for construction works.

1. Introduction

1.1. Aim, scope and target of the Protocol

1. Construction and demolition waste (CDW) is the **largest waste stream in the EU**, representing almost 40% of the total waste generated. [11] It is estimated that the total CDW outflow as a result of demolition and renovation activities will double, in absolute terms, between 2020 and 2050. [12] The amount of recovered CDW has increased over time, thanks to EU initiatives promoting preparing for re-use and recycling. However, most CDW is treated primarily by backfilling or low-grade recovery. Although re-use, preparing for re-use and recycling options exist, they are not sufficiently implemented. Evidence also shows that by increasing re-use, preparing for re-use and high-quality recycling of CDW in the EU, significant amounts of GHG emissions could be saved, thereby providing an important contribution to mitigating climate change. More material efficiency and circularity in CDW management could contribute to the overall circularity of the EU economy, the reduction of environmental impacts from mining and production of primary raw materials as well as EU access to critical and strategic raw materials. [13, 14] The **waste hierarchy provides clear guidance on the prioritisation of waste management options** and should be considered in C&D projects and CDW management.

Figure 1 The compass for EU waste management is the five-step «waste hierarchy» set up in the Waste Framework Directive. It establishes an order of preference for managing and disposing of waste [2]

Regulatory, technical, economic and awareness barriers hinder the widespread preparing for re-use and recycling of CDW in the EU. [14] CDW management varies country by country and depends on national legislation, established practices and infrastructure. Poor demolition and collection practises represent a bottleneck, as resources from demolition and renovation may often be contaminated and cannot easily be prepared for re-use or recycled. Perceived high costs of recycling and other economic constraints contribute to the lack of well-functioning markets for some CDW fractions, and the lack of knowledge of recycling schemes and other solutions and coordination between actors represents yet another barrier.

2. The '**EU Construction & Demolition Waste Management Protocol'** and the **'Guidelines for waste audits before demolition and renovation works of buildings'** were initially published in, respectively, 2016 and 2018. Their **aim** was to increase confidence in the CDW management process and the trust in the quality of CDW recycled

materials, by sharing a set of rules and best practices to function as inspiration for practitioners and policymakers.

3. While the objective of the revision of the Protocol — which now incorporates the guidelines for audits before demolition and renovation works of buildings — is to bring the document in line with recent policy and technological developments, its **overall aim** remains unchanged:

This revised Protocol aims to enhance CDW management processes at all stages of the value chain and increase the confidence in the quality of products prepared for re-use and materials for recycling. This document sets a number of rules and includes examples of best practices, technologies and tools from across the EU in the following areas:

- **Identification of CDW and construction products through pre-demolition and pre-renovation audits**
- **Selective demolition**
- **Source separation and collection**
- **Preparing for re-use and recycling**
- **Waste logistics**
- **Waste processing**
- **Quality management**
- **Policy and framework conditions.**

Achieving the aims of the Protocol requires know-how and cooperation between all stakeholders of the value chain.

4. It is expected that the Protocol will support practitioners in Members States in achieving the measures introduced by the **Waste Framework Directive (WFD)**, [2] i.e.: the promotion of selective demolition for the safe handling of hazardous waste, the facilitation of preparation for re-use and recycling, the establishment of sorting systems for certain CDW fractions, and the achievement of the recovery target for CDW established by the European Commission.

5. Furthermore, the Protocol is expected to support practitioners in Member States in achieving the goals set out in the '**European strategy for the removal of all asbestos**' to protect workers and citizens from health risks related to exposure to asbestos. [15] Construction works — including renovation and demolition activities — and management of CDW pose the highest risk of exposure to asbestos, due to the widespread historical use of asbestos-containing products in the construction sector. [16]

6. The Protocol is also expected to support the **reduction of intentional and unintentional microplastic releases** into the environment. Although construction materials are excluded from the scope of the EU sale restriction (Annex XVII of the REACH Regulation), the release of microplastics into the environment as a result of CDW management is to be minimised. [17]

7. The Protocol is referenced by the Climate Delegated Act [18] and the Environmental Delegated Act [19] of the EU '**Taxonomy Regulation**') [20]: it sets some of the conditions to be met by economic activities in the construction and real estate sector to qualify as environmentally sustainable.

*8. The **scope of the Protocol** includes waste from construction, renovation and demolition works (*

) and waste management processes that ensure that resources can enter the next production system. Audits before renovation and demolition of construction works and selective demolition of end-of-life construction works are given prominence in this Protocol since both processes play central roles in the establishment of circular value chains, as they ensure the identification of construction products for re-use and preparing for re-use and materials for recycling. They also ensure the identification and effective removal and disposal of hazardous substances and mixtures as well as problematic materials that may hinder re-use or recycling. Audits are a pre-requisite for the efficient removal and management of resources that can enter the market again. The Protocol addresses all steps of the values chain.

The Protocol excludes, however, the production phase of new materials or construction products, the design [21], building process and use phase, as well as waste prevention in general. The Protocol excludes excavation and dredging soils. Regarding geographic coverage, this Protocol has been developed for application in all 27 Member States of the European Union.

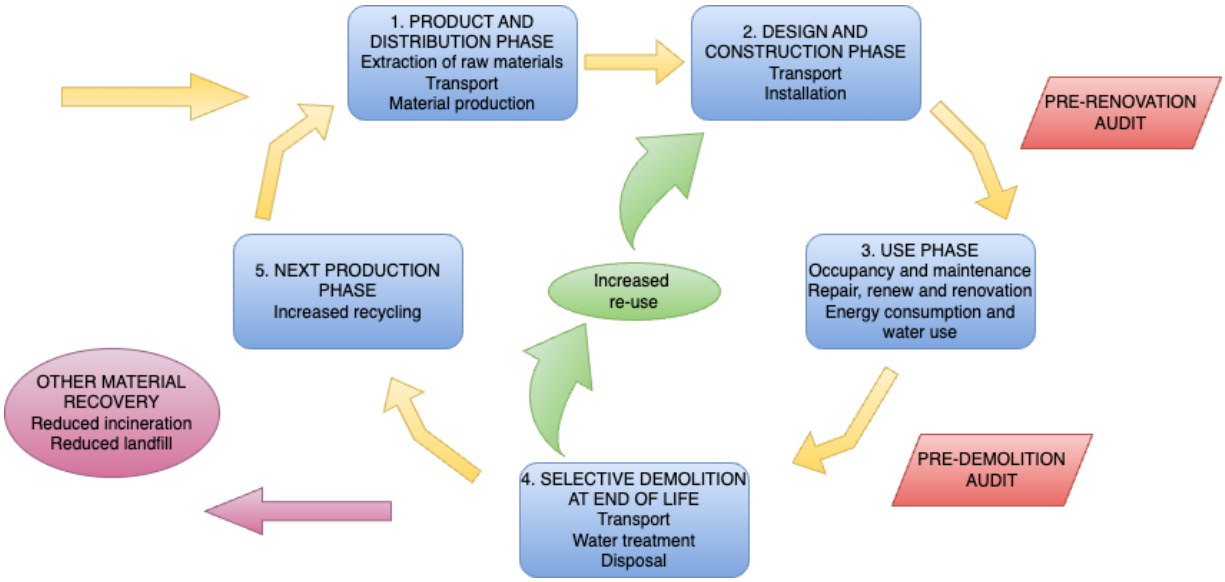


Figure 2 The demolition process as a crucial part of the circular value chain in construction (adapted from Værdibyg [22] in light of feedback received at the workshop)

9. The Protocol has the following **target groups**:

- Industry practitioners; construction sector (including renovation companies and demolition contractors), construction product manufacturers, waste treatment, transport and logistics providers as well as recycling companies;
- Public authorities at local, regional, national and EU levels;
- Quality certification bodies for construction works;
- Clients of demolition and renovation works;
- Clients of re-used products and CDW recycled materials.

Awareness, public perception and acceptance play an important role in achieving the aim of the Protocol. The information given in the protocol can support the work of educational instutions, learning centres, business associations etc. and in training and the development of a skill base.

1.2. Principles of the Protocol

In implementing the Protocol across the CDW management process, the following principles should be considered:

Principle 0: Legislative framework and support through policy

Fulfilling EU and national legislative requirements for CDW management is the basic principle of the Protocol. Member States are encouraged to develop legislative frameworks as well as national-level protocols in line with the objectives, principles and practices presented in this protocol.

Principle 1: Market-based and promoting competitiveness

This Protocol is based on practices and technologies adopted on the EU market and takes full account of the costs and benefits (including environmental ones) of CDW management. It is voluntary in nature, unless otherwise specified.

Principle 2: Ownership by practitioners and acceptance and support from policy makers

To ensure the widest recognition and adoption possible, the Protocol and its revised edition have been developed in a co-creation process with industry, stakeholders, Member State authorities and the European Commission.

Principle 3: Transparency and traceability throughout the CDW management process

Traceability is essential to guarantee that value can be derived from CDW treatment. Selective demolition along with traceability systems and technologies are key in ensuring transparency in CDW management and therefore quality in (prepared for) re-used products and recycled construction and demolition materials.

Principle 4: Promoting certification and audits throughout the entire process (enforceability)

The ‘weakest link’ principle means that efforts to increase quality and confidence are only worthwhile if they are made along the complete waste management chain. To assure a certain minimum level of quality along the entire waste management process, auditing and certification are important tools for increasing quality and confidence in (prepared for) re-used products and recycled construction and demolition materials. The Protocol focuses both on processes and products thereof.

Principle 5: No need to reinvent the wheel

The Protocol builds on standards, guidelines, protocols, best practices and certification schemes, notably the harmonised structure set in place in or by means of the Construction Products Regulation. [3] The Protocol is based on the highest common denominators that can be found at the time of writing and uses the findings from a wide range of studies and ongoing processes. Practitioners and policy makers are encouraged to apply this principle in their work with the development of new tools and legislative frameworks and guidance.

Principle 6: Location

Local circumstances including the scale and the surroundings of the project influence the potential of re-use and CDW management. The improvement of logistics supports circular supply chains and reduces resource consumption, waste, emissions and costs while boosting resilience.

Principle 7: Respecting environmental, health and safety rules and standards

Certain CDW treatment operations should not be promoted if this comes at the cost of the environment, health or safety. The Protocol builds on existing standards such as ISO14001 for the environment, OHSAS18001 or ISO45001 for occupational health and safety and other CEN standards.[23] It also promotes the uptake within the sector of the EU Eco-management and Audit Scheme (EMAS) as a tool to evaluate, report and improve the environmental performance of organisations.[24]

Principle 8: Data collection and generation throughout the CDW management process

The collection and generation of data and statistics for better policies and practices needs to be improved, also allowing for comparison between Member States. This requires tracking and tracing of all CDW. For the purpose of data comparability, it is important to use common names for the different CDW fractions.[25]

1.3. Revision and update of the Protocol and its structure

10. **The revision of the Protocol and waste audit guidelines** was initiated by the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, and awarded to RPA Europe S.R.L. and the Danish Technological Institute. Industry experts have played a major role in developing the Protocol, supported by the feedback, input and guidance from public sector officials. Annex A provides an overview of the contributors to this work.

The general objective of this work was to build on the work done in 2016 and 2018 by updating the Protocol and the waste audit guidelines in light of the evolution of technologies, practices and legislation, supporting industry in a shift to a circular economy by considering stakeholders' needs and the diversity of CDW management practices across the EU27 Member States.

11. The Protocol is structured to provide comprehensive information on various aspects of the CDW management chain and **guidance for the readers of the document is enclosed below**. Depending on your role or area of interest, you may focus on specific sections relevant to your work. The flow diagram (Figure 3) at the beginning of each chapter shows you which of the five components of the CDW management chain the chapter addresses. Consult the boxes in the document for information on best practice examples, links to relevant initiatives or more detailed information on specific topics. Consult the annexes for supplemental information and templates, which can be useful for the practical implementation of the Protocol.

Figure 3 Components of the CDW management chain

Understanding the Protocol and practical implementation: The Protocol is structured in seven sections. The first five sections are based on the CDW management process and are addressed to businesses and associations in this field; the last two sections are of a horizontal nature and are addressed to all actors of the entire value chain, including public authorities. The sections are:

- **Chapter 2 Renovation or demolition:** This section provides and overview of the factors to be considered in deciding whether a construction works should be demolished or whether renovation is to be preferred.
- **Chapter 3 Identification of CDW and construction products through pre-demolition and pre-renovation audits:** Review this section to understand the importance of audits before demolition and renovation, including the benefits and the key steps involved in conducting an audit.
    - Consult annex B to get information on hazardous substances and materials in construction works, hazardous properties and hazardous waste.
    - Check Annex C for illustrative templates for inventories and guidance on the decision-making process in the formulation of the inventory and management recommendations.
    - Annex D provides you with information on the European list of waste with a focus on materials from demolition and renovation activities.
- **Chapter 4 Selective demolition:** Focus on this section to get information on the advantages of selective demolition to enhance material recovery – specifically re-use, preparing for re-use and recycling, and waste management efficiency. Furthermore, this section provides information on improved source separation and collection, and the removal of hazardous substances.
- **Chapter 5 Waste logistics:** This section gives you insights into the proper handling, transportation, and storage of used products and waste materials.
- **Chapter 6 Waste processing and treatment:** Explore the various options for re-use and preparation for re-use and processing and treatment of waste, emphasizing recycling and re-use. Refer to annex E for an overview of available treatment options for different CDW fractions.
- **Chapter 7 Quality management and assurance:** Quality management and assurance is crucial in increasing confidence in CDW management processes and the trust in re-used products and recycled materials. It is also crucial for regulatory compliance and operational overview, and can also aid in the continuous improvement of processes. Learn about the quality control measures necessary to maintain high standards throughout the waste management process.
- **Chapter 8 Policy and framework conditions:** Successful CDW management as set out in the Protocol can only be achieved if the appropriate policy and framework conditions are in place. This section addresses those aspects and is specifically

aimed at public sector representatives, in order to support the dialogue between the public and private actors in the CDW value chain.

- **Annex F Checklist** provides an outline of the most important steps to follow in order to achieve the goals of the Protocol.

1.4. Terms and definitions

12. The use of **specific terms and clear, unambiguous definitions** enhances knowledge and understanding and supports dialogue and awareness among stakeholders along the value chain. Where terms are defined in EU legislation, standards and guidance documents, this Protocol refers to these definitions. However, developments in policies, practices and technologies in the field of CDW management and circular economy over the past years have also resulted in the emergence of new terms and concepts that are not yet defined in EU legislation. Some of these terms have been defined in documents and legislation at national level, but with different terminologies across Member States.

13. **Re-use of construction products and recycling of materials** can achieve a higher degree of material efficiency, environmental quality and circularity. As re-use gives continued lives to products that would have become waste, it is not strictly speaking a part of waste management or waste treatment. Therefore, a distinction is made throughout the text between — on the one hand — re-use (which is part of waste prevention), and — on the other hand — preparing for re-use and recycling (which are waste management operations).

Box 1 - From waste audit to pre-demolition/pre-renovation audit

- The terms *pre-demolition audit* and *pre-renovation audit* in the context of the Protocol build on the term *waste audit*[1] and reflect the development of the auditing process that has taken place over the past years, with an increased focus on improvement of re-use, preparing for re-use, recycling and the development of circular solutions in the construction value chain.
- It is typically easier to collect information on which construction products can be re-used and which materials can be recycled at the same time as information on CDW is collected. Moreover, both the assessment of construction products to be re-used and the assessment of CDW management routes prior to demolition and renovation activities is dependent on the identification of hazardous substances. However, in practise this is not always the case.
- For the purpose of this Protocol, the term “audit” refers to a preparatory activity with the objective of (1) collecting information about the qualities and quantities of construction products for re-use and preparing for re-use and CDW materials with the potential for recycling as well as other types of CDW materials that will be released during the demolition or renovation works and (2) giving general and site-specific recommendations regarding the demolition or renovation process. An important part of the audit is the identification of materials containing hazardous substances and those that might hinder re-use or recycling prior to demolition or renovation.

[1] The term *waste audit* was used in the ‘Guidelines for waste audits before demolition and renovation works of buildings’ which were published in 2018.

2. Renovation or demolition?

1. **Waste prevention and the reduction of resource consumption** are at the top of the waste hierarchy. Regular and extraordinary maintenance of construction works supports these priorities. When maintenance is not an adequate option, renovation or demolition may be necessary. Before demolishing construction works, it should always be investigated and assessed whether renovation can obtain the desired result more efficiently. Economic, environmental and technical factors must be considered before deciding between renovation or demolition.

For buildings, demolition and construction of new buildings according to new performance standards is typically regarded as best practice when it results in the reduction of the use of operational energy[2]. However, when considering the whole life cycle of a building — also taking into account the environmental impact of demolishing the old building and the embodied energy and carbon emissions from manufacturing the materials for the new building — **renovation is often the best solution**. Renovation of existing construction works can reduce the use of virgin or primary materials, prevent waste and greenhouse gas (GHG) emissions. Furthermore, following the waste hierarchy, renovation of existing construction works contributes to prevention of waste. Similarly, renovation or upgrade of infrastructure works can be preferable to demolition and reconstruction when the full life cycle impacts are considered.

2. There may be many reasons why a building or infrastructure needs to be demolished, including due to disasters or conflicts. If it is not possible to preserve and renovate a building or infrastructure, the opportunity to minimise resource and energy use must be investigated early in the process. **Re-use and preparing for re-use of construction materials and components offer large resource and energy saving potentials with important GHG emission savings**. This underpins the importance of removing barriers associated with re-use, preparing for re-use and recycling of CDW.

3. There is a need to record, store and provide access to construction works' data. **Digital building logbooks (DBL) can provide a single point of entry of verified and trusted building data** by connecting and integrating existing data sources such as Building Renovation Passports (BRP), Building Material Passports (BMP) and Digital Product Passports. [26]

Box 2 - Post-conflict and post-disaster reconstruction

The recovery process after a disaster or a conflict involves extensive, simultaneous construction efforts, and offers opportunities to implement significant enhancements through (re)construction, including measures to enhance hazard resistance, durability, water and sanitation provisions, or environmental sustainability.

Different kinds of assessments are carried out by local and national authorities, usually with the support of international actors such as the UN, the World Bank, and other assistance and financial institutions. The approaches include (but are not limited to) the Rapid Damage

[2] The energy used by a building during its day-to-day operation, including lighting, heating, cooling, and ventilating systems, and operating appliances.

and Needs Assessment (RDNA), the Post-Disaster Needs Assessment (PDNA), and the Global Rapid Post-Disaster Damage Estimation (GRADE).

The approaches broadly follow the same structure but can contain elements that vary depending on whether the needs assessment is carried out during/after a conflict or after a natural disaster. The main steps include[3]:

- Preliminary estimations of the scale of damages and losses to buildings, along with the amount of debris produced from the collapse and demolition of so many structures (percentages of houses damaged, total housing damages in monetary terms, etc.).
- The estimations for reconstruction and recovery needs in housing incorporate allowances for both physical and financial uncertainties, as well as extra expenses associated with adhering to stringent seismic resilient building regulations.
- A housing recovery framework, which must be based on effective urban planning guidelines, enforceable development regulations, and robust building by-laws.

The needs assessments identify several actions to be taken in the short-, medium- and long-term that can safeguard households, kick-start recovery, and provide a base for longer-term recovery. The recommended actions include:

- Decontamination, demolition, and debris removal. Initiating the decontamination, demolition, and clearance of debris from buildings that are destroyed or damaged is crucial to ensure the safety of the population and to expedite repairs and reconstruction. In this context, it is essential to develop a disaster debris management plan, including costs associated with dismantling and removal, disposal of demolition waste, and purchase of special equipment. The plan will also foresee safe separation of hazardous waste from non-hazardous waste which can be used in reconstruction efforts (e.g., building rubble).
- In the event of natural hazards like earthquakes, thorough studies involving micro-zoning and site investigations will be conducted in areas identified through comprehensive geological surveys. Adhering to scientific recommendations regarding seismic resistance is imperative during reconstruction efforts. Additionally, geotechnical research will be essential, particularly in regions where the ground may not be stable for rebuilding. This may necessitate exploring new locations within the same neighbourhood or nearby, guided by expert assessments that consider factors such as potential liquefaction and soil amplification maps. Plans for potential relocation may also be developed based on these evaluations.
- Continuously enhance both technical expertise and workforce capabilities to ensure the construction of resilient structures.
- In case of natural hazards such as earthquakes, use satellite-based products from the Copernicus Emergency Management Service for monitoring post-disaster reconstruction efforts, providing statistical data and descriptions of progress compared to baselines and subsequent updates, including calculations of reconstruction rates and impacted populations.
- The training of those who will be directly involved in housing reconstruction programs can play a decisive role in ensuring the quality and disaster resilience of the reconstructed housing.

[3] For example: https://documents1.worldbank.org/curated/en/099093003162314369/pdf/P1721710e2b4a60b40a5940f0793f8a0d24.pdf

Building Back Better

Apart from the housing reconstruction and rehabilitation initiative, it is crucial to integrate principles of disaster resilience, "building back better" (BBB), climate-neutrality, and inclusivity across the entire reconstruction process. The United Nations Office for Disaster Risk Reduction (UNDRR) defines Building Back Better (BBB) as “the use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies and the environment”. [27]

Training in BBB principles should be provided to architects, construction firms, local authorities and other stakeholders to facilitate housing rehabilitation and reconstruction.

Box 3 - Definition of a digital building logbook [26]

- A digital building logbook is a common repository for all relevant building data. It facilitates transparency, trust, informed decision making and information sharing within the construction sector, among building owners and occupants, financial institutions and public authorities.
- A digital building logbook is a dynamic tool that allows a variety of data, information and documents to be recorded, accessed, enriched and organised under specific categories. It represents a record of major events and changes over a building’s lifecycle, such as change of ownership, tenure or use, maintenance, refurbishment and other interventions. As such, it can include administrative documents, plans, description of the land, the building and its surroundings, technical systems, traceability and characteristics of construction materials, performance data such as operational energy use, indoor environmental quality, smart building potential and lifecycle emissions, as well as links to building ratings and certificates. As a result, it also enables circularity in the built environment.
- Some types of data stored in the logbook have a more static nature while others, such as data coming from smart meters and intelligent devices, are dynamic and need to be automatically and regularly updated. A digital building logbook is a safe instrument giving control to users of their data and the access of third parties, respecting the fundamental right to the protection of personal data. Data may be stored within the logbook and/or hosted in a different location to which the logbook acts as a gateway.

3. Identification of CDW and construction products through pre-demolition and pre-renovation audits

1. High quality CDW management and increased preparing for re-use and recycling of CDW materials start with good-quality audits. **Pre-demolition and pre-renovation audits offer insights into quantities and types of materials, construction products and waste and best management options**, providing an overview of resources available for preparing for re-use or recycling and of which hazardous substances or materials to expect. Annex B offers an overview of hazardous substances and materials to be found in construction works. Asbestos is among the substances of highest concern when it comes to CDW management, due to its widespread historical use in the construction sector.

Some Member States have implemented mandatory requirements to ensure the implementation of audits, whereas other Member States have set voluntary schemes. Standardisation in this area is ongoing at national and international level.[4]

3.1. What is a pre-demolition or pre-renovation audit?

2. **A pre-demolition or pre-renovation audit** is an activity commissioned typically by the owner of the construction works to a third party – other than the demolition contractor. The audit results in the inventory of materials, construction products and waste arising from the future demolition or renovation projects, and their management and recovery options. [28]

3. Carrying out an audit before renovation or demolition of construction works is a specific task within the **project planning**. The audit provides essential documents for demolition permits, reliable material and CDW estimates and allows the identification of hazardous substances and materials in advance to manage them correctly. Moreover, it facilitates comparison with reporting of amounts and separation rates during or after renovation or demolition works.

4. The **aim** of the audit is to:

- Identify and localise hazardous substances present at the jobsite and hazardous wastes that will be generated during the demolition or renovation of the construction works;
- Provide a comprehensive inventory of the non-hazardous wastes – both non-contaminated and contaminated fractions;
- Identify building components and materials with a potential for re-use and recycling and provide a comprehensive inventory of what was identified and the condition of it;

[4] As an example, in Germany there is the *DIN SPEC 91484_2023-09 – Procedure to record building materials as a base to evaluate the potential for a high-quality reutilization prior to demolition and renovation work (pre-demolition audit)*. At the time of writing (April 2024), CEN TC 350 SC1 Circular Economy in Construction has established the *Task Group Pre-demolition and pre-redevelopment audits and evaluation* to assess the need for standardisation and harmonisation of pre-demolition and pre-development audits and evaluation at European level.

- Provide additional information requested by the owner of the construction works or authorities such as recommended waste management, value of released materials and components, their environmental footprint etc. [28]

5. An audit is necessary to understand the type and amount of construction products and materials that will be deconstructed and/or demolished and to issue recommendations on their further handling. An **assessment of the viable recovery routes for materials** should also be given (including re-use and the potential re-use value, recycling on- and offsite, and the associated cost savings and energy recovery).

6. The audit must also **consider any relevant legislation**, such as the requirements for environmental permits if waste is to be used on-site, or requirements on hazardous waste management. The audit's findings support the decisions of the authorities to approve the planned work. The audit report should be revised in light of the results of the construction, demolition, or refurbishment process.

3.2. What are the benefits of an audit?

7. Proper planning and management of renovation, demolition, or construction projects, especially for larger, yield **economic, health and environmental benefits**. Conducting an audit adds significant economic and environmental value to the project.

Audits can achieve the following:

- Increase re-use, preparing for re-use of products and recycling of CDW materials.
- Promote fair competition amongst contractors.
- Increase awareness and ease traceability processes. They help avoiding unexpected costs which may arise from the late detection of hazardous materials, as well as the risks to health and environment associated with such late detection.
- Support waste management by:
  - Determining the presence and estimating quantities of hazardous substances;
  - Providing recommendations to remove hazardous materials in an environmentally responsible and safe manner;
  - Ensuring higher environmental and technical quality of products and materials with potential for preparing for re-use and recycling, respectively.

8. Audits contribute to **better demolition waste management**. Knowing the quantities and nature of materials expected leads to the optimisation of works (how many containers; on-site versus off-site sorting; etc.).

9. Audits help clients to identify quantities and qualities of materials, construction products and waste and the best management option, with setting performance levels for (renovation and demolition) contractors, supporting site-specific waste management plans, demonstrating environmental credentials, ensuring safety of workers, increasing material and labour efficiency, reducing waste and maximising profit. Audits enable owners of construction works to include clauses reflecting its requirements in terms of **prevention and management of waste** from the site. In the absence of the audit, it is difficult for the owner to include qualitative (quality of sorting desired on site) or quantitative (re-use, recycling and recovery) requirements in the call for tenders and to monitor the management of waste from the site.

3.3. When is an audit carried out?

10. Ideally, **pre-demolition and pre-renovation audits should be performed as early as possible and before the call for tenders or hiring a company to carry out the work**. The audit report should be a part of the tender specifications but, as a minimum, they should be performed before applying for the demolition or renovation permit. By annexing the inventory to the call for tenders, the owner of the construction works transfers this information to the contractor, so that the offer is drawn up based on the materials present. This helps avoid unfair competition between companies and prevents "discovering" hazardous waste during demolition, which can result in unforeseen costs. [29]

The earlier the audit is carried out, the more time for decision and planning. The audit can give insights into possibilities for a renovation process to be carried out and the options for re-using products in the same or other projects. Knowledge from the audit can foster dialogue as early as the design phase for a project.

3.4. What is the threshold for carrying out an audit?

11. **There are no standardised threshold values for pre-demolition or pre-renovation audits** that apply uniformly across all EU countries. The regulations and guidelines regarding pre-demolition and pre-renovation audits, as well as waste management in general, may vary from country to country within the EU. Each Member State has the autonomy to establish its own rules and regulations based on EU directives. Hence, national authorities should decide upon the threshold and scope for audits.

Box 4 - Examples: Threshold and scope for audits

- In Austria, pre-demolition audit is mandatory for demolition projects with an estimated waste production of more than 750 tonnes. The requirements for the audit depend on whether the volume of the building is greater or smaller than 3,500 m^3.
- In Denmark, a screening and mapping with respect to hazardous substances must be carried out for buildings demolished or renovated and where more than 1 tonne of CDW is expected. An audit of the building must be carried out if the screening shows the potential presence of hazardous substances. There are also requirements on the removal of hazardous waste from CDW, which in practice means that contaminants other than PCB must be included in the inventories to fulfil this obligation.
- In Germany, the pre-demolition audit is, until now, mandatory only following the detection of harmful substances. These audits arise essentially due to the obligation to evaluate the risk and adopt safety measures when workers may be exposed to hazardous materials or materials containing dangerous substances. [30]
- In Flanders, pre-demolition audits are not mandatory, but a pre-demolition inventory of the types/quantities of materials present in buildings is mandatory for non-residential building with an enclosed volume over 1,000 m^3. Hazardous waste and other waste materials are to be identified. [31] Furthermore, the follow-up by a recognised demolition management organisation is mandatory (demolition follow-up plan for non-residential buildings with enclosed volume over 1000m^3 and

residential buildings with an enclosed volume over 5000 m^3), and a demolition certificate is required upon completion of the works.

- In Sweden, there is no threshold. Pre-demolition audits are always required. [31]
- In the Netherlands, Dutch municipalities require a pre-demolition audit for each demolition in which more than 10 m^3 of waste is produced. The audit corresponds to an inventory indicating the nature and quantity of expected waste and a statement regarding the intended destination of the materials. [30]
- In the Basque Country (North of Spain), a pre-demolition audit must be carried out for demolitions where the ground/soil or where the building/installation to be demolish is listed in the inventory of potentially contaminated soils – as elaborated by the government. Hazardous materials must be identified and removed under the supervision of an external environmental company, that must sign the "OK" to demolish before starting the demolition. Non-hazardous materials prior to and after the demolition, must be managed under the supervision of the external environmental company and the government.
- In France, a compulsory audit is to be carried out for any significant demolition and renovation operation whose cumulative floor area is greater than 1,000m^2 and operations involving at least one building that has hosted an agricultural, industrial, or commercial activity and has been the site for the use, storage, manufacturing, or distribution of one or more substances classified as dangerous. At the end of the work, and inventory check must also be carried out.
- In Norway, requirements are in place for carrying out an audit with respect to hazardous waste, CDW, and products with potential for re-use.
- In Portugal, the waste management legislation stipulates that in the case of demolition or renovation of public buildings or public infrastructures the producers of CDW carry out a pre-demolition audit. [32]

12. **The first step to allow correct management of asbestos waste is its identification. Screening for asbestos in buildings is mandatory in most Member States.** Although EU legislation sets out the framework, objectives and principles for asbestos containing waste (ACW) management, the detailed strategies and approaches for screening, removal and disposal are a national competence, and consequently the specific requirements vary across Member States. [16]

Many other hazardous substances can be found in a construction works, such as lead, chromium, PCBs, PFOS and PFOA etc (see also Annex B).

3.5. Who participates in the audit process?

13. The **actors** involved, the stages and responsibilities can vary, e.g. depending on the complexity of the intervention and the specific requirements in place. Typically, the actors involved are:

- The **owner of the construction works** is responsible for appointing an auditor to draw up a pre-demolition audit based on audit requirements, if those are set by national authorities. The owner is responsible for setting the scope and performance levels for the auditor and the contractors in case no mandatory requirements are in place/ or in case the owner strives to set a higher level of ambition;
- The **authority** issues demolition or renovation permits and should establish mechanisms to ascertain (directly or with the intervention of third parties) that pre-

demolition audits are performed including a quality check system and their recommendations followed;

- The **auditor or auditor team** is an expert or a group of experts responsible for the pre-demolition audit. The auditor or auditor team must have appropriate knowledge of current and historical building materials (including hazardous materials), current and historical building techniques and building history and familiar with demolition techniques, waste treatment and processing as well as with (local) markets. Since the skills required for carrying out audits with focus on construction products for re-use, CDW or hazardous materials are typically very different and generally not available from one single auditor, the audit is often carried out by a team of experts and/or with subdivided responsibilities within the overall process. See more information on the requirements for auditors in Section 3.7.
- The **contractor** is responsible for demolition/renovation operations defined in the contract with the owner. The contractor should contribute to the traceability aspects of waste and shall fulfil responsibilities for waste management;
- The **waste manager** is responsible for the appropriate management and disposal of the waste received from the waste holder or producer. The waste manager should also contribute to the traceability aspects of waste and that extended producer responsibility schemes – if such measures are in place - are followed;
- The **products manufacturer** may contribute to the audit providing solutions and/or requirements for the re-used products and/or recycled materials, as well as with respect to extended producer responsibility schemes.

3.6. What are the steps of an audit?

14. An audit should follow the steps depicted in Figure 4. The steps are further described in the following sections. An audit consists of two central parts:

- **Inventory of materials and construction products:** identification of all materials and construction products present and (waste) materials present in the construction works that will be generated during the demolition or renovation, with specification of the quantity, the quality and location in the construction works as well as how they are installed (glued, screwed, etc.). All materials should be identified and a good estimation on the quantity to be collected should be given. The inventory serves to inform those involved in the demolition or renovation activities and particularly about contaminants. Ideally, it is annexed to the call for tenders and used by the demolition contractor when drawing up the offer and the waste management plan. It will also be useful for monitoring the demolition or renovation project. In addition, containing information on hazardous substances, the inventory can be used to assess the risks to workers' health and the environment and plan appropriate precautionary measures. [29]
- **Resource management recommendations:** the recommendations include information, advice and guidelines for which materials should (mandatorily) be separated at source (such as hazardous waste) and which products can/cannot be re-used or prepared for re-use or which materials can/cannot be recycled. It also gives information about how the waste (non-hazardous and hazardous) could be managed and the recycling opportunities. These recommendations serve as a decision-making tool for the owner and the contractor. They may also contain broader advice for the deconstruction and waste management depending on the demand. [29]

15. An audit takes full account of **local markets for CDW, re-used products and recycled materials**, including the available capacity of relevant treatment facilities.

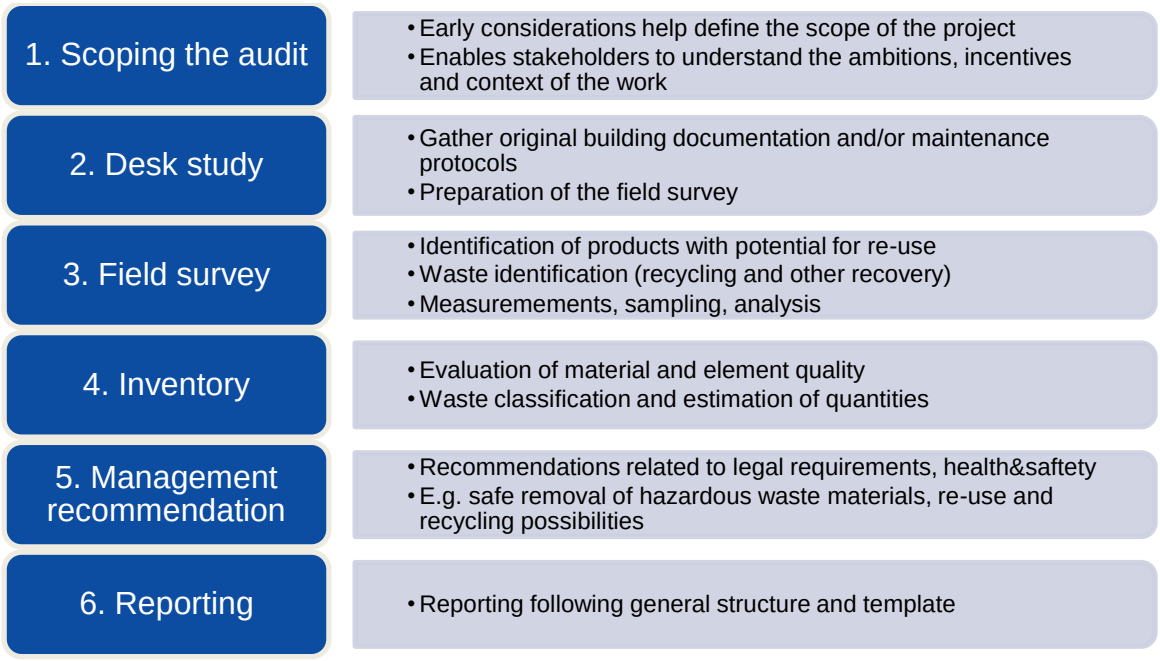


Figure 4 General scheme of the pre-demolition audit – The steps of the audit will depend on e.g. the complexity of the intervention and the (mandatory) requirements for the audit. Point 1-3 of the process feed into the inventory, based on which resource management recommendations can be described. The final step of the process is the reporting step.

3.6.1. How to scope the audit?

16. Before the intervention of the auditor, it is important to **define the scope of the demolition/renovation project** to understand the ambitions of stakeholders, the different incentives and the context in which the work takes place as well as to ensure the smooth running of all stages of the demolition/renovation. The scope should specify the following elements:

- The works concerned and for each separate building or infrastructure, the parts concerned by the demolition or renovation (for example, only the visible parts of the works or also underground levels — basements, foundations, buried equipment such as tanks, etc.).
- Ambitions of the owner of the construction works with regard to re-use of elements and recycling of materials: ensuring the minimum fulfilment of legislative requirements for the pre-demolition or pre-renovation audit or maximisation of re-use, preparing for re-use and recycling.
- Requirements for the economic assessment of all resources. This includes the evaluation of whether there are suitable facilities (e.g. for re-use, preparing for re-use, recycling and other recovery) close to the site, the approximate distance to those facilities, waste admission requirements, and costs of management of recycled materials and re-used construction products. [30] At the point in time for an audit an economic assessment of all resources can give the owner of the construction works an indication of costs which however may differ from actual costs.
- Whether the owner of the construction works is aiming at reusing (selected) products from the demolition/renovation project in a new construction project or in the renovation project.

The consideration of these elements helps in scoping the audit: from a very simple to a more detailed and extensive. It will also influence the choice of the (internal or external) auditor or team of auditors.

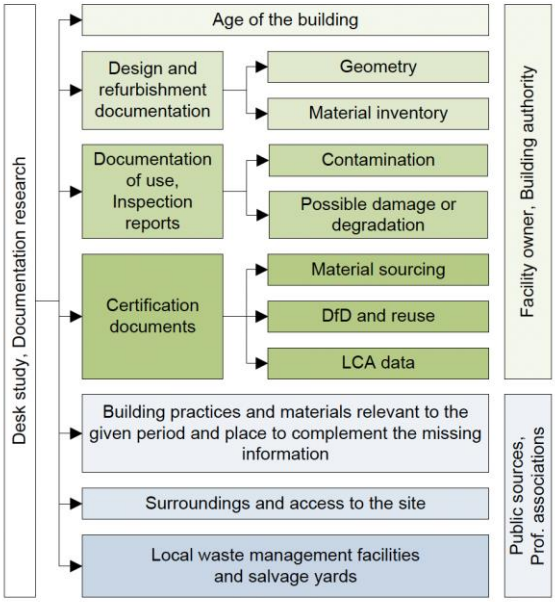


Figure 5 Desk study – Source: reproduced from Wahlström et al (2019) [28]

3.6.2. Desk study

17. The desk study for the audit aims to **gather all the relevant information from the documentation of the construction works**. This step prepares for the field investigation and usually leads to the development of a list of hazardous substances, materials and construction products likely to be present. Understanding what hazardous substances may be present in construction works and construction products is crucial to identify the materials that need to be separated prior or during demolition and directed to specific treatment. Several Member States, such as Austria, Belgium and Denmark have published guidance documents with information on the possible presence of certain materials depending on the age of the building. [28]

18. It is of great importance to collect at least:

- The **age of the construction works** — information about the history of the works and the type of materials and construction techniques to expect. This knowledge is important if design documents are not available.
- The **as-built documents** — architectural plans and technical drawings of the construction and/or renovation works contain information that is useful for planning the field survey and drawing up an inventory. They serve for preliminary identification of construction date/period, dimensions, construction typology, composition, type of materials, location of machinery and installations, details of hidden or difficult to access spaces, as well as the planning of a field survey.
- The **documentation of use** — in particular for industrial sites as well as for the history of maintenance and renovations is essential as the materials may be different from the year of the first building completion. Descriptions of production activities and exploitation permits are a useful source for information on storage and use of hazardous products (that may have contaminated other materials).
- **Certification of sustainability** is another source of the information about the recyclability of materials and re-usability of products for newer construction. The research on sustainability certification may focus on design for deconstruction and re-use, material sourcing and recycled content in materials, material connections and interfaces, environmental footprint of materials. [28]

- A **list of hazardous substances** to expect — e.g. existing asbestos inventory, information on specific incidents (fire damage, accidents and spills). If the assessment of hazardous substances does not exist, the auditor will have to take relevant measures to ascertain that health and safety issues are covered when performing the site visit.
- The **surroundings and accesses** — the knowledge of the environments is essential to plan the field study and provides information for the best strategy to perform waste management.
- The **local facilities** — available facilities for sorting, preparing for re-use, recycling; knowing where to find a local salvage yard or who handles products for re-use.

Relevant information on construction works can be found via different sources. This could be via departmental archives, land registers, building and housing registers, web mapping platforms. This varies across the EU Member States as does the degree of digitization of relevant sources. As building information is digitized, e.g. via online-archives, or BIM-solutions (at least for individual building projects), the desk study is also becoming more and more digital. See Annex B for more information on typical hazardous substances to expect in construction works.

Box 5 - Example: Guidance and online tool for identification of hazardous substances in buildings

- The Danish Technology Institute has compiled the "*Materialeatlas*" [33] listing construction products potentially containing hazardous substances.
- The Danish *Materialeatlas* is a description of typical construction products used during different building periods and aims to give an overview of which hazardous substances are typically to be expected in the different building parts, and thus gives a first indication of whether the building part is potentially suitable for re-use or recycling. The information is compiled based on experts' knowledge and experience in carrying out pre-demolition audits.
- A large number of products and materials are listed, and three colours have been used for giving information on suitability for re-use or recyclability: green for high potential, yellow for potentially re-usable or recyclable and potentially containing hazardous substances, and red colour for products and materials not suitable for re-use or recycling, respectively, due to potentially high content of hazardous substance.

19. The auditor should collect as much information as possible to plan the site visit correctly. Based on the study of all documentation, a **first draft of possible products and materials and uncertainties will have to be checked during the site visit**. The information can be complemented by computer models or IT solutions, or other tools developed by the auditors themselves. All the information collected at this stage of the audit should be part of the report or be annexed to the final report.

Box 6 - Example: Suggestions on where to look for relevant building information in France [34]

Find out about the history of the building from e.g.:

- DOE (File of works executed);
- Information available on sites such as Géoportail, IGN, GOOGLE MAPS, BASIAS, BASOL;

- Polluted land management plans;
- Prefectural reclamation orders;
- Old postcards (Delcampe type);
- Departmental archives;
- Land register;
- Historical aerial photographs;
- Minutes of notaries;
- Fire safety plans etc.

3.6.3. Field survey

20. The field survey has the **aim** of evaluating the condition of the construction works and drawing up recommendations for the management of released waste, materials and elements and potential logistical constraints related to the deconstruction of elements.

21. **The site visit consists of** visual inspections, comparisons of findings with collected documents, testing and measurements, preliminary planning and suggestions for deconstruction techniques and waste handling on site as well as communication between actors engaged by the owner.

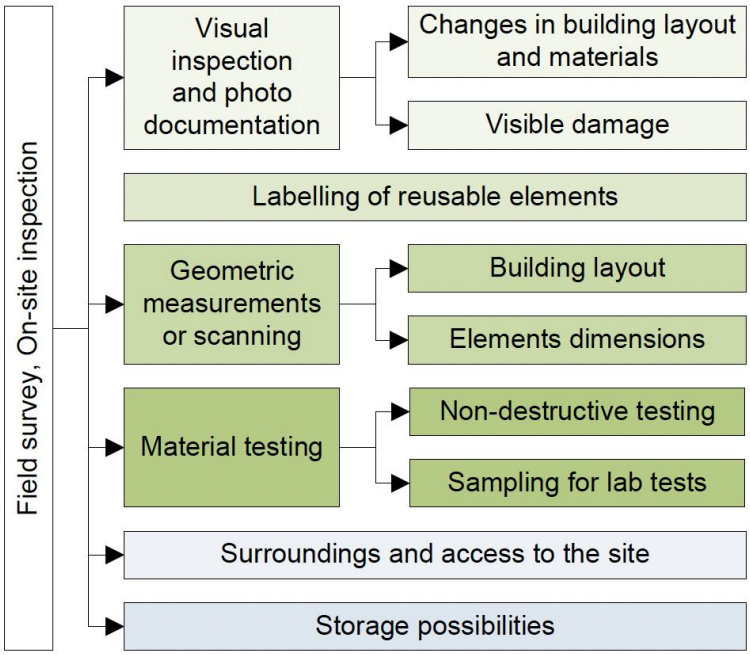


Figure 6 Field survey – Source: reproduced from Wahlström et al (2019) [28]

Important measures to be considered before and during the field survey

22. The accessibility of all premises must be guaranteed, otherwise a new visit must be scheduled to avoid the auditor having to formulate reservations in the audit report. However, if certain spaces/rooms are difficulty or dangerous to access, this should be noted and clearly indicated in the **limitations of the field survey**. [34] There are risks that must be considered, especially if a building is abandoned and/or in ruins. Examples include unstable or collapsed walls, protruding objects, hazardous substances, deteriorated stairs that require different precautions. [30] When the presence of asbestos or other hazardous substances is foreseen, the required safety measures need to be in place.

23. For safety reasons, **the auditor never intervenes alone**. It is imperative that the auditor is accompanied by a colleague, and, ideally, by a representative of the owner of the construction works, particularly in the case of sensitive areas, for example, chemical storage room, area with damaged floor, etc. During the visit, if the auditor and his colleague can share the areas to be inventoried, it is important that, for safety reasons, they inventory any area presenting a danger together. It is necessary to ensure that auditors and other personnel working in the building have adequate and up-to-date safety training. These safety measures can be adjusted according to the complexity of the intervention.

24. Materials and equipment covered by **Extended Producer Responsibility (EPR)** schemes must be identified and managed accordingly.[5]

Appropriate means for the field study

25. The auditor must have appropriate means for the field study. The information gathered during the desk study will help identifying what equipment is needed. **Typical equipment** includes:

- For documentation purposes: Pen and paper, notebook, a tablet or similar to take notes. A device to take pictures with. The plans or other relevant building documents.
- For health and safety purposes: equipment that allows permanent contact with the outside, first aid kit, as well as Personal Protective Equipment (PPE), such as safety boots, fluorescent vest, helmet, safety glasses, dusk mask, gloves, and protective clothing depending on the local context. For example, this means that if the presence of hazardous substances — such as asbestos — is expected, the required safety measures are adequate to work involving such substances or materials.
- For sampling purposes: flashlight, telemeter, metal detector, odometer, magnet, drone for industrial sites (may require authorisation), tools necessary to carry out destructive sampling (e.g., hammer, pliers, screwdriver, drill, core drill, crowbar), means to store and transport samples, and equipment to clean tools between samplings.
- Documentation of the audit and the process of drawing up inventories can be aided by digital tools.

Box 7 – Digital tools that can aid the field survey

Digital tools are constantly evolving, and are integrating AI solutions to aid field surveys and drafting inventories. Examples of tools that are developed either as part of projects and/or available on the market are:

- One of the deliverables of CircBoost[6] — a Horizon Europe-funded project running between 2023 and 2027 — will be an open-source 3D web circular economy map intended for use as an additional digital logbook feature. The objective is to create CityGML LOD3 models, which involves generating highly detailed and semantically rich representations of urban environments. These models will encapsulate details of existing residential buildings, facilitating a better understanding and management of urban spaces. The process is semi-automated, designed to streamline the integration of different Digital Twins technologies, which are instrumental in capturing and representing the dynamic and complex data associated with urban infrastructures.

[5] For example, in France the 'Anti-Waste for a Circular Economy' (AGEC) law also establishes an extended producer responsibility (EPR) scheme for "construction products or materials in the building sector intended for households or professionals, from January 1, 2022, so that construction or demolition waste resulting therefrom is taken back free of charge when it is subject to separate collection and so that traceability of this waste is ensured."
[6] CircBoost-project - https://circboostproject.eu/about-the-project/

- Audit-App by Concular[7] support pre-demolition audits according to DIN SPEC 91484:2023-09, which defines a procedure for recording building products as a basis for assessing the potential for subsequent use prior to demolition and renovation work so that all market participants have sufficient and uniform data depth at all points in the value chain.
- The GrowingCircle project[8] explored the potentialities of LiDAR technology in mobile devices to support visual inspection, labelling, geometric measurements and scan-to-BIM. [35]
- Two commercial applications available to practitioners to create digital twins of indoor and outdoor complex sites are Matterport[9] and NavVis[10].

How to structure the field survey?

26. Because every construction works is different, it is not possible to elaborate one global method for data collection, but it is important to work systematically and methodically. Therefore, a good and **efficient approach for a field survey consists of four parts**:

- Site visit and general analysis of the building.
- General audit and inventory.
- Detailed audit and inventory.
- Sample taking and analysis.

Site visit and general analysis of the construction works

27. Construction works are altered and renovated during their lifetime, and all these activities and changes are not necessarily documented in detail. Based on the visual inspection, the auditor should aim to **evaluate the consistency of the as-built documents** and other relevant documents of the owner of the construction works with the actual situation and get a first impression of the current condition of the works and its materials and products used. The aim is to check what was learned during the desk study:

- Has the layout been changed?
- Are there changes in the building materials and construction products expected?

General audit and inventory

28. The general audit and inventory serve to **understand which products and materials occur in the different parts of the construction works** and to collect the necessary information to identify, quantify and localise them in the building. The auditor or team of auditors should aim to:

- Determine the possible presence of hazardous substances that have not been identified during the desk study;
- Indicate locations where samples must be taken for possible complementary analysis;

[7] https://concular.de/din-spec-91484-pre-demolition-audit/
[8] Growing Circle project, https://growingcircle.netlify.app/cases/matosinhoshabit3
[9] https://matterport.com/en-gb/industries/architects-engineering-construction
[10] https://www.navvis.com/industry/surveying#use-cases

- Identify and quantify non-hazardous waste, in particular those covered by mandatory sorting systems (i.e. at least for wood, mineral fractions (concrete, bricks, tiles and ceramics, stones), metal, glass, plastic and gypsum);
- Identify locations, different structure and technical systems and their materials, with special care for materials that can seem very similar, and for instance, in the cases of complex systems where a material can be covered by another material;
- Take measurements or confirm those obtained during the desk-study;
- Make diagrams, take notes, take pictures of the different parts of the construction works and include them in the report to ease the understanding of the final report.

29. Visiting the site also makes it possible for the auditor to identify the **operational constraints relating to its demolition**, particularly the presence of large construction products, for example, specific technical equipment, large windows, and similar. A site inspection offers the possibility to recommend logistical methods and equipment for removing products and materials, to identify any neighbouring objects that can be affected by the demolition, to evaluate accessibility of vehicles, and to select areas for temporary storage for recovered products and materials. [28,34] Furthermore it offers the possibility to plan deconstruction tests to validate the ease of disassembling products and materials.

Detailed audit and inventory

30. During the detailed part of the audit, every room of the building to be demolished or renovated is visually inspected and inventoried both in terms of elements for re-use, hazardous substances present and waste materials for recycling or other recovery. Since not all materials can be visually identified and assessed, **non-destructive testing and destructive testing** are an important part of this work. During this exercise the auditor should aim to:

- Identify, quantify, and visibly mark construction products with re-use potential and note their location (e.g., paper, electronic map or BIM).
- Make note of relevant characteristics, such as the products´ size, condition, type, product name, date of manufacture (if available) etc.
- Make note of special precautions for the removal of products.
- Carry out visual inspection and non-destructive testing, e.g. assess potential degradation of products, for hazardous substances, moisture content.
- Carry out destructive testing to ascertain the nature of specific materials.
- Take pictures to aid documentation, e.g. pictures of products with re-use potential or pictures of sampled materials and sampling points.

Box 8 – Examples of non-destructive testing techniques

Non-destructive testing performed on site contributes to a better identification of materials and to find hidden materials. Possible techniques include Near-infrared (NIR) spectrometers, ultrasound equipment, metal detectors, flexible cameras for visual inspection of hollow areas inside walls, etc. Among these methods, handheld X-ray fluorescence (XRF) scanners can be used to identify heavy metals in building materials. External dimensions and internal spaces can be verified by adequate measurement methods. For higher accuracy of measurements or if there is requirement to build computer model of the building, more advanced techniques can be used, such as laser scanning, LIDAR or photogrammetry.[29]

Sample taking and analysis

31. The field survey must implement non-destructive or destructive techniques to assess the whole range of materials. **Destructive techniques** could involve opening of false ceilings and walls, opening of technical shafts, making a hole in wall and floor coverings, (partial) disassembly of technical installations (ventilation ducts ...), removing coating from surfaces, drilling to observe the composition at different depths or any other operation deemed necessary for complete information of the materials. Since destructive techniques are likely to be required, the field survey is best carried out when the building is no longer in use.

32. If the desk study suggests the existence of **hazardous substances** at the site, or if at any stage it is suspected that hazardous substances may be present, protocols to work with hazardous substances must be established and worker protection measures applied during the site visit, and in particular during destructive stages. The field survey should allow the auditor to complete the information collected during the desk study and take any sample required to perform the materials assessment.

33. The field survey can and should be complemented with the following operations:

- Chemical analysis of samples to confirm the identification of the materials and hazardous substances.
- Mechanical testing to study properties of the products to consider their reusability.

Chemical analyses of samples provide reliable data but requires adequate sampling. Several factors need to be considered when collecting and analysing samples: the sampling strategy, sampling technique, storage and transport of samples, and the laboratory analysis. The auditor needs to consult national legislation and guidance before sampling to clarify specific requirements that need to be considered, such as use of specific sampling strategies, (national) sampling rules/requirements, requirements for analytical standards and which hazardous substances to include in the survey.

If the building surveyed is abandoned it may be possible to remove samples for **mechanical testing**.

34. Following the field survey, the auditor will be able to develop an **inventory of materials and construction products** present in the building, indicating their nature, quality and location. The inventory will also indicate and locate construction products that require additional analysis.

3.6.4. Inventory of materials and construction products

35. Waste holders must have knowledge of the materials set for disposal and their potentially hazardous nature and contamination. Therefore, **the inventory of the materials and construction products is the most important output of the pre-demolition audit**. The inventory is typically based on the materials assessment provided by the documentation research, the field survey and results from any testing and analysis performed.

36. The **information on structural and non-structural construction products** and elements (such as pillars, beams, walls, slabs, etc. but also ceilings, partitions, heating, ventilation and air condition systems, electrical systems, plumbing, drainage, etc.) and corresponding materials should be organised to provide not only the total amount of waste, but also the total amount of the different types of materials.

37. Annex C gives an example of how an inventory of materials and construction products could be structured. The **materials assessment** should include at least:

- A summary of the type of materials and construction products to be expected;

- The type of material to be classified as inert waste, non-inert, non-hazardous waste or hazardous waste, detailing the LoW-code (from the European List of Wastes – see Annex D) and a description;
- Quantification in tonnes, cubic metres and/or other relevant units of measurement.

38. For statistical purposes it is important to provide the **LoW-code (and/or EWC-stat code).** However, the waste categories described by the respective codes are not detailed enough to provide sufficient information on the specific materials. Therefore, an additional description is often needed. Moreover, re-used products cannot be identified through waste codes, and there is currently no uniform way to classify and keep a statistical record of re-used products.

Additional information can be required by the owner of the construction works or authorities

39. Additional information can be required by the owner of the construction works or authorities, such as:

- An inventory of materials and elements recommended for deconstruction and re-use;
- The location of the (waste) materials and construction products in the building, in order to maximise the efficiency and safety of demolition or renovation;
- The quality of the materials to assess the impurities that could be present. The fewer impurities in the waste fraction, the higher the value it can have;
- The re-usability of construction products, which depends on their nature and conditions.

In fact, this **information is vital to support the materials assessment with respect to re-use, preparing for re-use and recycling**.

To take advantage of the audits full potential it is highly recommended to:

- Separate the source of waste by the different levels of the building or infrastructure works;
- Consider the feasibility of removal and separation;
- Include photographs showing the details to make the report easier to read.

40. It is advisable to perform this materials assessment not only for each infrastructure or building, but also for **each floor**. This information will be of great importance to assess and decide the waste management procedure to be implemented and how construction products for re-use can be managed.

41. Materials assessment should be **completed considering the ease of re-use, preparing for re-use and recycling of the materials, the minimisation of environmental pollution and health and safety risks**. This makes it very important to estimate if construction products for re-use and waste materials will be technically and economically separable, and to decide which different types of outlets should be proposed during the resource management planning stage of the audit.

42. All the information given above should be **complemented with photographs** to ease the work of the contractor when performing the construction, demolition or refurbishment activities. Photographs should be clear, and explicitly show the information they are intended to provide (it is good practice to note on the photographs the location of the detail shown).

3.6.5. Resource management recommendations

43. The audit should be completed with **recommendations on how to perform resource management and in particular separate collection on site**. They may include the following:

- Legal requirements that need to be followed
- Recommendations on the safe removal of hazardous waste, including techniques for the removal of hazardous substances and for the reduction of pollution surrounding the site;
- Recommendations regarding possible health and safety precautions to take during the deconstruction phase or the resource management phase;
- Identification of potential waste diversion of certain identified resource and waste streams (with a priority for re-use, preparing for re-use and recycling, and with lower priority for other treatment options) and estimation of the diversion rates. Different alternatives can be provided for different products, each material group or waste streams;
- Recommendations on how to best implement separate on site sorting of waste streams that are covered by mandatory sorting systems (i.e. at least for wood, mineral fractions (concrete, bricks, tiles and ceramics, stones), metal, glass, plastic and gypsum);
- Recommendations based on the client's requirements for the project and identification of factors that have an influence on different management options (see the example below);
- If available, identification and recommendation of local companies/solutions for re-use, preparing for re-use, recycling and other management options;
- If available, evaluation of optimal solution in terms of their market readiness;
- Identification of (economically or environmentally) beneficial on-site removal and sorting activities that may include the description of the (legally binding) requirements and conditions for storage, handling, separation, transport, treatment and for any other operation to manage the different waste streams;
- Recommendations deriving from the limitations of the field survey;

44. The audit should **specify the areas of the works potentially affected by contamination** and the best way to deal with them before beginning the other activities of the project (decontamination, enclosure etc.). If possible, selective demolition should be recommended to maximise source separation and resource recovery.

45. **Materials containing asbestos and other relevant hazardous substances** should be considered and the audit should include a reference to the national legislation regulating the way to handle these waste materials. It is advisable to prepare an environmental health and safety control plan describing the operations that should be performed to avoid contamination of the surrounding materials and environment including risk mitigation measures to be applied to minimise the exposure of workers and pollution into the environment. Any possible risk for workers should be specifically considered and reported to be included in a health and safety plan.

46. Annex C provides a **template for resource management recommendations** as well as calculation of potential recovery rates. Furthermore, Annex C provides an overview of the decision-making process in the formulation of the inventory and management recommendations.

Box 9 – Example: Factors affecting the recovery of materials in the demolition process

The extent to which materials may be recovered effectively in the demolition process depends on a range of factors, including:

- **Safety.** The presence of hazardous substances and requirements for their safe removal prior to demolition increase the needs for safety measures. Additional safety measures (and the needs for removal of hazardous substances) may increase project costs.
- **Time.** Selective demolition and the identification of optimal solutions for re-use, preparing for re-use and recycling may require more time than traditional demolition, so higher costs may be expected, which could be compensated for by being able to achieve higher re-use, preparing for re-use and recycling rates.
- **Economic feasibility, market acceptance.** The cost of removing a construction product (e.g. a roof tile) should be compensated for by its price, while, at the same time, the re-used construction product should be competitive and accepted by future users. For some materials, e.g. iron/metal/scrap, market prices fluctuate strongly depending also on seasonality.
- **Technical conditions and regulation.** The technical condition of products as compared to requirements in e.g. technical regulation, is a factor that governs whether re-use is possible or other management may be necessary.
- **Space**. When there is a spatial limitation on a site, separation of materials collected should take place in a sorting facility. Spatial limits specifically require good planning to allow for sufficient and appropriate sorting and storage equipment on site. However, it may limit the use of mobile processing and recycling devices.
- **Location**. The number of adequate sorting, preparing for re-use and 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**. Handling, storage and logistics need to be organised in such a way that materials and products are not affected negatively.
- **Choice of method and equipment**. The contractor's choice should always prioritise health and safety, which on the contrary (depending on the selected method and equipment) may hinder potential re-use or recycling.

3.6.6. Reporting

47. The final report of the audit should be prepared by the auditor. The **audit report** will be signed by the auditor ascertaining the accuracy of the content. It may contain several parts prepared by different auditors depending on the different expert skills and knowledge that was needed. The report must include the information regarding the project itself, all the information collected during the desk study and field survey and any information that can be useful for the owner, the contractor or any other stakeholder involved in the value chain of the project. Remember that the report forms the basis for the tender documents for the subsequent demolition or renovation and therefore the audit report must be available to the consultant drawing up the tender documents and to the contractors and demolition companies.

48. The main section of the final report includes the following information:

- **Scope of the report** (essential): A short presentation and description of the project with detailed information of the works to be performed, including not only parts directly affected by the works, but also those parts that should be kept.
  - General description of the project
  - Basic information about the owner and the works
  - Location of the site, incl. information about neighbourhood when relevant
  - History of major renovations and previous use(s)
  - Summary and conclusions of the desk study
- **Summary of the audit** (essential): Summary of the data collected during the audit including, but not limited to:
  - Estimated waste fractions arising (in tonnes, m^3 or other units)
  - Estimated total waste arising (absolute in tonnes, m^3 or other units)
  - Summary of hazardous wastes identified in the construction works
  - Description of the methodology followed, including the steps performed and the techniques employed, including information on sampling, testing and analysis.
  - List of documents that were available, for instance hazardous substances assessment, any information on the building or the construction materials used originally, etc.
  - Other supporting materials where available (pictures, site-plans and any other documents that could be useful for the correct performance of the project).
- **Inventory** (mandatory): The inventory of waste fractions and construction products is the core part of the audit report. It can be reported using the templates in Annex C. If a more detailed assessment has been performed, a summary by floor/level can be included. The documents filled in with full details should be included as annexes to the report.
- **Resource management recommendations** (essential):
  - Summary by type of outlet and recommended management of each waste stream, with a priority for re-use, preparing for re-use and recycling.
  - Assessment of the reachable re-use, preparing for re-use and recycling targets and disposal rates, e.g. using the recommended template in Annex C.
  - List of local waste management facilities (if possible) specifying their services, in particular sorting, preparing for re-use and recycling facilities.
  - Waste traceability process including recommended templates to be used and when possible, person(s) or organisation(s) responsible to perform waste traceability until the final outlet.
  - Other information of interest for stakeholders involved in the project, included but not limited to legislative framework in the country and summary of responsibilities and liability of each of the stakeholder's guidelines / advise / focus of attention regarding the selective demolition works planned, for example:
    - advise and guidelines for the safe removal of hazardous waste materials,
    - re-use or recycling possibilities for certain products and (high value) materials present in the building,
    - (legally binding) conditions for storage, transport and treatment of certain materials,

- recommendations deriving from the limitations of the field survey, such as the need for additional tests to decide on the management possibilities of materials or elements, etc.

Member States may have legal requirements on the structure and content of the audit report.

Resource and waste management plan

49. Mandatory requirements exist in some Member States to **prepare (site specific) resource and waste management plans**. Furthermore, building certifications systems, such as LEED, may also contain requirements on the development and implementation of a construction and demolition waste management plan. [36]

A resource and waste management plan is a strategic document which describes in detail, how the waste from a construction and demolition project is to be dealt with, focussing on the prevention, re-use and recycling of CDW. In some cases, the resource and waste management plan is prepared using predefined templates and must be submitted to the relevant authorities for examination and/or approval.

The resource and waste management plan cannot replace the demolition plan which is part of the execution planning and prepared by those responsible for the intervention, e.g. the contractor in charge (see also Section 0).

3.7. Quality assessment of audits

50. **Quality assessment of the audit** is based on two main aspects: requirements for auditors and traceability. The sections below provide general information, which — in practice — differs among Member States. Requirements for auditors (e.g. minimum number of years for professional work experience, requirements for relevant education diploma or equivalent training, certification) and traceability may be part of mandatory requirements for audits and/or selective demolition. They can also be part of voluntary schemes or specific for an actual project.

3.7.1. Requirements for auditors

51. Audits should be carried out by a **qualified expert or team of experts** and should meet a set of **minimum requirements**:

- **Skills.** Auditors should show combined knowledge and experience. Experience provides an important background that can complement the auditor's educational background and specific training.
- **Adequate education and specific training.** Auditors should have knowledge of current and historical construction, constructive systems, standardisation, materials, resource management processes and technologies (in particular related to re-use, preparing for re-use and recycling) and hazardous substances. This education and training may be acquired by tailored programmes/courses and be part of a certification or authorisation scheme, or similar.
- **Independence.** The auditor must be neutral and independent from the contractor or demolition company performing the demolition works, so that the results obtained can be used by all the stakeholders involved in the process.

Audits are carried out on behalf of the owner of the construction works or a third party commissioned by the owner of the construction works, and the expertise of the auditor or team of auditors must be adequate to the complexity of the intervention.

Auditors must be able to make recommendations on prevention and management for the different waste streams that the site may generate. Auditors must also be able to identify potential for re-use, preparing for re-use and recycling and propose recycling/recovery rate ranges by type of waste, specifying the technical conditions to achieve them. [34] Auditor must have adequate education and specific training on any of the topics listed below. [30,34] Auditors do not necessarily have to be experts on all the listed topics, but they should know that these topics are central, and where to find the information necessary for the audit:

- Construction systems and techniques used over time
- Physicochemical composition of construction materials used in structures and in finishes
- Stability of buildings and infrastructures
- Techniques for installing, removing and conserving materials and construction products
- Technical standards in force at the time of the audit
- Compilation of construction technical documents and their analysis
- Qualitative and quantitative assessment of resources and waste (measurement techniques, visual assessment of the condition of materials)
- The (local) market situation of re-use, preparing for re-use and recycling solutions
- Methods for characterising resources and waste (sampling and analysis techniques)
- Hazardous substances and materials in construction works
- Waste treatment, processing, disposal
- Definition of potential for re-use, preparing for re-use, recycling and recovery of waste
- Potential applications for the re-use of elements and recycled materials
- Documents for planning, monitoring and traceability of resources and waste
- Demolition techniques, including techniques for the removal of hazardous substances and to reduce pollution surrounding the site
- Health and safety measures applicable during the demolition
- Legal requirements for waste management at the time of the audit
- Construction value chain and the role of various stakeholders

3.7.2. Traceability

52. **Audits should be considered as living documents** that are revised periodically to reflect new information that emerges during the renovation or demolition process. This might be new information on hazardous substances present in the construction works, that waste was transported to another treatment facility, etc.

It is important to ascertain the quality of the audit performed and the resource management process. This can provide valuable insights and help both auditors, consultants and contractors to evaluate and improve the process and it should be done preferably in two stages:

- **Stage 1: Initial assessment of the audit**. After the audit is performed (and registered) it must be checked for its quality. This check may be part of mandatory

requirements where e.g. public bodies or professional associations check for completeness as compared to the set requirements. During the tendering process the contractor or demolition companies should be given sufficient time to evaluate the audit and clarify any questions.

- **Stage 2: Verification during or after renovation or demolition works and with the management process**. It is important to consider not only the amounts and separation rates, but also the type of resource management performed.

Any discrepancy found should be notified and justified. This verification can be mandatory and implemented/supported via electronic/digital systems. It can also be voluntary in nature.

Stage 2 is not part of the audit, but the audit facilitates comparison with the outcomes of the renovation and demolition process and the resource management process and it is the starting point for tracking and traceability throughout the value chain (see also Sections 0, 0, 6 and 7).

4. Selective demolition

1. **Selective demolition** promotes the removal and safe handling of hazardous substances and facilitates separate collection of material-specific fractions, re-use, preparing for re-use and high-quality recycling by selective removal of materials, and Member States shall take measures to promote selective demolition. An essential prerequisite for selective demolition is a completed and reported pre-demolition audit.

Before the intervention can be carried out any required permits need to be obtained and necessary notifications to the competent authorities need to be given.

2. Selective demolition is done in a pre-defined sequence of steps and can be applied on smaller and large-scale construction works. The **typical steps to be followed are**:

- Interruption of supply and drainage lines (e.g. energy, water)
- Shoring of floors or other relevant areas of the structure
- Disinfection of construction works/areas that contain e.g. parasites, rodents, insects etc.
- Removal of furniture, loose items, fixtures etc.
- Removal of hazardous substances and materials (see also Section 4.2)
- Removal and dismantling of supply and drainage lines
- Removal/dismantling of non-load bearing structures, ceilings, floor coverings, doors, windows etc.
- Demolition/deconstruction of load-bearing structures
- Demolition/removal of foundations and ground covers
- Site clean-up

This typical order can be deviated if special building conditions make it necessary and maybe different e.g. in demolition of civil engineering works. However, this should not impair the possibilities for removal of hazardous substances and materials and the possibilities for effective sorting of waste. Furthermore, it is critical to avoid cross contamination of clean materials with hazardous substances.

Demolition plan

3. It needs to be noted that whilst the audit and the resulting audit report focus on the products ('what'), a process-oriented **demolition plan** ('how') is to be prepared if any product or material from construction, renovation or demolition operations is to be re-used, prepared for re-use or recycled. Whilst the audit report sets out recommendations, the demolition plan sets out the detailed approach and specification to demolition, the treatment and logistics of the products and materials identified in the audit, and roles of different stakeholders. Therefore, there needs to be sufficient time between finishing the audit process and contracting and drawing up the demolition plan (e.g. at least 14 days).

The plan is part of the execution planning and therefore not a responsibility of the auditor. It is prepared by those responsible for the intervention, e.g. the contractor in charge, as the choice of method and work sequence as well as the choice and use of equipment and machinery are the responsibility of the contractor. However, the contractor must inform the client in writing of the chosen method and the planned procedure before the start of the work.

A good demolition plan contains information about:

- how the different steps of the demolition will be performed,
- by whom they will be performed,
- what steps are necessary (on-site or off-site) to ensure that products and materials are removed for re-use or recycling, respectively
- what steps are necessary to ensure the separate collection of material-specific fractions at source (i.e. at least those covered by mandatory sorting systems: wood, mineral fractions (concrete, bricks, tiles and ceramics, stones), metal, glass, plastic and gypsum),
- how both the non-hazardous and hazardous waste will be managed
- where and how materials will be transported,
- what will be the re-use, preparing for re-use, recycling, or other treatment and
- how to follow up.

Such a plan also covers how to address safety and security issues, as well as how to limit environmental impacts, including leaching and dust.

It is crucial that demolition activities are carried out **according to a plan and that necessary documentation is provided** (see also Section 4.3.3).

4. It is recommended that this whole process is **supervised by a local authority or by an independent third party,** for example by an external waste management organisation through:

- An “inter-demolition” control at site by a third party, after removal of the hazardous waste;
- After the fact: on the basis of sampling controls carried out by the same independent third party who has prepared the pre-demolition audit;
- After the fact: a desk control to check what happened with all the non-recyclable materials or non-reusable construction products (a check of transportation documents, certificates of treatment or waste processing, etc.).

Some Member States have in fact requirements, where authorities are authorised to e.g. review documentation, inspect the demolition process, check and trace the management of CDW from the intervention.

4.1. Improve source separation

5. A key aspect of proper resource management starts with improved source separation at the site of the intervention and **keeping materials separated**. Source separation, demolition, sorting and subsequent handling of CDW must take place in a way that ensures the separation of materials that cannot be treated in the same way (throughout the entire logistics or value chain). This is legally required for those waste streams that are covered by mandatory sorting systems, i.e. at least for wood, mineral fractions (such as concrete, bricks, tiles and ceramics, stones), metal, glass, plastic and gypsum.

Furthermore, hazardous waste must be kept separate from non-hazardous. Therefore, there must also be a removal of hazardous substances and the division into polluted and unpolluted flows. See also box 11.

Figure 7 Surface covering is removed from walls and floors prior to further demolition and deconstruction (to the left), reinforced concrete is separated into concrete and metal fractions on site (to the right) (Source: Danish Technological Institute)

6. **The better inert CDW is separated, the more effective re-use, preparing for re-use and recycling will be and the higher the quality of e.g. recycled aggregates and materials**. However, the degree of separation depends strongly on the options available at the site (e.g. space and labour) and on the costs and revenues of separated materials. Although mixed waste typically has greater disposal costs, source separation can be challenging. Construction works have become increasingly complex, and this has implications for demolition works. Furthermore, over the last few decades, an increasing number of materials have been glued and the use of composite materials has extended as well.

BOX 10 – EXAMPLE OF WINDOW DISMANTLING

Window frames can consist of different types of materials, such as wood, PVC and aluminium, and can contain several functional parts, typically consisting of metal. Dismantling on-site can consist of separation into frame, glazing/glass and even other functional parts, so that the different materials can be valorised.

If the window is kept as it is and transported as waste, glazing will most likely be damaged or even broken and it will be more challenging to keep material streams separate and free from interfering substances/materials, which might hamper recyclability e.g. in flat glass.

To enable on site dismantling and improve source separation, this needs to be considered in planning of space, equipment and timetable.

7. As set out by the WFD, Member States shall take **measures to ensure the establishment of sorting systems for construction and demolition waste** [2] at least for wood, mineral fractions (concrete, bricks, tiles and ceramics, stones), metal, glass, plastic and gypsum. Furthermore, Member States shall take measures to ensure, that hazardous waste is not diluted or mixed, either with other categories of hazardous waste or with other waste, substances or materials. [2]

8. When starting CDW recycling, one typically **starts with the easiest materials** for which secondary markets already exist. In many cases this will be the inert fraction, but in some Member States it can also be metals or wood. However, every situation is different.

9. **Materials ought to be separated in consideration of their treatment options** (see Chapter 0 for examples of treatment options) and the waste hierarchy, such as:

- cleaning for re-use (for example soil);
- re-use (for ex. structural steel, metal sheet and tiles);
- recycling for the original purpose (for ex. metals, paper, glass, and asphalt);
- recycling for another purpose (for ex. aggregates, wood for particleboard manufacturing);

Waste that cannot be recovered at the higher levels of the waste hierarchy, incineration with energy recovery and disposal (for ex. hazardous waste) may be required.

10. Source separation involves the **types of operations as mentioned above – the typical steps in selective demolition.**

4.2. Removal of hazardous substances and materials

11. Proper identification and removal of hazardous substances and materials (also referred to as **decontamination**) needs to be done for a number of reasons other than re-use or recycling:

- to avoid pollution and protect the environment;
- to protect the health of workers;
- to protect the health of people living in the surroundings of the site; and
- for safety reasons.

Examples of typical hazardous waste products from construction, renovation or demolition works include asbestos, tar, radioactive waste, PCBs, lead, electrical components containing mercury, insulation materials containing hazardous substances etc. See Annex B for additional information on hazardous substances and materials in construction works.

12. Decontamination is necessary so that hazardous substances and materials will neither contaminate the recyclable materials nor pollute air, land and water during the demolition process. Even if present in a very small proportion of the total waste materials, **the possible presence of hazardous substances (and interfering materials) and waste materials can hinder the recyclability of materials** as the quality of the recycled products is reduced. Markets' confidence in the recycled waste materials will be reduced drastically. Hazardous waste therefore needs to be removed correctly and systematically prior to demolition as it can be 'explosive', 'oxidising', 'toxic', 'harmful', 'corrosive', 'irritating', 'carcinogenic' or 'infectious', or have other hazardous properties. The resource and waste management plan needs to foresee which actions are to be taken if unexpected hazardous waste materials are found. Depending on the Member State, the treatment of some of these waste types (e.g. asbestos) is regulated.

13. Throughout the process, hazardous waste removal needs to **comply with existing EU and national legislation.** The European Chemicals Agency's CHEM database (https://chem.echa.europa.eu) provides a search function for chemical substances which returns information on their physicochemical and (eco)toxicity properties, hazard classifications and EU legislation.

14. Member States typically have **requirements for the identification and removal of asbestos prior to demolitions or requirements to the separation during demolition**,

as well as a licensing or permit system for asbestos removal operations or operators.[11] Moreover, many countries have specific guidelines for asbestos – identification, removal and management of asbestos containing waste.

Box 11 - Example: Best practices for asbestos removal

In the report "Study on asbestos waste management practices and treatment technologies" [16] a list of best practices has been formulated for further consideration by the Member States:

- A comprehensive guide to legal requirements and best practice (e.g. to raise awareness)
- Proactive screening triggers not limited to demolition and renovation (e.g. when selling or renting, etc.)
- Screening targets (e.g. a data by which all private or public buildings must have been screened for asbestos)
- Support for screening (framework contracts, financial support)
- Inventories of buildings with asbestos
- Design of the asbestos survey that stimulates removal
- Financial incentives/funding for asbestos removal
- Embedding ACW management into other requirements/funding
- Including the potential for illegal dumping as an explicit policy consideration
- Support for private citizens
- Public register of asbestos removal companies

Box 12 - Example: List of CDW materials that need to be removed before demolition – the Austrian standard ÖNORM B3151 – Dismantling of buildings as a standard method for demolition [37]

The following hazardous materials are to be removed:

- CDW materials representing or containing dangerous substances
- Loose artificial mineral fibre (if hazardous)
- Components or parts containing mineral oil (such as an oil tank)
- Smoke detectors with radioactive components
- Industrial smokestacks (for ex., fireclay boxes, bricks or lining)
- Insulating material made up of components containing Chlorofluorocarbon ((H)CFC) (like sandwich elements)
- Slags (for ex., slags in inserted ceilings)
- Oil-contaminated or otherwise contaminated soils
- Fire debris or otherwise contaminated CDW

[11] An overview of removal, separation and collection practices can be found in "Study on asbestos waste management practices and treatment technologies" [16].

- Isolations containing polychlorinated biphenyl (PCB)
- Electrical components or equipment with pollutants (for ex., vapor discharge lamps containing mercury, fluorescent tubes, energy-efficient lamps, capacitors containing PCB, other electrical equipment containing PCB, cables containing insulating fluid)
- Cooling liquid and insulations from cooling devices or air-conditioning units containing Chlorofluorocarbon ((H)CFC)
- Materials containing polycyclic aromatic hydrocarbon (PAH) (like tar bitumen, tar board, cork block, slags)
- Components containing or impregnated with salt, oil, tar, phenol (e.g. impregnated wood, cardboard, railway sleepers, masts)
- Material containing asbestos (for ex., asbestos cement, sprayed asbestos, night storage heaters, asbestos flooring)
- Other hazardous materials

The following interfering substances/materials are not hazardous materials. However, they need to be removed, since they would prevent or complicate the intended CDW treatment or treatment step:

- stationary machines (e.g. building services systems)
- electrical appliances
- floor structures, raised floor constructions
- non-mineral floor or wall coverings (except wallpaper)
- suspended ceilings
- surface-mounted installations made of plastic (e.g. cables, cable ducts, sanitary facilities)
- facade constructions and systems (e.g. curtain facades, glass facades, thermal insulation composite systems)
- seals (e.g. bitumen cardboard, plastic films)
- construction products containing gypsum (e.g. gypsum plasterboard, gypsum floorboards, flowing screeds containing gypsum), except for wall and ceiling plasters containing gypsum and composite screeds containing gypsum
- partition walls made of cork, aerated concrete, cement-bonded wood wool panels, wood, plastic
- glass, glass walls, walls made of glass blocks
- loosely installed mineral wool, glass wool and other insulation materials, except for impact sound insulation
- Doors and windows (except those that serve as dust protection during demolition)
- Plants and soil (e.g. from green flat roofs)

If it has been identified that the removal of hazardous substances needs to be carried out prior to the renovation or demolition, a decontamination study will typically have to be conducted by specialists in hazardous substances. This is necessary to plan and conduct the safe and efficient removal of hazardous substances. In addition, this decontamination work must be carried out by specialised companies.

15. While the presence of certain hazardous substances in building materials (e.g. tar bitumen, asbestos containing materials) can often be easily ascertained or should be expected (e.g. depending on the material, the year of manufacture of the construction product or the year of the construction works), **the presence of other pollutants** (e.g. PCB, PFAS, heavy metals etc.) **is often not easily verifiable**, or the materials may not be easily decontaminated or the contaminated products dismantled. This is particularly critical as they can pollute the soil and groundwater.

16. There are several **methods and technologies for removing hazardous substances.** It is important to take measures to avoid the release of hazardous substances and microplastics into the environment and to ensure the health and safety of those performing the treatment. Which method or combination of methods is used in a project depends on the construction works, the building materials and the hazardous substances present:

- Demolition - In the classic sense, total or partial/partial demolition
- Chipping – removal using a hammer and chisel or similar tools
- Sanding – removal of surface polluted with hazardous substances (e.g. paint, varnishes) using sandpaper or similar attached to appropriate machine/equipment with mechanical suction
- Cutting - cutting away material/adjacent construction/material by use of high-speed cutting equipment with the appropriate tool depending on the materials.
- Milling - removal of surface and part of the underlying construction/material when using mechanical milling tools with mechanical suction
- Blast cleaning - surface removal using various blasting agents carried out at high pressure
- Dry cleaning/absorbent cleaning - removal of material using solvents, organic such as inorganic, or application of absorbent material to surfaces for extraction of hazardous substances
- Thermal cleaning - extraction/removal of hazardous substances using thermal treatment

For a number of those methods, it is highly recommended — and may be a requirement — to use water and vacuum equipment to avoid the spreading and inhalation of dust. The use of PPE is mandatory.

4.3. Selective demolition and dismantling

17. After the pollutants and contaminants have been removed and a “shell-like” state has been achieved, further **mechanical dismantling** can be carried out. Different kind of demolition or dismantling procedures exist for this purpose. It is important to take measures to avoid release of microplastics into the environment.

Figure 8 Dismantling of concrete element for re-use (Source: Danish Technological Institute)

18. **Main waste streams**, including inert waste from construction works, **should be treated separately** (e.g. non-contaminated concrete, bricks, masonry, tiles and ceramics). For the

use of recycled materials in high grade applications, a more selective demolition can be required (such as separate collection/dismantling of the concrete and masonry).

19. An increasingly wide range of construction products need to be considered for **(manual) dismantling to enable re-use**, including techniques such as stripping (before demolition) and scavenging (after demolition). Examples include glass, marble fireplaces, precious woods such as walnut and oak, traditional sanitary ware, central heating boilers, water heaters, radiators, window frames, lamps and lamp-frames, steel structures, and cladding materials. Other materials which are to be considered for recycling include plasterboard and gypsum-based products, insulation foam, concrete, and mineral wool and glass wool. Numerous solutions are provided by the 36 *Reuse toolkit: Material sheets*[12].

20. Such operations allow for subsequent re-use of products and recycling of the materials themselves, but also aim at the purification of the main resource stream (i.e. inert waste destined for the production of recycled aggregates), since **side-streams or interfering substances/materials can compromise the quality of the CDW recycled material**. Side-streams risk not being treated properly if there is no local/national regulation in place. See box 12 for examples of interfering substances/materials.

Quality protocols, End-of-waste guidelines or decisions as well as relevant certification schemes support this so that the level of purity relates to the possible end-uses of materials, e.g. the recycling for the original purpose.

4.3.1. Onsite operations

21. **Consider onsite operations as they can offer cost advantages and reduce transport needs**. However, decisions on onsite preparing for re-use and recycling need to be taken on a case-by-case basis depending on the site characteristics like size of the site and proximity to green areas, residents and businesses. Such decisions need to consider economic, environmental, social and health factors and risks. Such operations often require permits or licenses (see also Section 6.1). Some onsite operations such as onsite crushing may also result in lower quality recyclates compared to stationary recycling facilities which tend to be more technologically advanced. If the separation of the listed substance groups and the main components is not technically possible at the point of origin or involves disproportionate costs, the separation must be carried out in an approved treatment facility.

Figure 9 Suitable layout of the site with space for waste containers can support good on-site operations (Source: Danish Technological Institute)

[12] Reuse Toolkit: Material sheets. Available at: https://opalis.eu/sites/default/files/2022-02/FCRBE-all_sheets_merged-EN.pdf

4.3.2. Packaging waste

22. Packaging waste is generated in demolition activities as a result of packing for safe storage, transportation, processing or final disposal of materials. Examples include e.g. packaging of asbestos containing materials before transportation and treatment/final disposal, or preparation and packaging operations of re-used products. During construction and renovation, packaging waste is often generated via new and packaged products, that are brought to the site and installed. **Packaging materials[13] brought onto construction sites should be minimised** as much as possible through optimisation of the supply chain, for example bulk deliveries, supplier take-back agreements etc. Packaging waste is not CDW and any packaging waste arising on-site should be sorted as much as possible according to local waste collection practices, like plastics, wood, cardboard, metal. The correct assigning of waste codes to packaging waste is important (taking into account local specificities) when considering contaminated packaging, for example paint cans. Contamination can be reduced by minimising the amount of hazardous waste. For example, paint cans should be empty and cleaned out as much as possible and left with the lid off to dry any remaining residue. [38] Once this is done the cans can usually be classified as non-hazardous waste and can be easily recycled.

4.3.3. Documentation is essential

23. Throughout the waste management cycle, monitoring is crucial: **all contractors need to have the necessary documentation, and all activities carried out need to correspond to what was documented**. This contributes to transparency and trust in the CDW management process.

As stated before, it is crucial that demolition activities are carried out according to a plan and that a verification of the management process is carried out during and after the renovation or demolition works. During the renovation or demolition, the contractor needs to track and record information to be able to create an overview after the intervention has been completed:

- What happens with hazardous waste, to be able to ascertain that they are correctly removed and disposed of.
- Record latest information on the presence of hidden hazardous wastes.
- The amounts or resources and waste that were set free should be compared with what was estimated.
- The actual treatment solutions should be compared to what was recommended or advised.
- Materials that were collected together and materials that were separated.
- Which materials were separately collected / selectively collected but put in a mixed container.
- How (and where) were the quantities measured?
- Final “destination” for all resources and materials, e.g. documented via certificates, receipts and similar.

This gives an overview of what has really been collected at source and to where the construction products and waste materials have been transported (for re-use, for pre-treatment (sorting), for recycling, for incineration, landfilling, …). This information should be (1) checked with what was foreseen in the inventory, and (2) provided to the authorities.

[13] Packaging waste (waste classification code 15) is not CDW, even if generated on construction sites.

Box 13 - Example: Documentation of the demolition and CDW management in Austria [39,40]

- In Austria, documentation of the CDW management must be provided and must be kept for at least seven years.
- Documentation for demolition must be available on site before and during demolition and must be kept for at least seven years. The demolition documentation consists of:
  - The description of the project/building
  - The documentation of the pre-demolition audit
  - The demolition concept
  - The protocol stating that the building is clear for demolition

5. Waste logistics

5.1. Transparency, tracking and tracing

1. **Transparency needs to be assured throughout all phases of the waste management process**. Transparency and traceability are key for the assessment of risks and hazards in the management of CDW, and important for building confidence in the products and processes, and to mitigate any negative environmental impacts, such as pollution into the environment.

2. Proper CDW management still presents a problem in the EU, and data on its treatment is partly missing. [41] **Therefore it is necessary to strengthen record keeping and traceability mechanisms through the establishment of electronic registries** especially for hazardous CDW. Good practices already exist in this domain in some Member States.

3. Registration of CDW constitutes a fundamental step for **tracking and traceability,** and to register waste it is necessary to know what types of CDW and products for re-use are expected. Therefore, a pre-demolition or pre-renovation audit (Section 3) is of high importance. But equally important is to check afterwards that the resources have been processed according to a plan, that the waste and resources leaving the site is effectively what was assessed and registered and that rules and regulations for the handling of these waste and resource streams have been enforced; and equally, that the products assessed for re-use where managed accordingly. Incentives for tracking and tracing are e.g. the possibilities to obtain certificates, achieving “better quality class” material (see e.g. Box 16 on the Tracimat system), which can off-set additional costs incurred by additional CDW registration steps.

4. When registering CDW, it is strongly recommended to use the **European List of Waste (LoW)** [25] to assure compatibility of data across the European Union. For statistical purposes Member States are obliged to report statistical data on waste generation and treatment according to the **statistical waste nomenclature EWC-Stat** (see also Annex D).

5.2. Improve logistics

5. **Try to keep distances short**. Proximity of sorting and recycling plants is very important for CDW, which in case of bulky materials such as aggregates for construction (asphalt, concrete, etc.) cannot be transported by road over long distances (usually maximum 35 km). Unless transported in large volumes by zero-emission road transportation, rail or waterway, long distances are simply not economically attractive.[14] The environmental benefits of recycling and re-use diminish over distance too.

[14] The lighter and the more valuable CDW material is, the longer is the affordable transport distance.

Life cycle assessments (LCA) can be used as a tool for identifying the optimal distance. The transport of the waste (and resources) should also be planned so that the vehicles do not go half-empty or that the distance to an approved reception station becomes unnecessarily long. Light waste materials should be compacted before transport to increase their bulk density and thereby improve transport efficiency, provided that the recyclability of the waste materials is not hindered.

6. **Optimise the use of road networks and profit from appropriate information technology (IT)**. Many navigation software solutions allow setting driving directions to minimise fuel consumption.

7. **Where possible, use waste transfer stations** (or collecting boxes) – they play an important role in the local waste management system, serving as the link between a local CDW collection point (a demolition site) and a final waste treatment facility. Facility sizes, ownership, and services offered vary significantly between transfer stations. Nevertheless, they all serve the same basic purpose: consolidate waste from multiple collection points. Occasionally, transfer stations also provide waste sorting and recycling services. It is important to assure traceability of CDW materials also in the case of waste transfer stations.

8. **Guarantee the avoidance of external pollutants.** For example, in the case of glass recycling, the degree of cleanliness of the containers is crucial. This requires the necessary attention by the logistic organisation – such as to avoid the use of multi-use containers. As soon as glass comes into contact with concrete, stone or brick residues, it is no more suitable for recycling in a circular mode (re-melting). It should be specified in the audit which waste fractions to be sorted and kept in separate (and maybe clean) containers.

5.3. Stockpiling potential and proper stocking

9. Re-use of products, and recycling and recovery of CDW materials **requires proper stocking**. For every construction, renovation and demolition site it is important to plan space for proper stocking and logistics from the start, so that there are places on-site where CDW and products for re-use can be sorted, processed, packaged and stored while ensuring that their quality is maintained, and hazardous substances are handled and disposed of properly.

10. **Stockpiling can take place at the demolition site or at e.g. waste transfer stations, treatment facilities or even landfills**. Stockpiling can be necessary for logistical purposes and to increase the potentials for recycling and preparing for re-use, as the demand for construction products or materials often does not match in time with the dismantling in a renovation or demolition project or the processing and treatment of materials at treatment facilities and recycling plants.

Stockpiling can only be done during limited amounts of time: one year before disposal and three years before recycling. [7] In either case it is crucial to take precautionary measures to maintain the quality of the materials and minimise environmental risks. Stockpiling may require a permit.

11. **Take precautionary measures that minimise risks.** CDW stockpiling can cause various emissions and risks (like pollution of air, land and water, leaching or run-off of contaminants, particulates and microplastics; heat generation with potential to cause fire; generation of litter; dust, biogas and odour emissions etc.). However, precautionary measures exist. For example, the waste should be segregated and disposed in separate dedicated containers, and some waste types — e.g. plasterboards — should be kept dry. [42,43]

12. **Manage the risks,** which depends on the following factors [7]:

- waste type, amount of material and chemical and physical characteristics of the materials being stockpiled;

- location and climate of the site;
- hydrological and hydrogeological conditions including proximity to surface;
- limit values for the protection of the surrounding environment (groundwater, surface water and soil);
- length of time materials will be stored;
- proposed management approach to the stockpiled materials, including safety aspects of guarding the site from unauthorised visitors and the presence of a continuous monitoring system.

13. Therefore, stocking and stockpiling should be conducted in an appropriate manner so that the risk of harm to human health and the environment is prevented or minimised. **Stocking and stockpiling must be undertaken only** for genuine and beneficial purposes, and storage time should be minimised as far as possible.

6. Waste processing and treatment

6.1. A variety of waste processing and treatment options

1. The application of the **waste hierarchy** [2] offers wide-reaching benefits in terms of resource efficiency and environmental sustainability. A wide range of waste processing and treatment options exist, and these are commonly known as preparing for re-use, recycling, other recovery (e.g. backfilling and energy recovery), and disposal – in that order of priority. The actual choice of the waste management option differs from country to country and from case to case, depending on regulatory requirements, as well as economic, environmental, technical, public health and other considerations. However, following the waste hierarchy is a legal obligation.

An overview of available treatment options in the EU for the most common CDW fractions is given in Annex E.

6.1.1. Hazardous waste should be kept separate from non-hazardous waste

2. **Hazardous waste should not be mixed with non-hazardous waste.** Some types of CDW are not hazardous in their original form, but during the demolition stage can become hazardous through their mixing, processing or disposal. Hazardous waste can also pollute non-hazardous materials and thus make them non-reusable/recyclable. One example is asbestos which may be present in construction works constructed before the mid 1980s. If asbestos-containing products (e.g. asbestos cement sheets used for roofing) are not managed properly, it can contaminate the remaining materials of the building as well as the surroundings. Accordingly, hazardous waste always needs to be separated and disposed of according to the national regulations on hazardous waste.

3. A **visual inspection** of the incoming waste is recommended upon arrival and before unloading. If during inspection significant impurities are observed, the waste can be refused and redirected to a suitable treatment facility. In some Member States, the price for delivering contaminated waste is higher. Waste should be checked for the presence of hazardous substances based on information on the source or upon visual inspection. The latter can be supported by automated solutions and the use of cameras and sensors, which make the inspection more reliable.

6.2. Examples of onsite and non-onsite re-use

4. **Onsite and non-onsite re-use** involve dismantling construction products from an existing project and reintegrating them into a new project on the same site or at another

construction site close by (although perhaps in a different position and/or function than the original). This type of re-use includes[15]:

- Identification of products to be re-used;
- Carry out tests to define performance if necessary;
- Selective and careful dismantling of products;
- Documentation of the products;
- Storage, possibly transportation and protection of deconstructed products (dedicate a space inside or outside the building), in certain urban construction sites storage must be done off-site;
- Preparing for re-use on site or non-onsite: cleaning, remanufacturing, custom cutting, etc.

Whether construction products are suitable for their intended use depends strongly on their environmental and technical performance and characteristics. Furthermore, they need to fulfil the regulatory requirements (e.g. national building code, CPR) and any contractual requirements for a given use.

“Design For Disassembly” is an important precondition if re-use of construction products should be more widespread.

5. The offer in suitable construction products is obviously conditioned by the building in question, but also (above all) by the requirements of the new project. This requires prior identification of products suitable for this operation as well as essential coordination work between the actors. Carrying out a **prior audit with the aim of estimating the potential for re-use of products present on the site** and the involvement of the project author for the integration of said products are part of the approaches recommended.

Box 14 - Examples of guidance documents on re-use

- Circular Economy How-to Guide: Reusing products and materials in built assets: This guidance document contains a practical How-to Guide which is a follow up to the UKGBC Circular economy guidance for construction clients: How to practically apply circular economy principles at the project brief stage. This How-to Guide will explore reuse in more detail and set out actions for project teams to take forward during design and construction stages. Link: https://www.ukgbc.org/wp-content/uploads/2020/04/how-to-guide-reuse.pdf
- The project FCRBE - Facilitating the circulation of reclaimed building elements in Northwestern Europe developed a number of guidance documents and handbooks, namely a collection of 36 material sheets concerning how to reclaim and reuse different materials, a “Reuse toolkit – the reclamation audit”, and a “Reuse toolkit – procurement strategies” that can be accessed. Link: https://vb.nweurope.eu/projects/project-search/fcrbe-facilitating-the-circulation-of-reclaimed-building-elements-in-northwestern-europe/#tab-3

[15] Vadémécum Bâtiment Circulaire (2022): https://www.guidebatimentdurable.brussels/sites/default/files/documents/2022-03/32845-vademecum-batiment_circulaire.pdf

6.3. Preparing for re-use

6. **Preparing for re-use** means 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. [2] If re-use does not require any preparatory treatment, i.e. the product can be re-used directly, the product will not be considered waste.

7. **Preparing for re-use is to be promoted** as it involves application with little or no processing and less administrative burden than recycling. Often, re-use offers greater environmental advantages than recycling since environmental impacts associated with reprocessing do not arise or are much smaller compared with recycling. However, in practice this may not always be easy.

8. To ensure high re-use rates of used construction products with a potential for re-use, **a market for these products has to exist**. In many Member States the development of such markets is still in an early stage. To create demand, proof of satisfying quality is required. Tracking and tracing and relevant documentation is necessary for this. Usually, it is the contractor that is responsible for confirming the quality, e.g. documenting if the products for re-use were removed and handled as prescribed by the owner of the construction works. [44]

Examples of preparing for re-use include the cleaning of bricks from demolished buildings to be re-used in walls, checking and cleaning of old floorboards to be re-used for flooring, repurposing windows into indoor applications, or cleaning and checking of tiles to be re-used in roofings.

Figure 10 Preparing for re-use includes cleaning of bricks (Source: Danish Technological Institute)

9. **Digital platforms** are important tools to improve the market for the sale of re-used construction products.

Box 15 - Examples of Digital platforms

Several Member States have developed databases for used products. In Sweden, the association Bygg Igen has created an online marketplace for used products for the whole country[16].

In Finland, the free online service Material Market[17] allows companies and organisations to offer products and materials for others to use or search for waste transport and reception services as well as expert services.

The German platform Concular.de[18] contains a material shop where products for re-use are on sale. This is similar to another German marketplace called restado[19] and the Belgian RotorDC Deconstruction&Consulting[20]. The Belgian Opalis website shows an overview of professional retailers who sell reusable products from dismantled buildings[21].

[16] http://www.byggigen.se/
[17] https://www.materiaalitori.fi/
[18] https://shop.concular.de/
[19] https://restado.de/
[20] https://rotordc.com/shop
[21] https://opalis.eu/en/about

6.4. Recycling

10. **Recycling means 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. [2]

11. **Sound planning of construction activities** and related waste management activities on construction sites are a prerequisite for high recycling rates and high-quality recycling products. Besides the environmental benefits, recycling may also result in greater job creation, reduced use of primary materials and reduced landfilling. Avoidance of landfilling also supports environmental protection, a smarter use of natural resources, energy savings, a net decrease in greenhouse gas emissions, avoidance of excavations in (or exploitation of) rural/forest regions, and avoidance of future remediation costs. Studies show a clear environmental benefit from increased recycling and preparing for re-use but make also clear that high quality materials and proper demolition to preserve the quality of the materials are important provisions. [12]

12. **Materials can either be recycled onsite into new construction resources or offsite at a recycling plant**. Materials can also be recycled and used as secondary raw material in the production of new construction products at a manufacturing site. Typical materials recycled from construction works 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. For more details and examples, please refer to Annex E.

It is beneficial from an environmental point of view to target recycling routes that maintain the quality of the waste material. Emphasis should also be put on keeping impurities and contaminants as low as possible to prolong the recycling cycles.

Figure 11 Concrete elements ready for recycling (to the left); processing of CDW (to the right) (Source: Danish Technological Institute)

6.5. Other recovery

6.5.1. Other material recovery

13. Other material recovery includes **recovery operations in which waste replaces other materials**. It excludes, however, preparing for re-use, recycling and energy recovery, and is accordingly ranked low in the waste hierarchy. Other material recovery occurs when a waste material is used for a different end purpose than it was originally produced for. When waste is used for other final material recovery, attention must be paid to the fact that the

use of the waste material must serve a useful purpose and the management of the waste materials should be environmentally sound.

14. Backfilling is an example of other final material recovery. It is defined as “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”. [2] For most applications suitable CDW is crushed, inert waste. Mixed waste is not regarded as suitable. Backfilling can be useful in particular situations, when preparing for re-use or recycling is not possible, and can be applied in the context of the waste hierarchy.

15. However, **backfilling should be used as a last option** as it can undermine as an easier option the incentives to re-use and recycle in higher value applications. CDW should be treated before being backfilled, to avoid unwanted environmental effects, such as hazardous substances leaching into the groundwater. Registration of the backfilled areas and monitoring of the leachate is strongly recommended.

6.5.2. Energy recovery

16. **CDW that is used as a fuel or other means to generate energy is referred to as energy recovery if there is a net energy surplus, e.g. by substituting other fuels**. If CDW is incinerated in a municipal solid waste incinerator, the R1-formula [2] needs to be fulfilled for the process to be regarded as recovery and not disposal. Co-incineration in for example cement kilns is another way whereby energy can be recovered from waste. Incineration and co-incineration must be conducted in accordance with the BREF on waste incineration. [45]

17. **Use as Solid Recovered Fuels (SRF)** (sometimes also referred to as Refuse Derived Fuels (RDF) though the quality of RDF may not be similar to the quality of SRF) is another possibility for using CDW as a fuel, after having exhausted all possibilities for re-use, preparing for re-use and recycling.

18. **Make use of available technologies.** Several technologies have been developed for the processing (shredding) of CDW for SRF sorting and production. Standards, e.g. EN 15539:2011 have been developed to define the quality of SRF[22].To support the transition to a circular economy it is important to keep materials in circulation. This is not the case though when materials are used as fuels, and accordingly the use as fuels should be applied only if preparing for re-use or recycling are not viable solutions.

6.6. Disposal

19. **Disposal means any operation which is not recovery**. [2] Examples of disposal are landfilling or incineration without energy recovery. Disposal is ranked lowest in the waste hierarchy and should be avoided when possible. However, for certain waste streams disposal may be the only option available. This could be the case for waste materials contaminated with hazardous substances, e.g. asbestos containing waste (ACW) or PCB contaminated waste. At present, landfilling is the most common treatment solution for ACW, and quantities of ACW are expected to increase in the coming years because of an increase in renovation and demolition activities due to energy renovation. ACW is landfilled in hazardous and non-hazardous landfills, depending on the availability in the relevant Member State, and landfilling requirements (e.g. packaging of landfilled asbestos waste, deposit cells, covering of cells, etc.) differ across Member States. While several asbestos waste treatment technologies are emerging in the EU, there are still a number of barriers hindering their implementation at industrial scale. [16]

[22] EN 15539:2011. Solid recovered fuels – Classification and specification

7. Quality management and assurance

1. **Quality management and assurance of CDW management processes increase the trust in the quality of re-used products and CDW recycled materials.** In turn, this encourages the use of secondary raw materials. The quality of secondary raw materials is based on their environmental and technical performance. Appropriate quality management procedures and protocols ensure that the outputs meet pre-defined quality standards, which guarantee their market value. Thus, there is a need to promote quality assurance of the primary processes (from the audit process, to selective demolition, waste logistics and waste processing) (Section 7.1) and the provision of reliable and accurate information about the performance of products for re-use and recycled materials (Section 7.2).

2. **Traceability and tracking** are essential to the functioning of markets for re-used products and recycled construction materials. Documentation of all CDW management stages and the maintenance of the information through the value chain, from demolition site (waste origin) to re-use of products, material recycling and waste treatment and disposal ensure transparency and regulatory compliance. [46]

7.1. Quality of the primary process

3. Quality management legal and voluntary requirements — e.g. training requirements; certification/authorisation of stakeholders; inspections by authorities; comparison of audit recommendations to the real outputs — differ between countries. Many national, regional and local authorities have developed **electronic reporting and notification systems** to support the auditing process, facilitate required notifications to the authorities, the registration of waste streams, and the maintenance of documentation to track and trace resources.

Table 1 summarises the main elements and steps of quality management in the primary process. The term "requirement" in this context refers to both legislative and voluntary requirements. For more detailed information see also the Sections 3 to 0.

Table 1 Quality management steps in different stages of CDW management and re-use of products

CDW management		
Waste identification, source separation and collection	**Waste transportation**	**Waste processing and treatment**
Pre-demolition audit (a/o asbestos detection): • Requirements on auditor skills • Requirements on audit report content • Documentation of performed audit, e.g. via notification to authorities • Assessment of the audit, e.g. via public bodies Selective demolition: • Requirements on demolition plan • Requirements on skills, authorisation, certification of demolition companies and	Safe and sound transport: • Proper packaging of resources and waste, especially hazardous waste • Cleanliness of transportation equipment Special provisions: • Declaration for hazardous waste; • Identification form or transport form; • Registered or approved transporter/carrier • Receipts/documentation of transportation	Waste acceptance (at sorting / recycling / landfilling site): • Visual inspections • Control of transportation documents, quality guarantees • Documentation of acceptance, e.g. receipt, electronic notification to authorities • Input control (for example asbestos protocol) Legal requirements on sampling, testing and documentation prior to use (assessment against environmental limit values)

CDW management		
Waste identification, source separation and collection	**Waste transportation**	**Waste processing and treatment**
companies performing decontamination. • Inspection of the demolition process, e.g. by public authorities • Documentation of resource management during and after demolition and verification against audit information, e.g. receipts and other type of transport documentation Identification and separation of hazardous waste: • Requirements on skills, authorisation, certification of companies performing decontamination. • Documentation of waste management (a/o keeping hazardous waste separate) • Registration of waste		Quality assurance schemes dedicated to secondary raw materials, including industrial associations quality requirements[23] (e.g. if no relevant standards exist) • Acceptance criteria (such as for raw materials used for waste-derived products manufacturing); • Documentation of materials • Frequency of the sampling and testing of batches; • Identification of the recycled aggregates used in a specific product or civil engineering works (delivery note) (final tests of the waste derived, products clearly documented). Factory production control (addressing essential characteristics of products according to CPR);
Re-use of products		
Identification of re-useable elements, source separation and collection	**Transportation**	**Processing and treatment**
Pre-demolition audit: As listed above and in addition: • Specific testing and documentation requirements (e.g. on-site non-destructive testing of re-usable elements) Selective demolition: As listed above and in addition: • Specific requirements to deconstruction, documentation, packaging and storage • Requirements formulated e.g. by the client Identification and separation of hazardous waste: As listed above	Special provisions: • If necessary or required, tailormade declarations and/or transportation documents • Cleanliness of transportation equipment • Requirements for transportation, e.g. to packaging, storage during transport etc. • Receipts/documentation of transportation	Acceptance: • Documentation of acceptance, e.g. receipts by the client, marketplace • If necessary or required, tailormade declarations Control: • Specific testing and documentation requirements (e.g. of-site non-destructive testing or destructive testing of re-usable elements) Documentation: • Factory production control (addressing essential characteristics of products according to CPR)

[23] E.g. the Eurogypsum quality requirements for recycled gypsum

4. In general, **quality management and quality assurance become more important if recycled construction materials are used in 1) high-grade applications and 2) in large volumes (high recycled content).** Quality management is vital throughout every stage of the primary process, but at some stages and for some materials, good quality management is even more important. Secondary raw materials, like unbound recycled aggregates, can release hazardous substances if these are not removed prior to demolition and CDW processing. Recycled CDW materials— such as recovered plastics and wood — may be used in subsequent production processes, and if contaminated may impact on the health of workers in the construction, renovation, demolition and recycling sectors. Quality management and assessment (Table 1) help to ensure the quality of products for re-use and materials for recycling and the safety of workers.

5. Environmentally sound application of secondary raw materials can be secured by **introducing quality management checks and tools** at all stages of the primary process: 1) at renovation and demolition sites; 2) during waste transportation and transfer; and 3) at CDW recycling facilities (see Table 1). At all these stages, good documentation and adequate traceability procedures should be put in place.

6. **Make use of existing management systems and standards** such as ISO 9001 (quality), ISO 14001 and/or the Eco-Management and Audit Scheme (EMAS)[24] (environmental) and OHSAS 18001 (health and safety). Existing quality management systems provide a solid framework for more specific schemes aiming to ensure the quality of secondary raw materials. Quality management can provide competitive advantage, improve business performance and manage risk, reduce liability costs, attract investments, remove barriers to trade, enhance brand reputation and increase access to new customers, identify operation efficiencies and ensure greater profitability, encourage internal communication, demonstrate regulatory compliance and environmental commitment, reduce accidents, downtime and associated costs. [47]

BOX 16 – example: TRACIMAT[25]

Tracimat is a non-profit Flemish demolition management organisation which monitors materials from demolition/renovation from their origin until the first processor, with the aim of improving re-use and high-grade recycling. Tracimat certifies the quality of pre-demolition audits as well as the selective demolition process by issuing a "certificate of selective demolition" for demolition waste that has been selectively and safely collected and subsequently gone through a tracing system.

Thanks to the identification of all materials in a building and the preparation of an extended waste inventory, the follow–up of the selective demolition process and the recording of all the demolition waste materials set free during the works, more guarantees about the quality of the demolition waste material can be given. Quality is pursued by daily monitoring of demolition sites to identify bottlenecks to which solutions are found through research projects.

In addition, Tracimat generates awareness, information and in-depth training for experts and contractors on the different stages of the recycling route (identification of hazardous waste, high potential recycling waste, demolition techniques, acceptance criteria of recyclers).

[24] Under EMAS, Sectoral Reference Documents (SRDs) — which provide guidance on Best Environmental Management Practices — are available for the waste management sector and are in development for the construction sector: https://green-business.ec.europa.eu/eco-management-and-audit-scheme-emas/emas-resources/emas-reference-documents/emas-sectoral-reference-documents_en

[25] Information provided by Tracimat.

7.1.1. Quality management at the waste identification, source separation and collection stages

7. **Quality control during pre-renovation/pre-demolition audit and the renovation or demolition activity** is an important contributing factor of occupational safety and recyclability of the CDW materials. If hazardous substances such as asbestos and heavy metals are not removed properly and building materials are not separated at the demolition site, entire waste streams can get contaminated. In several Member States guidelines and protocols exist for the identification and removal of asbestos, tar and other hazardous substances (see also Section 4.2).

8. **All actors involved should receive adequate training on resource management and be acquainted with the project's waste management plan before commencing work**. [36] Standardised practices — such as sorting — across various sites and areas can increase predictability and ensure workers follow routine protocols.

9. **Appointing a person to oversee resource management allows for smoother communication and planning between all stakeholders**, including cooperation between the construction and demolition site and the waste transporters and processors. The responsible person should have adequate training and expertise in waste and resource management.

10. **Quality management of the demolition process and associated internal checks and inspections can be outsourced to specialised waste auditing companies.** This can increase transparency and effectiveness. In Belgium, for example, "valorists" help to plan and implement the collection and sorting of products and materials for re-use and recycling and communicate with project stakeholders.

11. The **key quality management steps in the waste identification, source separation and collection** consist of an audit, an onsite reporting, and a final report for the stakeholder or treatment facility that receives the resources for further processing and treatment**.** Some Member States have voluntary quality management certification schemes for demolition projects and processes.

BOX 17 – Example: Voluntary schemes

- In the Netherlands, most contractors are certified by the demolition process scheme BRL SVMS-007[26], which is controlled by third parties and the council of accreditation.
- Since 2004 in Germany the RAL Quality Association for Demolition Works e.V., an independent association, evaluates quality services in the demolition industry. In cooperation with the RAL German Institute for Quality Assurance and Labelling e.V., the association ensures the quality of demolition services and certifies specialist companies with the RAL quality mark for demolition work (RAL-GZ 509)[27].

12. During a new construction, key quality management steps include the **identification of types and amounts of expected waste and amounts**, to be reported in the resource and waste management plan**.** Planning for different types of waste during the different stages of the construction process may contribute to reduce management costs. The choice of construction products without or with low concentrations of hazardous substances and mixtures results in lower amounts of hazardous waste during the construction process and, at the end of the building life, the demolition process. Safer construction products may also

[26] Veligslopen, https://www.veiligslopen.nl/en/
[27] RAL Gütezeichen Abbrucharbeiten, https://www.ral-abbruch.de/

contribute towards a healthier indoor environment. Reporting, feedback and follow-up activities during the construction process ensure correct management and allow for corrections. This aspect is highlighted in building certification schemes.[28]

7.1.2. Quality management during CDW transport

13. CDW should be transported to the respective storage or treatment facility safely and in compliance with local legal requirements. [48] **Safe and sound transport** includes adequate packaging of resources and waste, and in particular of hazardous waste, and cleanliness of transportation equipment to avoid contamination and cross-contamination. CDW transport is to be implemented by registered specialised companies.

14. Communication between the construction and demolition site and the companies in charge of CDW transport and processing is important for the quality of materials. The handling and transfer of waste should be done by trained staff and the process should be documented and validated. Moreover, the collection, packaging, transport, trade and treatment of hazardous waste may require a permit. **Before transfer, the contractor should verify if the waste is hazardous and provide appropriate transport means.** Hazardous waste should be kept separate from other waste, safely stored, using clearly labelled containers and out of reach of unauthorised people. Moreover, the contractor should prove that the hazardous CDW is transferred to an authorised facility. Proper management of separated waste streams and documentation of waste shipments and deliveries facilitate compliance with waste acceptance criteria and environmental requirements at the receiving facility and speed up checks and inspections. [49]

7.1.3. Quality management during CDW processing and treatment

15. Recyclers can take several steps to ensure the quality of input materials for recycling, such as following strict **acceptance protocols** of inert waste requiring checking of material certificates, delivery notes and the waste shipments themselves. Such practices can be facilitated establishing cooperation and dialogue with demolition and waste transport companies.

16. **Quality Assurance schemes exist for specific products** — such as for recycled aggregates — in several Member States. These schemes set waste acceptance and environmental requirements to be met to ensure input material quality.

17. **Quality Assurance schemes contribute to reduce the risk of environmental pollution and material contamination**. When the schemes are implemented properly, each step (selective demolition-waste acceptance, factory production control, final testing) reduces the risk of hazardous substances passing to the final products. Quality Assurance schemes can also ensure that waste treatment output is in line with expectations, product specifications and/or standards, and that the entire waste treatment process is monitored and optimised, thus improving the overall environmental performance of waste treatment. Waste treatment output intended to be permanently incorporated into construction works must be tested according to the harmonised products standards and EADs (European Assessment Documents) under the CPR. [3]

18. Many Member States also have more general quality management schemes which apply for all process steps, for instance **guidelines to make sure that employees work with good equipment and are skilled and trained.**

19. **Practitioners are encouraged to work with end-of-waste criteria, where in place.** The Waste Framework Directive allows Member States to develop end-of-waste criteria for different waste materials, based on the criteria listed in Article 6. [2] Some countries have already developed these criteria; others have opted not to work with them. Stakeholders in the construction and demolition supply chain often indicate that end-of-waste criteria are a

[28] For example, the German Sustainable Building Council (DGNB) certification (https://www.dgnb.de/en)

precondition for development of a market of secondary construction materials. The ambition of this Protocol is just to provide elements and building blocks to allow Member States and industry to make informed choices fitting the specific context.

7.2. Quality of products and product standards

20. In theory, there could be several ways to validate the technical performance and quality of re-used products and recycled materials, including certification, accreditation, labelling and marking. However, most construction products are covered by the CPR and therefore harmonised European standards apply, whether these are made of primary or secondary raw materials. [3] This section looks at the rules and guidelines for placing re-used products and recycled materials on the European market and related quality assurance instruments.

21. **Making use of existing European product standards.** The CPR lays down harmonised rules for the marketing of construction products and provides tools to assess the performance of construction products. When placing new construction products on the market, the characteristics and reporting formats defined in the harmonised European product standards (hENs) must be followed. CE-marking is mandatory. If a hEN covers used construction products, then these rules also apply for the re-used construction products.

22. **If these European product standards do not apply, make use of European Technical Assessments as a voluntary road to CE-marking.** New or used products that are not covered by hENs can still be CE-marked with the use of European Technical Assessments (ETA) issued according to European Assessment Documents (EAD). The ETA document provides information about the performance of a construction product, to be declared in relation to its essential characteristics. This voluntary tool enables manufacturers to place re-used products on the EU market and allows them to declare specific information about the performance of their products.

23. **Factory production control (FPC) prescribes the frequency and types of sampling and testing.** There are several classes, starting with self-declarations up to third party control by a notified body **(**for products that are used for installations with higher safety requirements). The rules for different levels of production control are laid down in the CPR and the respective harmonised European product standards or EADs.

24. **In case harmonised European product standards or assessments do not apply** or are lacking, national rules or industrial associations quality requirements maybe useful.

8. Policy and framework conditions

1. Successful CDW management as set out in this Protocol can only take place if the appropriate policy and framework conditions are in place. To achieve this, a **dialogue between public and private actors** within the construction sector and in the field of CDW management is of the greatest importance. Whilst Sections 1 to 7 are addressed to private actors and companies active in the field, this Section is aimed at public sector representatives, active at local, regional and national levels. Key areas for public action are 1) An appropriate regulatory framework; 2) Enforcement; 3) Right public procurement and incentives; 4) Awareness, public perception, and acceptance.

8.1. An appropriate regulatory framework

2. Regulation of CDW management requires **waste ownership to be clear**, in line with existing national legal frameworks and contractual terms between owners of construction works, the (demolition) contractor, the intermediate holder (e.g. sorting operator), the final recycling operator and the end user of the recycled products. Such clarity is a condition for any transactions in the value chain – and attain confidence between all actors involved.

8.1.1. Circularity and harmonisation with EU initiatives in the regulatory framework

3. Regulatory frameworks can promote measures to counteract the consumption of resources and raw materials and include basic requirements to promote circular and sustainable practices, as well as align policies with EU initiatives. The **waste hierarchy provides clear guidance on the prioritisation of waste management options** and should be considered in C&D projects and CDW management.

4. **Competent authorities should include CDW initiatives in their waste management plans.** Member States competent authorities shall establish waste management plans setting out environmentally sound measures to improve preparation for re-use and re-use, recycling, recovery and disposal of waste.

5. Several Member States have **specific regulations regarding CDW management**. [50] Member States — such as Portugal, [51] the Netherlands, [52] Denmark [53] and Flanders [54] — have published national strategies and action plans for the circular and sustainable transition of their countries' construction and demolition sectors.

6. Other countries (e.g. Finland [55] and Germany [56]) have issued **reports identifying ways to promote the recovery and recycling of plastics on construction sites**, as well as increase the use of recycled plastics in construction products which is aligned not only with circular construction practices, but also with the EU's Plastics Strategy. [57]

7. Additional guidance on CDW management exist. **JRC's Best Environmental Management Practices (BEMPs) for the Waste Management sector** include CDW management strategies. BEMPs are aimed at waste management companies and waste authorities and include: developing integrated waste management plans; embedding life cycle thinking and assessment into waste management strategies and operations; using economic instruments to reduce waste amounts, encourage preparing for re-use and recycling and improving product design. [58]

8.1.2. Facilitating Re-use

8. Regulatory frameworks can **encourage the re-use of materials** through awareness raising, development of hENs or EADs for used construction products under the CPR, development of guidance documents, creation and support of re-use markets and defining clear requirements for re-use (e.g., clear status for re-use materials, responsibility, insurance coverage for re-used products, adoption of quality standards and certificates for construction products with recycled materials) [59,60]. Physical and digital platforms and networks are emerging to connect the supply and demand of products from deconstruction and facilitate re-use (see Box 15 for examples of digital platforms). The Netherlands is encouraging re-use in construction through materials passports and the Concrete Agreement, where stakeholders work together on the sustainability of concrete, including its re-use.[29]

8.1.3. Demolition and renovation permits and licenses

9. Local authorities are responsible with **issuing demolition and renovation permits or licenses,** which allow the promotion and enforcement of high-quality waste management plans based on pre-demolition audits and encourage circularity. Several Member States (e.g. Finland [61], Flanders [62] and Ireland [36]) have permitting and licensing requirements that include mandatory recording, tracking and reporting, analysis of waste types and quantities, approval of a responsible person to oversee demolition work, and authorisation requirements for waste collection.

10. **Post-demolition follow-ups and evaluation processes are very important.** Requiring demolition reports after the works have been carried out allows the local authorities to monitor whether the plans were implemented effectively (see for example Section 9-9 of the Norwegian Technical Regulation TEK17 [63]). Local authorities are encouraged to provide the demolition operator with incentives to climb higher in the waste hierarchy.

11. When designing a regulatory framework for CDW, it is important that the **administrative burden is kept to a minimum**.

8.1.4. Integrated waste management strategies

12. Local, regional or national authorities could **set up integrated waste management strategies** that allow for CDW waste management to be promoted in a more systematic way. CDW management is driven by economic instruments, regulations, standards, enforcement practices and awareness and should be considered in an integrated waste management strategy. These plans and strategies are above all useful at regional or national level and take full account of the specific situation. Integrated waste management plans should:

- Involve stakeholders
- Prioritise waste prevention and re-use in construction projects
- Establish minimum requirements for waste sorting and management
- Identify and quantify future CDW waste flows and ensure development plans allocate enough area for CDW treatment and collection
- Calculate total costs and impact of implementation of strategies
- Establish more ambitious objectives and monitoring and enforcement mechanisms

[29] https://www.betonakkoord.nl

- Include measures to avoid illegal dumping, littering and the spread of hazardous substances and microplastics
- Provide clear guidance on proper CDW management. [58]

13. **Economic instruments** can be incentivising or disincentivising and include:

- Taxes (e.g., product levies on aggregates, landfill taxes, incineration taxes);
- Waste pricing (e.g., different fees per unit of collected volume for different waste fractions);
- Deposit refund schemes (e.g., business to business schemes for reusable packaging like pallets, deposits for estimated waste amounts in a waste management plan as a requirement for licensing);
- Extended producer responsibility schemes; and
- Others (e.g., subsidies, positive incentives).

14. **Landfill restrictions are a prerequisite** for developing a market for recycled CDW materials. Restrictions on incineration can be relevant to divert certain CDW fractions, such as plastic, wood and paper, from incineration to recycling. This could be in the form of sorting requirements for mixed CDW or specific requirements for waste sent to incineration. A mix of bans and high taxes on landfilling and incineration could provide the necessary incentives. However, such restrictions always need to be accompanied by other measures and, as a minimum requirement, sufficient capacity to recycle the diverted materials.

15. **Landfill bans can be a powerful instrument**. A progressive reduction of landfills, taking into account transition periods where necessary, is imperative to prevent detrimental impacts on human health and the environment and to ensure that economically valuable waste materials are gradually and effectively recovered through proper waste management and applying the waste hierarchy. [7] In Member States with large waste incineration capacity, measures aiming to reduce the capacity may promote recycling and preparing for re-use. Landfill restrictions are governed by EU law as well as Member State-specific legislations. The EU Landfill Directive [7] defines the acceptance criteria and procedures for different categories of waste (for ex., municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills defined as waste disposal sites for the deposit of waste onto or into land[30]. As part of landfill restrictions, it is important to establish a clear position vis-a-vis backfilling practice (see Section 6.5.1).

16. Proper implementation of landfill or incineration bans requires a **strict and standardised acceptance policy**. Waste must be treated before being put in landfills; hazardous waste must be directed to landfills accepting hazardous wastes; landfill sites for inert waste must be used only for inert waste. Waste for incineration must be sorted to ensure that only waste suitable for incineration is incinerated, i.e. waste that may be recovered otherwise and waste that may give rise to emission of pollutants beyond what can be controlled by abetment measures at the incineration plants.

17. **Landfill taxes can be a powerful and flexible instrument**, allowing forms of waste management alternative to landfilling to compete in terms of economic feasibility. They are set by Member States, regions or local authorities, and need to be adjusted to the local situation (urban versus rural), nature of the waste (hazardous versus non-hazardous) as well as its condition (processed or not). The higher landfill taxes should be set for recyclable waste materials, whilst lower amounts should apply to inert non-recyclable waste. The same applies to taxes on incineration.

[30] In this context, excavated soils/rocks need to be separated as well. However, as they are naturally occurring materials they are not considered in the scope of this Protocol.

18. **Hazardous waste treatment needs to be regulated in the waste treatment stage** through environmental regulation. These norms and standards envisage the elimination of hazardous substances and specifies the treatment to be applied to each of them.

19. The EU has **additional regulations regarding the management of materials and waste containing Persistent Organic Pollutants (POPs) [64] and asbestos [65].** Wastes containing POPs listed in the Regulation annex IV and exceeding certain limits need to be destroyed and cannot be circulated in new products. All countries have regulation for the removal of asbestos prior to demolition or renovation. The legislative requirements for other substances varies depending on the materials used in construction.

20. **Technical guidance on waste classification exists at EU [66] and national level**, although none are specifically for classifying CDW. Several Member States, such as Finland and Denmark, have national guidelines on hazardous waste management in CDW.

21. Depending on the local situation, **taxes on virgin materials may be considered to provide price incentives to use recycled materials.** However, they should be used prudently as they could increase the cost of construction without necessarily bringing the desired benefits to the environment or to the economy, especially if they lead to imports/transports of materials from countries or regions where such taxes are lower or not applied. More broadly, combinations of policy instruments tend to work better than single policy measures. Taxes on virgin materials and/or gravel taxes have been tested across Europe – and it is important to profit from the insights obtained.

22. It is recommended that revenues arising from **landfill or incineration taxes are earmarked** for financing measures that promote and support waste management policies and practices (e.g. decontaminating sites, functioning of public waste management authorities, subsidizing CDW recycled materials). Such revenues should not flow back to the general state budget.

8.1.5. Allow space for storage and recycling in public planning

23. The available CDW storage and recycling capacity is crucial for promoting CDW management. The feasibility of recycling is highest in densely populated and urbanised areas. However, this requires that space is reserved and that **permits are issued to build such facilities in appropriate locations** close to the urban areas.

24. **Public authorities in general and municipalities in particular have several roles to play:**

- Estimate the required capacity in a given territory (based on integrated waste management plans and strategies);
- Design a framework for recycling, including the correct financial/economic incentives;
- Review proposals for site selection for facilities and issue permits based on all the considerations above;
- Address public perceptions with the aim to open mindsets and overcome ‘Not in my Backyard (NIMBY)’ attitudes;
- Enforce the scheme by monitoring the correct use and implementation of permits;
- Take corrective measures where required (e.g. giving renovation companies access to container parks to deliver flat glass waste; it is an efficient way to promote the recycling of flat glass from the renovation of construction works, with limited logistics costs).

25. If there is a shortage of permanent recycling facilities, **temporary recycling installations and onsite recycling may be an option.** Some materials of higher value (e.g., plastics, ceramics, glass, gypsum, wood and metal) can be transported further away

without compromising economic feasibility. Building storage systems can also be part of the solution.

26. As part of such permits or licenses, **local authorities also need to form a view on the use of mobile recycling plants (or mobile crushers).** Mobile recycling plants are specific to inert CDW, e.g. concrete and bricks, but also asphalt. Advantages of mobile recycling plants are a reduction of transportation costs, and direct on-site access to the recycled materials. However, factors to consider when deciding on permits for such mobile installations include [67]:

- The complexity of the feed material as mobile plants can be used only for crushing and magnetic separation
- Environmental and health aspects – including microplastics, dust, noise, vibrations, leaching, accident risks;
- The neighbourhood perspective – distance to residential areas (microplastics, dust, noise, vibrations, accidents);
- Emissions – mobile recycling plants are typically diesel-fuelled, whilst fixed installations run on electricity, which is associated with lower emissions[31].

The decision between processing on-site (mobile) or at a stationary plant depends on the situation. Irrespective of the choice between mobile or stationary recycling plants, the quality of aggregates produced needs to be of similarly high quality. In addition, recycling plants should fulfil all requirements related to environmental-, health- and workers safety legislation.

8.2. Enforcement is key

8.2.1. Enforcement of landfill and incineration restrictions

27. Enforcement is primarily the responsibility of local and/or regional authorities, and the **impartiality** of those involved (including politicians, civil servants, and police force) needs to be secured.

28. Local authorities need to **manage complaints about illegal dumping actively**. This includes thorough investigations and follow-up of any such reporting.

29. **Proportional sanctions for illegal activities need to be imposed**, wherever they occur along the value chain of CDW (from illegal landfilling through waste dumping). They need to be set at high levels to act as deterrents, especially when hazardous waste is concerned.

30. In case enforcement is not sufficiently effective at local level, in particular with regard to hazardous waste, **higher authority levels** (regional, national) need to intervene with corrective or complementary measures.

8.2.2. A special word about enforcement of hazardous waste

31. Hazardous waste needs to be addressed systematically in all stages of CDW processing. **Governments should adopt concrete actions to enforce existing legislation**. This needs to be done at different stages in the waste management cycle: waste identification, collection and sorting, waste logistics and waste treatment [2]. During waste identification, collection and sorting, regulatory measures need to cover the necessity of conducting a pollutant investigation in the form of a pre-demolition/pre-renovation audit

[31] It depends on the fuel used in the power station generating electricity.

or a waste management plan, before the renovation/demolition takes place, and promote waste flow separation.

32. **Hazardous waste must not be mixed** with other types of hazardous waste or non-hazardous waste [2]. Producers of hazardous waste as well as companies collecting and transporting hazardous waste shall keep a record of the quantity, nature and origin of the waste. Authorities shall take the necessary measures to enforce these provisions.

8.2.3. Documentation is essential

33. Throughout the waste management cycle, monitoring is crucial. **Therefore, it is essential that all authorities have the necessary documentation.** This creates transparency and trust in the CDW management process.

Box 18 – Examples that may be relevant:

Member States are expanding their documentation and reporting requirements to aid in the tracking and traceability of waste flows. Denmark has transport reporting requirements where notifications must accompany CDW from the project site to the reception facility [68]. Sweden has mandatory reporting requirements for waste and recycling operations subject to a permit for the amount of CDW received and how it was treated. Sweden has also expanded its reporting requirements in waste management plans: stakeholders have to report which construction products can be re-used and how these should be taken care of, the amount of waste that may be generated and how it should be taken care of, including how to enable high quality material recycling, and the removal and safe handling of hazardous substances.

8.3. Public procurement

34. **Authorities at all levels can provide incentives for promoting the use of CDW recycled materials.** Public authorities must lead by example and can include circular priority rules in public tenders, enable use of recycled materials, involve public authorities in testing new CDW management tools and techniques on their construction works through public procurement and set minimum requirements. Green Public Procurement (GPP) criteria have been published for use in office buildings and road construction[32]. The Commission is looking into developing more GPP criteria based on Level(s) and promoting the use of BIM in public procurement requirements.

35. CDW management strategies at the construction site can be enhanced by including requirements for sorting in the contracts. **Contractual agreements can encourage better consideration of re-use, recycling and recovery targets** and general or technical criteria by including penalties in the event of poor execution or failure to achieve the objectives required or bonuses in the case of exceeding the objectives.

8.4. Awareness, public perception and acceptance

36. National, regional and local authorities can stimulate and promote CDW management practices through providing support, encouraging experimentation, providing good governance, vision and spreading good examples. **Authorities need to inform companies about the legal requirements** (made at local, regional, national or EU level) regarding CDW management. Upon request, advice should be given on how to comply with all legal

[32] DG Environment, http://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm

requirements. All local, regional and/or national authorities play a role for effective CDW management. It is the construction/renovation/demolition company's responsibility to acquire the necessary knowledge with respect to the planned operations.

37. **Local authorities can actively contribute to increase cooperation along the waste value chain.** The construction value chain is complex and is composed of large and smaller actors, from private builders and architects, to consultants, contractors, renovation/demolition companies, waste management companies and recyclers, and manufacturers and distributors of construction products. The costs and benefits of CDW management are not distributed equally along the value chain; costs tend to be incurred during the early stages whilst benefits tend to accrue further downstream. Examples of cooperation initiatives are 'recycling platforms' (or waste transfer facilities), or virtual platforms (e.g. websites) that bring companies into contact with each other.

38. Once the quality of CDW and the waste management process itself have been addressed, it is time to **address the public perception, awareness and acceptance of CDW recycled materials.** It is therefore important that all actors in the value chain are sufficiently aware of the value inherent in working with CDW recycled materials, and are confident in their quality.

39. All policy and framework conditions need to provide the appropriate incentives in a **concerted and coherent manner**, consistently across all authorities — from municipalities, cities and regions to Member States and the European Union. This requires various authorities to communicate with each other on a regular basis.

40. **All stakeholders** (including industry and NGOs) should be consulted and involved in the process. Stakeholders should be engaged on: 1) Measure current practices and collect data; 2) Support in the organisation of the sector along the value chain; 3) Communicate about norms, rules and laws set for CDW recycled materials; 4) Develop an information campaign on the quality of CDW recycled materials; 5) Raise awareness about the pitfalls of NIMBY effects.

41. **The broader public can also be engaged** by facilitating (e.g. through mobile apps) and promoting the reporting of illegal dumping.

42. **Cooperation between authorities and industry is essential** for the development of guidelines, and information and training efforts.

43. Financial support to **research and innovation** in the construction and demolition sector and the CDW management sector allows organisational and technological innovations to thrive. Regulatory and financial support is also key to allow innovations to compete against more established practices and technologies.

44. **Training and skills.** Developing a skills base is essential to facilitate the circular transition in construction, renovation and demolition. Awareness and training make it possible to ensure good involvement and understanding of the issues by all stakeholders on the site, and thus compliance with the removal and sorting conditions required for the valorisation of secondary resources. Employees at all stages of the value chain must have the appropriate skills and motivation to apply circular principles and use appropriate tools. Raising employee's knowledge and skills can be done developing training programs for educational institutions, learning centres, business associations and on-site staff training that include circular principles, re-use methods and CDW management practices. Additionally, it is important to provide clear instructions on hazardous waste and its particular dangers.

45. **Market for secondary materials.** Efforts should be made to develop a market for secondary materials, eliminate bottlenecks and increase market confidence. The region of Flanders in Belgium is taking steps to increase market confidence through improving the monitoring of material flows, guaranteeing quality for re-used products, and stimulating the market for circular construction. Cooperation between the construction and demolition industry, waste industry and users of materials is important for the creation of a functioning market.

Annex A Contributors

The revision and update of the Protocol and the Guidelines for waste audits have seen the participation of over a hundred stakeholders between November 2023 and May 2024. Here we aknowledge the contribution of those that have supported us by providing written feedback to the various drafts of the document.

LIST OF CONTRIBUTORS	
Name and position	**Organisation**
Inez Postema, CEO	AC Minerals Asbeter
Antonella Contino, Sustainability and Circularity	AGC Glass Europe
Stephen McAleenan, Senior Contracts Manager	Barnmore Demolition
Eléonore de Roissart Jeroen Vrijders	Buildwise
Krisztián Petrovszki, Expert	CLEAN-WAY Ltd.
Collective input (coordinated by Vagner Maringolo, Sustainable Construction Manager at CEMBUREAU)	Concrete Europe
Dominik Campanella, CEO	Concular
Mette Skovgaard, Consultant	Danish Competence Center for Circular Transformation (Dakofa)
Alexis Murgat, Business Line Manager	Dekra
Mona Nasseredine	Directorate for Housing, Urban Planning and Landscapes (DHUP) of the French Ministry of Ecological Transition
Antoine Stilo	EuRIC
Jan te Bos, Director General	EURIMA
Céline Carré, Sustainable Construction Working Group Leader	Eurogypsum
Spyros Mathioudakis, Policy Officer	European Builders Confederation (EBC)
Claudiu-Nicolae Sonda, Policy Officer for Sustainability and Construction	European Confederation of Woodworking Industries (CEI Bois)
Quentin de Hults, Director Pia Voutilainen, Director at Scandinavian Copper Development Association	European Copper Institute (ECI)
Esther Santos, Secretariat	European Demolition Association (EDA)

LIST OF CONTRIBUTORS	
Name and position	**Organisation**
Antoine Stilo, EU Policy Advisor	European Recycling Industries' Confederation (EuRIC)
Aizea Astor Hoschen, Legal and Policy Officer	European Waste Management Association (FEAD)
Dr. Hans-Jörg Kersten, Head of Environment	Federal Association of Gypsum
Roland Starke, Expert	Federal Ministry of the Republic of Austria for Climate Action, Environment, Energy, Mobility, Innovation and Technology
Geert Cuperus, Secretary General	Fédération Internationale du Recyclage (FIR)
Walburga Sodermanns-Peschel, Head of Environment and Recycling Department	German Demolition Association
Shumaila Khatri, PhD Candidate	Inland Norway University of Applied Sciences
Isabel Milagre Martins	Laboratório Nacional de Enghenharia Civil
Erik Sandonis, Technical office and R+D+i manager	Lezama Demoliciones
Andris Mālnieks, Senior Officer of Construction Policy Development	Ministry of Economics of Republic of Latvia
Flora Anvarifar	Ministry of Infrastructure and Water Management of the Netherlands
Isabel Martins, Researcher	National Civil Engineering Laboratory of Portugal (LNEC)
Philippe van de Velde, Policy Advisor Construction Waste Koen de Prins, Construction and Demolition Waste	Public Waste Agency of Flanders (OVAM), Belgium
Richard Geevers, Director	PSLoop
Johan D'Hooghe	Recycling Assistance BV & Tracimat
René Čechmánek, Research Worker	Research Institute of Building Materials (VUSH)
Damien Verraver, CEO	Retrival
Gilli Hobbs, Director	Reusefully Ltd.
Alice Palumbo	SEC Newgate EU
Juan Carlos Hernandez Parrodi, Senior Project Manager	Stadler
Gregory Richards, Policy and Regulations Manager	Stora Enso

LIST OF CONTRIBUTORS	
Name and position	**Organisation**
Inés Díez Ortiz, R&I	Tecnalia
Archibald Carlier, Project Engineer - QHSE	Tradecowall
Ana Nadazdi, Civil Engineer	University of Belgrade, Faculty of Civil Engineering (Department of Project Management in Construction, Faculty of Civil Engineering)
Edwin Zoontjes, Association Manager	VERAS (Dutch association of demolition and renovation contractors)
Martin Berwart	Walloon Union of Architects

Annex B Hazardous substances and materials in construction works, hazardous properties and hazardous waste

Hazardous substances and mixtures and hazardous waste

1. Hazardous substances and mixtures are defined as substances or mixtures fulfilling the criteria relating to physical hazards, health hazards or environmental hazards laid down in Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures [6]. Moreover, waste is considered hazardous if it displays one or more of the hazardous properties listed in Annex III to the Waste Framework Directive [2].

Hazardous properties

Annex III to the Waste Framework Directive [2] describes 15 properties (HP 1 to HP 15) of waste which renders it hazardous. The table below provides an overview of the hazardous properties.

Table B-1 Hazardous properties

Hazardous Properties	
HP 1	Explosive
HP 2	Oxidising
HP 3	Flammable
HP 4	Irritant – skin irritation and eye damage
HP 5	Specific Target Organ Toxicity (STOT)/Aspiration Toxicity
HP 6	Acute Toxicity
HP 7	Carcinogenic
HP 8	Corrosive
HP 9	Infectious
HP 10	Toxic for reproduction
HP 11	Mutagenic
HP 12	Release of an acute toxic gas
HP 13	Sensitising
HP 14	Ecotoxic
HP 15	Waste capable of exhibiting a hazardous property listed above not directly displayed by the original waste

Asbestos

2. The use of asbestos has been banned in the EU since 1 January 2005 and some Member States introduced a ban on asbestos before this date. Construction works — including renovation and demolition activities — and management of construction and demolition waste pose the highest risk of exposure to asbestos, due to the widespread historical use of asbestos-containing products in the construction sector. Asbestos is a hazardous material, and while a number of asbestos waste treatment technologies are emerging, the most common treatment is landfilling.

Table B-2 Overview of places where asbestos can be found in industrial and residential properties [16]

What	Description
Sprayed coatings on ceilings, walls, beams and columns	This contains up to 85% asbestos and breaks up very easily. It is one of the most dangerous materials containing asbestos.
Asbestos cement (water tanks, roof slates, panels, gutters and downpipes, soffits, flue)	Asbestos cement is mainly a mixture of chrysotile (white asbestos) and and/or crocidolite (blue asbestos) with cement, moulded and compressed to produce a range of asbestos cement products.
Lagging on boilers and pipes	This type of asbestos has many different appearances but is mostly a fibrous material which flakes and powders easily.
Asbestos Insulating Board (AIB)	Normal building items such as wall panels boards, bath panels, ceiling tiles and plasterboard. It is difficult to tell the difference between asbestos insulating board items and non-asbestos materials.
Floor tiles, textiles, composites and paper	• Asbestos floor tiles were once a popular choice for flooring and are now often hidden under carpets. • Textiles can be found in fuse boxes behind the actual fuse. Old fire blankets and heat resistant gloves can also be made of asbestos textiles. • Asbestos composites can be found in toilet cisterns and seats, windowsills, and bath panels. • Asbestos paper was used for lining under tiles and inside metal cladding.
Asbestos rope seals and gaskets	Asbestos rope seals and gaskets can be found in gas or electric heating appliances
Textured decorating coatings on walls and ceilings, e.g., Artex	Textured coatings were used to produce decorative finishes on ceilings and walls. In the past, they have had various trade names such as ‘Artex’.
AIB partition walls, interior and exterior window panels, around boiler, behind fire and airing cupboards	Normal building items such as wall panels boards, bath panels, ceiling tiles and plasterboard. It is difficult to tell the difference between asbestos insulating board items and non-asbestos materials.
Sprayed insulation coating boiler	Insulation on the underside of roofs and sometimes sides of buildings and warehouses. Also used as fire protection on steel and reinforced concrete beams/columns and on underside of floors.
Roofing felt	Asbestos roofing felt was often used for garage roofs, outbuildings etc.

Substances that can render waste hazardous

3. If CDW contains hazardous substances or is contaminated by hazardous substances at levels exceeding the legal limits, it is classified as hazardous waste. In these cases, specific precautions are necessary when handling CDW or during the renovation of construction works to prevent impacts to public health, occupational health and safety, and the environment. Prior to a renovation or demolition process, it is essential to identify hazardous substances and materials or elements containing hazardous substances and recommend the most appropriate management option. The most common groups of hazardous chemical compounds that are found in building materials are [30]:

- Alkylphenols and related compounds;
- Antimicrobials;
- Asbestos and related compounds;
- Bisphenol A (BPA) and structural analogues;
- Chlorinated polymers;
- Chlorobenzenes;
- Chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC);
- Formaldehyde;
- Monomeric, polymeric, and halogenated organophosphate flame retardants (HFRs);
- Organotin compounds (COEs);
- Perfluorinated and polyfluorinated alkyl substances (PFAS) / Perfluorinated compounds (PFCs);
- Phthalates (and ortho-phthalates);
- Polychlorinated biphenyls (PCB);
- Polycyclic aromatic hydrocarbons (PAH);
- Short and medium chain chlorinated paraffins;
- Toxic heavy metals;
- Volatile organic compounds (VOC) (wet-applied products);
- Wood treatments containing creosote or pentachlorophenol.

4. These substances are usually found in demolition works of buildings and infrastructure predating their use restrictions. **Hazardous substances in re-used products** should not be neglected: these products are not classified as waste and therefore are not regulated by waste legislation, but rather by products' safety legislation and chemical legislation, such as REACH and CLP.

Box 19 – Example: Relevant guidance documents with focus on hazardous substances and materials in construction

- Hazardous substances in construction products and materials – PARADE. Best practices for Pre-demolition Audits ensuring high quality Raw materials [28]: This guidance document aims to give an overview of potential hazardous substances that might occur in construction products and how to deal with hazardous waste during renovation and demolition activities. (in English)
- Demolition mapping guidance document [69] - Annex A of this document contains a table with examples of hazardous materials, which construction elements they can typically be found in and how the CDW containing them would be classified according to the European List of Wastes (LoW). (in Finnish)
- Protocole de déconstruction pour la Région de Bruxelles-Capitale [29] – The document provides a checklist (particularly useful for field visit) to support the identification of hazardous substances, where in the building they can be found, and the materials they are typically contained in. (in French)
- Guía para la Gestión de Residuos de Construcción y Demolición en el Ámbito de la Rehabilitación Energética de Viviendas [70] – The guidance document focusses on CDW management in energy renovation of buildings. It contains special information on asbestos containing materials and where they can be found in buildings. (in Spanish)
- Decontamination of hazardous substances [71] Publication from the EDI – European Decontamination Institute containing information on hazardous substances that may appear in construction, demolition, dismantling, or refurbishment sites.. (in English)
- LBC Red List – list published annually by the International Living Future Institute that includes substances prevalent in the building industry. (in English)[33]

[33] Link to the LBC Red List, https://living-future.org/red-list/

Annex C Recommended templates for inventory of materials and elements and management recommendations

Research and development are ongoing on how to best structure templates for audits, how to integrate with digital tools for mapping, quantification and reporting. The templates presented below are meant for inspiration and can be adapted to specific needs.

For example, information on the building to be audited can be supplemented with additional data fields. DIN SPEC 91484 offers some ideas:

- building category
- location (such as street, town, postcode)
- construction/type (such as monolithic construction method, prefabricated or mixed construction method)
- year of construction
- gross volume
- gross floor area
- type of use
- information on past renovations.

Likewise, information on element-level may be supplemented with additional information that gives a better understanding of connection types, dismantlability, link to pollution report, information on suggested use, information on potential CO_2-savings (e.g. from the environmental product declaration (EPD), if this is available for a re-used material), need for additional tests and documentation needs. Also, fields for contact data to the auditor may be added.

Recommended templates for inventory of materials

Table C-1 Recommended template – minimum content

BUILDING: Relevant information:						
Type of material	**Material identification**	**Waste code (EWC and EURAL)**	**Location**	**Quantity**	**Unit**	**Observations or other information**

Table C-2 Inventory of materials – 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					

Table C-3 Recommended template - detailed assessment

BUILDING: Level: Other relevant information:									
Construction unit:									
Type of material	**Material identification**	**Waste code (EWC and EURAL)**	**Location**	**Quantity**	**Unit**	**Possible outlets[1]**	**Recommended outlet[2]**	**Precautions to take during the deconstruction phase[3]**	**Pictures and notes**

1 Reuse; recycle; backfill; energy recovery; elimination.
2 The recommended outlet must be identified taking into account the hierarchy of waste treatment and the potential possibilities in the proximity of the jobsite
3 Ex: do not leave the frame on the plasterboards; be careful to remove the power plugs, etc.

Table C-4 Recommended content. Summary

Building	Level	Material to evacuate	Construction units	Quantity/ weight	Unit	Recommended outlet
Building	Ground floor, Level 1, Level 2					
		TOTAL OF INERT WASTES				
		TOTAL OF NON-INERT NON HAZARDOUS WASTE				
		TOTAL OF HAZARDOUS WASTES				

Inventories of materials (essential) are recommended to be compiled according to the following options:

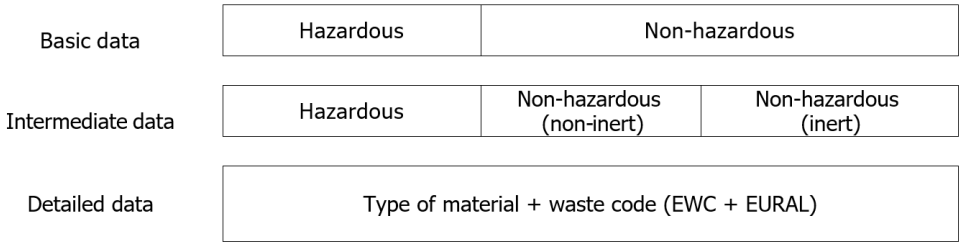


Figure C-1 Options for the inventory of materials

Recommended templates for inventory of elements

The classification of elements by means of waste codes is typically not possible, since the codes where not designed with re-use in mind. So far, there is no uniform and standardised way to classify elements for re-use.

The template below contains a field for material identification and waste codes. When elements cannot be re-used and are composed of different materials (e.g. a window), these can be identified by waste codes.

Table C-5 Recommended template for inventory of building element

BUILDING: **Level:** **Other relevant information:**								
Construction unit:								
Element	**Units**	**Location**	**Reusable**	**Possible markets**	**Quantity**	**Materials identification and Waste codes**	**Precautions to take during the deconstruction phase**	**Pictures and notes**

Inventories of elements can follow a similar structure as the inventories of materials. It should be noted that the materials of the elements listed in this part cannot be excluded from the inventory of waste materials (with the exception of "certain re-use"). Materials present in the different elements should be detailed using the templates provided above.

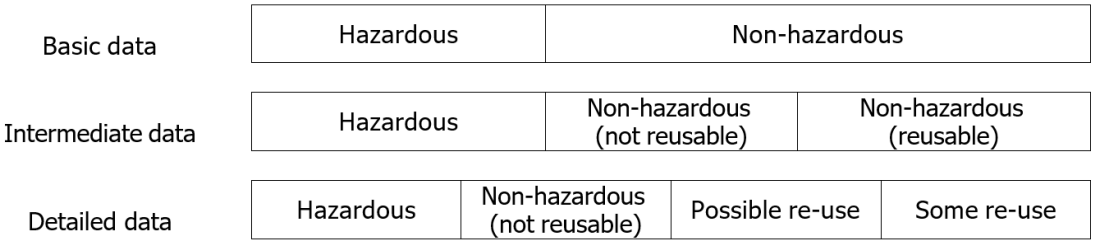


Figure C-2 Suggested levels of reporting of elements

Recommended templates for waste management recommendations

Table C-6: Recommended template for waste management recommendations

BUILDING: **Level:** **Other relevant information:**							
Construction unit							
Type of material	**Waste code (EWC and EURAL)**	**Location**	**Possible outlets[1]**	**Recommended outlet[2]**	**Precautions to take during the deconstruction phase[3]**	**Handling precautions**	**Legal storage /transport/ treatment conditions**

[1] Reuse; recycle; backfill; energy recovery; elimination
[2] The recommended outlet must be identified taking into account the hierarchy of waste treatment and the potential possibilities in the proximity of the jobsite
[3] Ex: do not leave the frame on the plasterboards; be careful to remove the power plugs, etc.

Recommended templates for summary by type of outlet and potential recovery rates

The summary of materials by type and outlet is useful at the very end of the project. This table presents a basic structure for such a summary and may be adapted to the specific project needs.

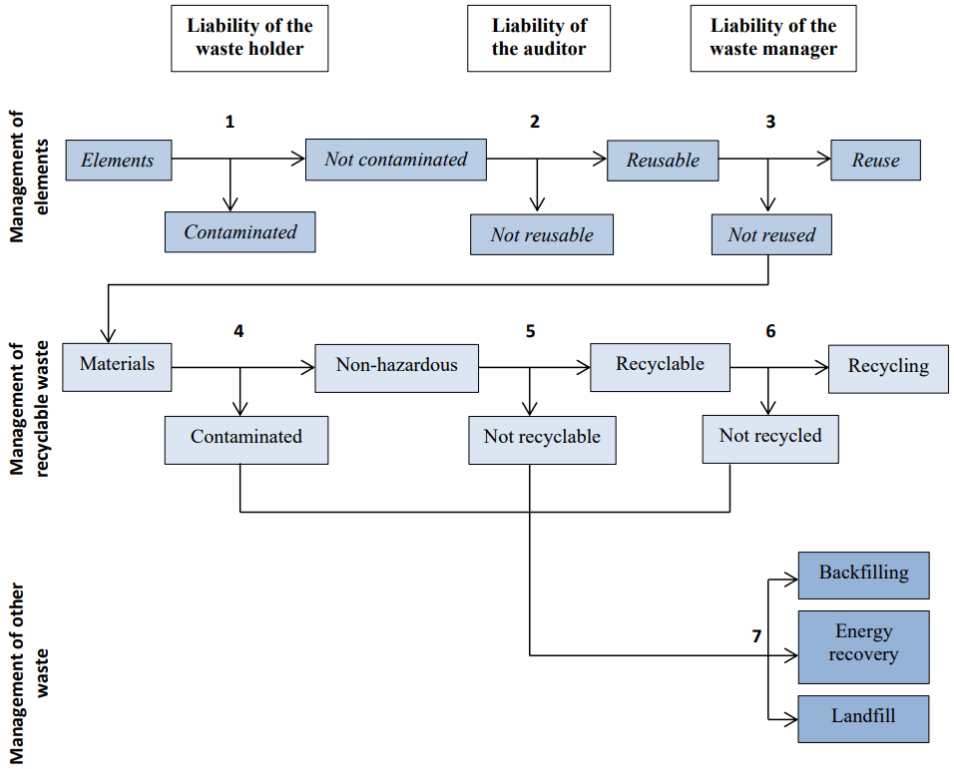
Table C-7 Summary by type of outlet and potential recovering rates calculation

Type of material	Element/ Material/ Waste	Quantity	Unit	Comments
Reuse				
Total tonnage of material reused				
Percentage of material reused				
Recycling				
Total tonnage of material recycled				
Percentage of material recycled				
Backfilling				
Total tonnage of material backfilled				
Percentage of material backfilled				
Energy recovery				
Total tonnage for energy recovery				
Percentage for energy recovery				
Elimination				
Total tonnage of material landfilled				
Percentage of material landfilled				

Rate of reuse	%
Rate of recycling	%
Rate of backfilling	%
Rate of energy recovery	%
Rate of landfilling	%

Decision-making process in the formulation of the inventory and management recommendations

Figure C-3 Decision-making process in the formulation of the inventory and management recommendations



Certain materials and waste streams may be contaminated and/or regulated, which means that the waste holder in that case may be obligated to dispose of them (1, 4). Where relevant, contaminated elements will typically be separated into separate material streams prior to further treatment (1).

In a circular economy, we strive to keep material cycles free of hazardous substances to enable re-use and recycling. Therefore, management recommendations may be based on the contamination level or materials hazardousness. However, the presence of harmful substance does not always prevent re-use or recycling. Both environmental limit values set out in relevant environmental legislation, end-of-waste criteria and product requirements/acceptance criteria may regulate and describe acceptable limits of hazardous substances. This information is to be considered by the auditor. (2,5)

It might be possible and feasible to remove hazardous substances or lower the content of hazardous substances prior to further management of elements and waste streams (2,5).

When assessing the reusability of elements, it is important to include aspects like demountability, accessibility, market readiness. Whether elements are suitable for their intended use depends strongly on their environmental and technical performance and characteristics. Furthermore, they need to fulfil the regulatory requirements (e.g. national building code, CPR) and any contractual requirements for a given use. (2)

Elements that cannot be re-used will typically be separated into separate material streams prior to further treatment. (2, 3).

If elements cannot be dismantled as anticipated or are damaged during demolition, they might need to be recycled or treated otherwise. (3, 6)

At the point of the audit, the management recommendations (for the waste manager) are formulated on the basis of the information gathered throughout the audit process and for the identified CDW and elements. Elements that cannot be re-used and CDW that cannot be recycled — depending on the type of material, kind of contaminant and contamination level — can be managed via different treatment options (3, 6, 7).

Annex D European list of waste

European list of waste

1. The European List of Waste (LoW) [5] (also referred to as European waste catalogue) establishes a list of waste defined by a six-digit code. The different types of wastes are divided into 20 chapters. The numbers of these chapters are the first two-digit numbers of the waste code.

Chapter 17 groups together “Construction and demolition wastes (including excavated soil from contaminated sites)”, but some waste that can be found on a jobsite can be linked to other chapters. Regardless of type, it is important to state what other sorts of waste could be present in a building.

Any waste marked with an asterisk (*) in the list of wastes shall be considered as hazardous waste.

Classification of waste according to EWC-stat categories [72]

2. Regulation (EC) 2150/2002 on waste statistics [73] requires Member States to report statistical data on waste generation and waste treatment according to the statistical waste nomenclature EWC-Stat. The EWC-Stat is a substance-oriented aggregation of the waste types defined in the European List of Wastes (LoW). The transposition table between the EWC-Stat and the List of Wastes is established in Annex III of the Regulation.

3. The European List of Wastes (LoW) is the waste classification in the EU for administrative purposes, i.e. for permitting and supervision in the field of waste generation and management. The LoW defines 839 waste types which are structured into 20 chapters, mainly according to the source of the waste (i.e. the economic sector or process of origin).

4. Whereas the Waste Statistics Regulation stipulates that the EWC-Stat must be used for the reporting of data to Eurostat, it does not prescribe a specific classification to be used for data collection. Countries are free to use any waste classification as long as they can produce the defined formats in the required quality.

In practice, most of the countries collect their data according to the List of Waste and convert it subsequently into the required EWC-Stat-categories on the basis of the transposition table in Annex III of the Regulation. The direct use of the EWC-Stat for data collection is applied only by a few countries.

Identification of different types of waste

5. The different types of waste that need to be identified should fit in one of the following groups:

- Inert waste - waste that does not undergo any significant physical, chemical or biological transformation. Inert waste will not affect other materials, even if they come into contact in any way likely to produce environmental pollution or harm to human health. The total leachability and pollutant content of this waste must be insignificant, and in particular not endanger the quality of surface water and/or groundwater. [7]
- Non-inert non-hazardous waste - this group of wastes can be divided into several waste fractions, containing both non-contaminated and contaminated wastes.
- Hazardous waste - hazardous waste is defined in Directive 2008/98/EC [2] as waste showing one or more of the hazardous properties listed in Annex III. Hazardous waste is subjected to specific precautions for their disposal and is regulated all along Europe.

Considering the different regulations in the different Member States, this section represents only the most common situation in European countries and should be considered merely as a recommendation.

Classification of CDW

6. Waste containing hazardous substances is classified as hazardous primarily based on the European List of Wastes and marked as such with an asterisk (*) in the List of wastes. In some cases, a particular type of waste on the list can be either hazardous or non-hazardous depending on specific properties of waste (e.g. 17 08 01* gypsum-based construction materials contaminated with hazardous substances; 17 08 02 gypsum-based construction materials other than those mentioned in 17 08 01). In the latter case, the waste status must be assessed based on its hazardous properties. In practice, this means that the content of hazardous substance is compared to hazardous waste classification as well as substance-specific limit values. The waste classification has several implications. For instance, there are numerous EU regulations setting special requirements for waste defined as hazardous waste (e.g., shipment, landfilling, and treatment).

7. When a decision must be made as to whether CDW should be classified as hazardous waste, it must be investigated whether it is technically possible to separate the hazardous substance(s) from the waste:

- In practice, the auditor will be faced with waste types where it will not be possible or meaningful to separate the hazardous substances from the waste, because they are a completely integrated part of the waste, such as hazardous substances in glazed tiles or sanitary ware.
- In other cases, hazardous substances can be easily separated from the other waste, for example, PCB-containing capacitors in lighting fixtures.
- Between these two extremes, it can be more uncertain whether hazardous substances can or should be separated from the non-hazardous part of the waste, and which parts of the waste must form the basis of the classification. In these instances, in Denmark for example it is up to the municipality to make a concrete assessment[34].

Materials that can be present in construction and demolition activities

A non-exhaustive list of materials that can be present in construction and demolition activities is given below.

Chapter 17 from the European List of Waste [5]

Table D-1 Chapter 17 from the European List of Waste

17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
17 01	**concrete, bricks, tiles and ceramics**
17 01 01	concrete
17 01 02	bricks
17 01 03	tiles and ceramics
17 01 06*	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing hazardous substances
17 01 07	mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 02	**wood, glass and plastic**
17 02 01	wood
17 02 02	glass
17 02 03	plastic

[34] VEJ nr 9139 af 25/02/2019 - Vejledning om håndtering af bygge- og anlægsaffald (2019) - https://www.retsinformation.dk/eli/retsinfo/2019/9139

17 02 04*	glass, plastic and wood containing or contaminated with hazardous substances
17 03	**bituminous mixtures, coal tar and tarred products**
17 03 01*	bituminous mixtures containing coal tar
17 03 02	bituminous mixtures other than those mentioned in 17 03 01
17 03 03*	coal tar and tarred products
17 04	**metals (including their alloys)**
17 04 01	copper, bronze, brass
17 04 02	aluminium
17 04 03	lead
17 04 04	zinc
17 04 05	iron and steel
17 04 06	tin
17 04 07	mixed metals
17 04 09*	metal waste contaminated with hazardous substances
17 04 10*	cables containing oil, coal tar and other hazardous substances
17 04 11	cables other than those mentioned in 17 04 10
17 05	**soil (including excavated soil from contaminated sites), stones and dredging spoil**
17 05 03*	Soil and stones containing hazardous substances
17 05 04	Soil and stones other than those mentioned in 17 05 03
17 05 05*	dredging spoil containing hazardous substances
17 05 06	dredging spoil other than those mentioned in 17 05 05
17 05 07*	track ballast containing hazardous substances
17 05 08	track ballast other than those mentioned in 17 05 07
17 06	**insulation materials and asbestos-containing construction materials**
17 06 01*	insulation materials containing asbestos
17 06 03*	other insulation materials consisting of or containing hazardous substances
17 06 04	insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 06 05*	construction materials containing asbestos
17 08	**gypsum-based construction material**
17 08 01*	gypsum-based construction materials contaminated with hazardous substances
17 08 02	gypsum-based construction materials other than those mentioned in 17 08 01
17 09	**other construction and demolition wastes**
17 09 01*	construction and demolition wastes containing mercury
17 09 02*	construction and demolition wastes containing PCB (for example PCB-containing sealants, PCB-containing resin-based floorings, PCB-containing sealed glazing units, PCB-containing capacitors)
17 09 03*	other construction and demolition wastes (including mixed wastes) containing hazardous substances
17 09 04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03

Other types of materials

Table D-2 Other types of materials - European List of Waste

2	**WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING,FOOD PREPARATION AND PROCESSING**
02 01	**wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing**
02 01 08*	agrochemical waste containing hazardous substances

3	**WASTES FROM WOOD PROCESSING AND THE PRODUCTION OF PANELS AND FURNITURE**
03 03	**wastes from pulp, paper and cardboard production and processing**
03 03 08	wastes from sorting of paper and cardboard destined for recycling

4	**WASTES FROM THE LEATHER, FUR AND TEXTILE INDUSTRIES**
04 02	**wastes from the textile industry**
04 02 22	wastes from processed textile fibres

8	WASTES FROM THE MANUFACTURE, FORMULATION, SUPPLY AND USE (MFSU) OF COATINGS (PAINTS, VARNISHES AND VITREOUS ENAMELS), ADHESIVES, SEALANTS AND PRINTING INKS
08 01	**wastes from MFSU and removal of paint and varnish**
08 01 11*	waste paint and varnish containing organic solvents or other hazardous substances 08 01 12 waste paint and varnish other than those mentioned in 08 01 11
08 01 13*	sludges from paint or varnish containing organic solvents or other hazardous substances
08 01 19*	aqueous suspensions containing paint or varnish containing organic solvents or other hazardous substances
08 02	**wastes from MFSU of other coatings (including ceramic materials)**
08 02 02	aqueous sludges containing ceramic materials
08 04	**wastes from MFSU of adhesives and sealants (including waterproofing products)**
08 04 09*	waste adhesives and sealants containing organic solvents or other hazardous substances
08 04 10	waste adhesives and sealants other than those mentioned in 08 04 09

12	WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS
12 01	**wastes from shaping and physical and mechanical surface treatment of metals and plastics**
12 01 09*	machining emulsions and solutions free of halogens
12 01 14*	machining sludges containing hazardous substances

13	OIL WASTES AND WASTES OF LIQUID FUELS (EXCEPT EDIBLE OILS, AND THOSE IN CHAPTERS 05, 12 AND 19)
13 02	**waste engine, gear and lubricating oils**
13 02 05*	mineral-based non-chlorinated engine, gear and lubricating oils
13 05	oil/water separator contents
13 05 02*	sludges from oil/water separators

14	WASTE ORGANIC SOLVENTS, REFRIGERANTS AND PROPELLANTS (except 07 AND 08)
14 06	**waste organic solvents, refrigerants and foam/aerosols propellants**
14 06 02*	Other halogenated solvents and solvents mixtures
14 06 03*	Other solvents and solvents mixtures

15	WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED
15 01	**packaging (including separately collected municipal packaging waste)**
15 01 01	paper and cardboard packaging
15 01 02	plastic packaging
15 01 03	wooden packaging
15 01 04	metallic packaging
15 01 05	composite packaging
15 01 06	mixed packaging
15 01 10*	packaging containing residues of or contaminated by hazardous substances
15 02	absorbents, filter materials, wiping cloths and protective clothing
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by hazardous substances

16	WASTES NOT OTHERWISE SPECIFIED IN THE LIST
16 01	**end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)**
16 01 07*	oil filters
16 01 13*	brake fluids
16 01 14*	antifreeze fluids containing hazardous substances
16 02	**wastes from electrical and electronic equipment**
16 02 09*	transformers and capacitors containing PCBs
16 02 11*	discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 13*	discarded equipment containing hazardous components ([1]) other than those mentioned in 16 02 09 to 16 02 12
16 02 14	discarded equipment other than those mentioned in 16 02 09 to 16 02 13
16 05	**gases in pressure containers and discarded chemicals**
16 05 06*	laboratory chemicals, consisting of or containing hazardous substances, including mixtures of laboratory chemicals
16 06	batteries and accumulators
16 06 01*	lead batteries
16 06 02*	Ni-Cd batteries

(1) Hazardous components from electrical and electronic equipment may include accumulators and batteries mentioned in 16 06 and marked as hazardous; mercury switches, glass from cathode ray tubes and other activated glass, etc

18	WASTES FROM HUMAN OR ANIMAL HEALTH CARE AND/OR RELATED RESEARCH (EXCEPT KITCHEN AND RESTAURANT WASTES NOT ARISING FROM IMMEDIATE HEALTH CARE)
18 01	**wastes from natal care, diagnosis, treatment or prevention of disease in humans**
18 01 09	medicines other than those mentioned in 18 01 08

20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS
20 03	**other municipal wastes**
20 03 01	mixed municipal waste
20 03 07	bulky waste

Annex E Overview of available treatment options

1. This Annex summarises the content of the 2022 JRC report “Background data collection and life cycle assessment for construction and demolition waste (CDW) management” [12]. Additional information can be found in the 2024 JRC report “Techno-economic and environmental assessment of construction and demolition waste management in the European Union. Status quo and prospective potential” [13]. For the purpose of this Protocol a few amendments have been made in the descriptions of concrete, plastic, glass, gypsum and insulation. According to the JRC report, “Available treatment option” means that the technology corresponds to a Technology Readiness Level (TRL) of 9 and is available across Europe, however not necessarily in all Member States. References to sources of information or boxes in the table below refers to the JRC report.

Table E-1 Available treatment options/ per type of waste

CDW	Available treatment options	Classification according to WFD
Mineral waste Concrete Bricks Tiles and ceramic Mixed/other mineral/inert waste	Sorting and crushing of mineral waste (mixed or as individual fractions) for production of aggregates to be used in road construction as a substitute for sand or gravel or other lower quality aggregates. Concrete waste can be processed into recycled aggregates for production of concrete of the same or lower quality, replacing gravel or crushed rock (e.g. granite). This is still a minor application route, as standards for concrete set specific requirements regarding the use of recycled aggregate in new concrete, and these requirements can vary significantly across MSs, as MSs can have introduced national annexes to the European standard regulating the field, EN 206. Furthermore, utilisation of the fine fraction still poses some technical and regulatory issues. In some MSs, e.g. the Czech Republic, the fine fraction is allowed as an additive to cement according to the standard ČSN EN 197-6. Old bricks from buildings erected before the 1960s can be prepared for reuse if the buildings are selectively dismantled and following a cleaning process.	Other recovery when used in road construction (backfilling) but may in several MSs be reported as recycling. Recycling if concrete waste is used for production of new concrete. Preparation for reuse (reuse of old bricks with lime-based mortar).
Plastic	If sorted according to their polymer type, plastic from CDW can be mechanically recycled to granulates to be used for production of new plastic products, often though at a lower quality, similarly to what happens with plastic waste from other sectors. It should be noted that plastic in CDW is composed by several different plastic types (PVC, PP, HDPE, PS, EPS, PU) which may require different treatment technologies. Some plastic types can be identified easily in end-of-life buildings and/or CDW, as they have specific applications in easily recognisable building components (e.g. PVC in pipes and window frames, EPS in insulation). This may make their separation and potential recycling easier (cf. Box 1 and Box 5 below). However, other plastic types are rarely sorted according to the polymer type, due to small amounts, complexity and lack of space. Plastic may also be feedstock recycled (recovery of its carbon content through e.g. pyrolysis or gasification) or incinerated to recover its energy content.	Recycling or other recovery (incineration with energy recovery).
Metal Mixed metals Ferrous Non-ferrous	Ferrous metals (iron and steel) and non-ferrous metals (e.g. aluminium, zinc and copper) can be remelted and used for production of new metal. This is largely common practice across Europe, as metals are easy to identify and sort, and the recycling is typically economically sustainable.	Recycling

CDW	Available treatment options	Classification according to WFD
Glass	The glass fraction of CDW can be grouped into two categories: flat glass used for external applications (insulating glazing) and flat glass used for interior applications (Bergmans et al., 2019). If selectively collected and not contaminated by any external sources of stony, metallic and plastic material contaminants, flat glass can be treated and recycled into new flat glass. Another possibility (and the most widespread treatment method for selectively collected flat glass currently) is recycling into container glass and other glass products.	Recycling
Wood	Depending on the quality and the content of hazardous substances, wood from construction activities can be recycled or used for energy recovery. If the wood waste is clean, it can be used in the production of particleboards. If contaminated, incineration with energy recovery is often the preferred solution. In rare cases, wood is prepared for reuse, e.g. for structural purposes.	Recycling (if used for particleboard production), or other recovery (incineration with energy recovery). In rare cases, preparation for reuse.
Gypsum	Gypsum in CDW is often in the form of plasterboards. If collected selectively, this waste can be recycled into gypsum, paper and possibly ferrous materials. The recycled gypsum can be used for production of new plasterboards or in cement production.	Recycling
Insulation	The available treatment technology depends on the type of insulation material. Inorganic insulation materials such as mineral wool can – if collected selectively and not contaminated by other materials – be recycled. Stone wool can be recycled in a closed loop for production of new stone wool or be recycled in the brick industry. Technologies for closed-loop recycling of glass wool are under development. Mineral wool produced before 1997 in some countries is classified as hazardous waste and this represents a barrier for recycling, with regards to e.g. transportation and treatment permits. Polymer based insulation materials are mostly landfilled or incinerated, whereas biobased insulation materials most often are incinerated or composted if their content of fire-retardants is unproblematic.	Recycling, other recovery (incineration with energy recovery) or disposal (landfilling)
Paper and cardboard	A large share of paper and cardboard in CDW is packaging materials originating from construction activities. If selectively collected paper and cardboard can be recycled and used for production of new paper and cardboard, otherwise they may be incinerated.	Recycling, other recovery (incineration with energy recovery)
Mixed waste, generic	Mixed waste represents an unknown mix of the above-mentioned waste materials. Depending on the treatment of this waste fraction (e.g. sorting) and its content it may be either backfilled, recycled, incinerated or landfilled.	Recycling, other recovery (backfilling, incineration with energy recovery), disposal (landfilling)
Hazardous waste (total, excluding hazardous soil and dredging spoil)	Typical contaminants in CDW are heavy metals in paint (e.g. Pb), organics in soft joints, paint (e.g. PCBs, chlorinated paraffins), asbestos fibres in fibre-cement boards, and mineral wool classified as hazardous. Thus, if contaminated, all abovementioned waste materials may theoretically be classified as hazardous waste, and their treatment will depend on the waste type and the contaminant. Treatment methods may be high-temperature incineration, incineration in MSWI with special permits for combustion of hazardous waste, landfilling in specific cells for hazardous waste, or storing in underground landfills, e.g. old quarries.	Other recovery (incineration with energy recovery), disposal (incineration without energy recovery or landfilling)

Annex F Checklist

1. The Protocol aims to enhance CDW management processes at all stages of the value chain and increase the confidence in the quality of products prepared for re-use and materials for recycling. This checklist helps practitioners of the construction and demolition industry to see if they have followed the most important steps in their demolition, construction and renovation projects to guarantee optimal re-use and recycling of construction materials.

Waste identification, source separation and collection

IMPROVE WASTE IDENTIFICATION

- ☐ Prepare a **pre-renovation / pre-demolition audit**, carried out by a **qualified expert:**
  - to specify the quantity, the quality and location of materials
  - to identify which products can be re-used or be prepared for re-use, and which materials can be recycled, recovered or need to be disposed of
  - to take full account of local facilities and markets for CDW (materials and products)
- ☐ Prepare a process-oriented **resource management plan** showing how products are to be re-used or prepared for re-use or materials recycled and how pollution into the environment is minimised.
- ☐ Decide on the best treatment options for different products and materials: direct re-use, preparing for re-use, recycling in the sameapplication or another application, other recovery or disposal.
- ☐ Guarantee efficient **supervision and traceability**.

IMPROVE SOURCE SEPARATION

- ☐ **Keep materials separated** during the renovation, demolition and construction process to guarantee the quality of products and materials, in particular those covered by mandatory sorting systems (i.e. at least for wood, mineral fractions (concrete, bricks, tiles and ceramics, stones), metal, glass, plastic and gypsum).
- ☐ **Remove hazardous waste** (decontamination) correctly and systematically prior to renovation and demolition.
- ☐ **Ensure selective demolition and dismantling**.
- ☐ **Minimise packaging materials** as much as possible.
- ☐ **Provide necessary documentation** to all contractors to support transparency and monitoring.

Waste logistics

TRANSPARENCY, TRACKING AND TRACING

- ☐ **Provide necessary documentation** to all contractors to support transparency and monitoring.
- ☐ **Use the European List of Waste** to assure comparability of data across the EU.

IMPROVE LOGISTICS

- ☐ Try to **keep distances short and make use of zero-emission transportation** to keep re-use, preparing for re-use and recycling economically attractive and environmentally sound.
- ☐ Optimise the transport network and make use of supporting IT systems.
- ☐ Where possible, use waste transfer stations and/or waste sorting and recycling services.
- ☐ **Guarantee the integrity** of materials from dismantling to recycling during transportation.

STOCKPILING POTENTIAL AND PROPER STOCKING

- ☐ **Proper stocking and stockpiling** of CDW materials and construction products is required in certain situations. Stockpiling can be necessary for logistical purposes and to increase the potentials for preparing for re-use and recycling.
- ☐ Take **precautionary measures** to minimise emissions and risks, taking local conditions into account.

Waste processing and treatment

WASTE PROCESSING AND TREATMENT OPTIONS

- ☐ **Follow the waste hierarchy** to maximise benefits in terms of resource efficiency, sustainability and cost savings.
- ☐ Do not mix hazardous waste with non-hazardous waste.
- ☐ Process or treat materials on the basis of **environmental criteria and regulations** that are in place.

PREPARING FOR RE-USE

- ☐ **Re-use or prepare for re-use** as many products as possible, since re-use has an even greater environmental advantage than recycling.

RECYCLING

- ☐ Recycle materials, either **on-site** into new construction or **off-site** at a recycling plant. Aim to achieve high-quality recycling, wherever possible.
- ☐ **Promote recycling**, particularly in densely populated areas where supply and demand are close together.
- ☐ Ensure **sound planning of waste management activities** to guarantee high recycling ratesand high-quality recycling products.

MATERIAL AND ENERGY RECOVERY

- ☐ **Backfilling** can be considered in particular situations, when re-use, preparing for re-use or recycling into higher quality application is not possible.
- ☐ **Energy recovery** should be limited to and considered only for materials that cannot be re-used, prepared for re-use or recycled.

Quality management and assurance

QUALITY OF THE PRIMARY PROCESS

- ☐ Introduce quality management and quality assurance checks and tools **in all stages of the re-use or recycling route,** including minimization of pollution into the environment.
- ☐ Make use of existing general **quality management schemes** like ISO 9000, ISO 14001 and EMAS.
- ☐ **Key quality management and assurance** checks and tools **per process step:**
  - **Waste identification, source separation & collection**: prepare a pre-renovation and pre-demolition audit,on-site reporting and a final report for the sorting or recycling plant.
  - **Renovation, demolition, construction:** identify expected waste materials and products and their amounts for preparation of a resource management plan.
  - **Waste logistics**: verify if the waste is hazardous or not and provide appropriate stocking and transport.
  - **Waste processing and treatment**: selective demolition-waste acceptance,factory production control, final testing.

QUALITY ASSURANCE RELATED TO PRODUCTS AND PRODUCT STANDARDS

- ☐ Follow the same European standards that apply to primary materials for recycled materials.Make use of existing European product standards (CPR).
- ☐ If these European product standards do not apply, make use of European Technical Assessments (EAD).
- ☐ In case European product standards or assessments do not apply, use Quality Assurance (for ex., ISO 9000) schemes as an additional tool.

Annex G References

[1] Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008R0765-20210716

[2] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20240218

[3] Regulation (EU) No 305/2011 Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011R0305 and Regulation (EU) 2024/… of the European Parliament and of the Council laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011 which will enter into application in autumn 2025

[4] Dodd N., Donatello S. & Cordella M., 2020. Level(s) indicator 2.4: Design for deconstruction user manual: introductory briefing, instructions and guidance (Publication version 1.1). Available at: https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2021-01/UM3_Indicator_2.4_v1.1_18pp.pdf

[5] Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the European List of Waste. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0955

[6] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008R1272

[7] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01999L0031-20180704

[8] ISO 9000:2015 – Quality management systems – Fundamentals and vocabulary. Available at: https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en

[9] ISO 6707-1:2020(en) Buildings and civil engineering works — Vocabulary — Part 1: General terms. Available at: https://www.iso.org/obp/ui/#iso:std:iso:6707:-1:ed-6:v1:en

[10] Recyclingportal.eu, Report: Waste transfer stations in different EU regions, 2009, http://www.recyclingportal.eu/artikel/22506.shtml

[11] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics

[12] Damgaard, A., Lodato, C., Butera, S., Fruergaard, T.A., Kamps, M., Corbin, L., Tonini, D., Astrup, T.F., Background data collection and life cycle assessment for construction and demolition waste (CDW) management, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/772724, JRC 130992. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC130992

[13] Cristobal Garcia, J., Caro, D., Foster, G., Pristera, G., Gallo, F. and Tonini, D., Techno-economic and environmental assessment of construction and demolition waste management in the European Union, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/721895, JRC135470, Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC135470

[14] D. Caro, C. Lodato, A. Damgaard b, J. Cristóbal, G. Foster, F. Flachenecker, D. Tonini (2024) Environmental and socio-economic effects of construction and demolition waste recycling in the European Union, Science of the Total Environment, Vol. 908, 15th January 2024, 168295, Available at: https://www.sciencedirect.com/science/article/pii/S004896972306922X?via%3Dihub

[15] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on working towards an asbestos-free future: a European approach to addressing the health risks of asbestos. Brussels, 28.9.2022. COM(2022) 488 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A488%3AFIN

[16] RPA Europe and Danish Technological Institute (2024). Study on asbestos waste management practices and treatment technologies. Report prepared for DG Environment. Available at: https://op.europa.eu/da/publication-detail/-/publication/ee7ac52d-caf7-11ee-95d9-01aa75ed71a1/language-en/format-PDF/source-306449004

[17] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

[18] Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objective, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02021R2139-20240101

[19] Commission Delegated Regulation (EU) 2023/2486 of 27 June 2023 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to the sustainable use and protection of water and marine resources, to the transition to a circular economy, to pollution prevention and control, or to the protection and restoration of biodiversity and ecosystems and for determining whether that economic activity causes no significant harm to any of the other environmental objectives and amending Commission Delegated Regulation (EU) 2021/2178 as regards specific public disclosures for those economic activities, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202302486

[20] Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32020R0852

[21] Circular Economy - Principles for Building Design (2020). Available at: https://ec.europa.eu/docsroom/documents/39984

[22] Værdibyg (2020). Circular Demolition. First Edition. Available at: https://vaerdibyg.dk/vejledning/circular-demolition/

[23] https://www.cencenelec.eu/areas-of-work/cen-sectors/construction/

[24] https://green-business.ec.europa.eu/eco-management-and-audit-scheme-emas_en

[25] Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council

Directive 91/689/EEC on hazardous waste. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02000D0532-20231206

[26] Technical guidelines for digital building logbooks – Guideline to the Member States on setting up and operationalising digital building logbooks under a common EU framework (2023) https://www.ecorys.com/app/uploads/2019/02/DBL-Technical-Guidelines-for-DBLs.pdf

[27] Build Back Better – in recovery, rehabilitation and reconstruction, Available at: https://www.unisdr.org/files/53213_bbb.pdf

[28] Wahlström, M., Hradil, P., zu Castell-Rudenhausen, M., Bergmans, J., van Cauwenberghe, L., Van Belle, Y., Sičáková, A., Struková, Z., & Li, J. (2019). *Pre-demolition audit - overall guidance document: PARADE. Best practices for Pre-demolition Audits ensuring high quality RAw materials*. EIT RawMaterials. Available at: https://cris.vtt.fi/ws/portalfiles/portal/27438769/EIT_RM_PARADE_Predemolition_audit_overall_guidance_document_Final_2019.pdf

[29] Buildwise (2023). Protocole de déconstruction pour la Région de Bruxelles-Capitale (2023): https://www.buildwise.be/media/qconb22f/protocole-de-deconstruction-pour-la-region-de-bruxelles-capitale_fr.pdf

[30] LNEC, APA and IMPIC (2022). CLOSER Close to Resources Recovery. Guia Português de Auditorias Pré-Demolicão. Available at: https://closer.lnec.pt/guide/R4_Guia%20portugues%20auditoria%20pre%20demolicao.pdf

[31] Margareta Wahlström, Malin zu Castell-Rüdenhausen, Petr Hradil, Katrine Hauge Smith, Anke Oberender, Maria Ahlm, Johan Götbring and Jette Bjerre Hansen (2019). Improving quality of construction & demolition waste – Requirements for pre-demolition audit, TemaNord 2019:508. Available at: https://norden.diva-portal.org/smash/get/diva2:1294662/FULLTEXT01.pdf

[32] Decreto-Lei 24/2024, Diário da República n.º 61/2024, Série I de 26 de março 2024

[33] DTI (2016) Guidance document “MATERIALEATLAS over byggematerialers genbrugs- og genanvendelsespotentialer”. Available at: https://www.innobyg.dk/media/75876/materialeatlas.pdf. Online tool available at: https://vcob.dk/vcob/cirkulaert-byggeri/byggevarer/materialeatlas/

[34] 3AR (2020). Guide de bonnes pratiques - pour la réalisation du diagnostic produits/matériaux/déchets avant démolition/réhabilitation significative de bâtiments (2020): https://www.democles.org/uploads/2020/08/guide-de-bonnes-pratiques-2020-web.pdf

[35] Mêda P, Calvetti D, Sousa H. Exploring the Potential of iPad-LiDAR Technology for Building Renovation Diagnosis: A Case Study. *Buildings*. 2023; 13(2):456. https://doi.org/10.3390/buildings13020456

[36] EPA (2021). Best practice guidelines for the preparation of resource & waste management plans for construction & demolition projects. Environmental Protection Agency of Ireland. Available at: https://www.epa.ie/publications/circular-economy/resources/CDWasteGuidelines.pdf

[37] ÖNORM B3151 Rückbau von Bauwerken als Standardabbruchmethode: https://www.ris.bka.gv.at/Dokumente/Bundesnormen/NOR40187245/II_290_2016_OENORM_B_3151.pdf

[38] Joint Research Centre, Institute for Environment and Sustainability, Pant, R., Manfredi, S., *Supporting environmentally sound decisions for Construction and Demolition (C&D) waste management – A practical guide to Life Cycle Thinking (LCT) and Life Cycle Assessment (LCA)*, Pant, R.(editor), Manfredi, S.(editor), Publications Office, 2011, https://data.europa.eu/doi/10.2788/54401

[39] Schneeberger, E (2023). Baurestmassen - Verwertung und Entsorgung. Available at: https://www.wko.at/ooe/gewerbe-handwerk/bau/broschuere-baurestmassen-1.pdf

[40] Province of Styria (2020). The Styrian Guide to Construction & Demolition Waste. Available at: https://www.abfallwirtschaft.steiermark.at/cms/dokumente/11629595_71142128/f46de97c/BRM_Leitfaden2020_EN.pdf

[41] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A new Circular Economy Action Plan for a cleaner and more competitive Europe. COM/2020/98 final

[42] South Australia EPA. Guideline for stockpile management. ISBN 978-1-921125-91-8. Available at: https://www.epa.sa.gov.au/files/4771349_guidelines_stockpile.pdf

[43] WISH (2020). Reducing fire risk at waste management sites. WASTE 28, Issue 3 – March 2020. Waste Industry Safety and Health Forum. Available at: https://www.wishforum.org.uk/wp-content/uploads/2020/05/WASTE-28.pdf

[44] Værdibyg (2021). Dilemmas and decisions in the circular demolition process. First edition. Guide no. 43. Available at: https://vaerdibyg.dk/vejledning/dilemmas-and-decisions-in-the-demolition-process/

[45] Frederik Neuwahl, Gianluca Cusano, Jorge Gómez Benavides, Simon Holbrook, Serge Roudier; *Best Available Techniques (BAT) Reference Document for Waste Incineration;* EUR 29971 EN; doi:10.2760/761437

[46] Lehtonen, K, Oy, Y (2019). Rivningsarbeten – guide för utförare och beställare. Available at: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161884/YM_2019_29.pdf?sequence=4&isAllowed=y

[47] Johnson, R and Witts, D (2010). Implementation of a Quality Management System (QMS) within the MRF Industry. WRAP Guidance. Available at: https://www.wrap.ngo/resources/quality-management-systems-for-municipal-MRFs/final-report

[48] Pinasseau, A., Zerger, B., Roth, J., Canova, M. and Roudier, S., *Best Available Techniques (BAT) Reference Document for Waste treatment Industrial Emissions Directive 2010/75/EU* (Integrated Pollution Prevention and Control), EUR 29362 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-94038-5, doi:10.2760/407967, JRC113018.

[49] LIST (2022). Guide de la Déconstruction - D'ëmweltverwaltung Am Déngscht vu Mënsch an Ëmwelt. Le Gouvernment du Grand-Duché de Luxembourg. Ministère du Developpement Durable et des Infrastructures. Administration de l'environnement. Available at: https://environnement.public.lu/fr/offall-ressourcen/types-de-dechets/dechets-construction-demolition-dcd/guide-deconstruction.html

[50] Villoria Sáez, P., Osmani, M., (2019). A diagnosis of construction and demolition waste generation and recovery practice in the European Union, Journal of Cleaner Production, Vol. 241, 2019, 118400, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2019.118400. Available at: https://www.sciencedirect.com/science/article/pii/S0959652619332706

[51] Fonseca, P., Frazão Pedroso, M., Tavares, V., Aguiar Costa, A., Santos, L., Laranjeira, L. (2022). Plano de Ação para a Circularidade na Construção. Ed. BUILT CoLAB, Porto - Portugal. Available at: https://circularidade.builtcolab.pt/#plano-acao

[52] CCE (2018). Transition Agenda Circular Economy. Building Towards the Circular Economy in the Netherlands in 2050 Together. Circular Construction Economy. Available at: https://circulairebouweconomie.nl

[53] Indenrigs- og Boligministeriet (2021). National strategi for bæredygtigt Byggeri. Available at: https://www.sbst.dk/Media/638248402790994130/National%20strategi%20for%20bæredygtigt%20byggeri.pdf

[54] OVAM (2022). Towards Circular Construction. Policy Programme 2022 -2030. Available at: https://ovam-english.vlaanderen.be/documents/177280/797580/Towards+Circular+Construction+Policy+Programme+2022-2030.pdf/36131f60-7d92-dd30-9d8d-6c13a9c13f96?t=1692016710925

[55] Ympäristöministeriö (2020). Rakentamisen Muovit. Rakennustyömaiden kierrätyskelpoisten muovijakeiden kierrätyksen tehostaminen ja kierrätysmuovituotteiden käytön lisääminen rakentamisessa. Muovitiekartta Suomelle 9/2020. Available at: https://ym.fi/documents/1410903/40549091/rakentamisen_muovit_A4_v3.pdf/9999a63d-a09e-b840-4ab1-fb1de6672fbd/rakentamisen_muovit_A4_v3.pdf?t=1694178723504

[56] Bendix, P, Berg, H, Sebestyén, J, Ritthoff, M, Perschel, L, Eckert, D, Kocina, R, Achenbach, H (2021). Förderung einer hochwertigen Verwertung von Kunststoffen aus Abbruchabfällen sowie der Stärkung des Rezyklateinsatzes in Bauprodukten im Sinne der europäischen Kunststoffstrategie. Umwelt Bundesamt. Texte 151/2021. Available at: https://www.umweltbundesamt.de/publikationen/foerderung-einer-hochwertigen-verwertung-von

[57] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A European Strategy for Plastics in a Circular Economy. COM(2018) 28 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN

[58] Dri, M., Canfora, P., Antonopoulos, I. and Gaudillat, P., Best Environmental Management Practice for the Waste Management Sector, EUR 29136 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-80361-1, doi:10.2760/50247, JRC111059. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC111059

[59] Gouvernement de la Région de Bruxelles Capitale (2018). Plan de Gestion des Ressources et des Déchets. Pour une consommation durable, sobre, locale et circulaire. Pour une société zéro déchet. Available at: https://environnement.brussels/media/442/download?inline

[60] Barth, S, McKinnon, DL (2023). Nordic Network for Circular Construction. Nordic Council of Ministers. Available at: https://pub.norden.org/nord2023-031/nord2023-031.pdf

[61] South Ostrobothnia Business, Transport and Environmental Center (2020). Demolition Quick Guide for the Work Orderer. Demolition Project Planning, Implementation and Waste Utilization. Guide 5, 2020. Available at: https://www.doria.fi/bitstream/handle/10024/177601/Opas_5_2020.pdf?sequence=6&isAllowed=y

[62] Decree of the Flemish Government of 17 February 2012 establishing the Flemish regulations regarding the sustainable management of material cycles and waste. Artikel 4.3.3. Available at: https://navigator.emis.vito.be/detail?woId=44297

[63] Direktoratet for Byggkvalitet (2022). Building technical regulations (TEK17) with guidance. Chapter 9 External environment. Section 9-9. Final report for actual disposal of waste. Available at: https://www.dibk.no/regelverk/byggteknisk-forskrift-tek17/9/9-9

[64] Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1021

[65] Communication for the Commission on working towards an asbestos-free future. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A488%3AFIN

[66] Notices from European Union Institutions, Bodies, Offices and Agencies European Commission. Commission notice on technical guidance on the classification of waste (2018/C 124/01). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018XC0409(01)

[67] Pacheco-Torgal, F, Tam, VWY, Labrincha, JA, Ding, Y, and de Brito, J (2013). Handbook of recycled concrete and demolition waste. Woodhead Publishing Limited (ISBN 978-0-85709-682-1), p. 122, p.212. Available at: http://repositorium.uminho.pt/bitstream/1822/28958/1/Ch.1%20-%20Recycled%20concrete.pdf

[68] BEK nr. 496 af 21/05/2024 om håndtering af affald og materialer fra bygge- og nedrivningsarbejde, Available at: https://www.retsinformation.dk/eli/lta/2024/496

[69] Hradil, P, Wahlström, M, Teittinen, T, Lehtonen, K (2019). Purkukartoitus - opas laatijalle. Ympäristöministeriön Julkaisuja. 2019:30. Available at: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161883/YM_2019_30.pdf?sequence=1&isAllowed=y

[70] Granados Menéndez, H, Fernandez Castillo, J, López-Asiain Martínez, J (2023). Guía para la Gestión de Residuos de Construcción y Demolición en el Ámbito de la Rehabilitación Energética de Viviendas. Guía 03 Fondos Next Generation. Consejo General de la Arquitectura Técnica de España y el Consejo Superior de Colegios de Arquitectos de España. Available at: https://www.cgate.es/PDF/wGuiaRCD-02.pdf

[71] EDI (2024). Decontamination of hazardous substances. Special publication. Available at: https://www.decontaminationinstitute.org/library/edi-special-publication-2024/

[72] Guidance on classification of waste according to EWC-Stat categories Supplement to the Manual for the Implementation of the Regulation (EC) No 2150/2002 on Waste Statistics (2010) https://ec.europa.eu/eurostat/documents/342366/351806/Guidance-on-EWCStat-categories-2010.pdf/0e7cd3fc-c05c-47a7-818f-1c2421e55604

[73] Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02002R2150-20101018

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

EU open data

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and re-used for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Publications Office
of the European Union