Annex 7

Some Potentially Hazardous Elements in C&DW

Table to accompany text in Chapter 2
## SOME POTENTIALLY HAZARDOUS ELEMENTS IN C&DW

<table>
<thead>
<tr>
<th>Product / material</th>
<th>Potentially hazardous component(s)</th>
<th>Potentially hazardous properties</th>
<th>Treatment and/or disposal options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete additives</td>
<td>Hydrocarbon solvents</td>
<td>Flammable</td>
<td>Return to supplier, recycle, remove for specialist disposal.</td>
</tr>
<tr>
<td>Damp proof materials</td>
<td>Solvents, bitumens</td>
<td>Flammable, toxic</td>
<td>Return to supplier, recycle, remove for specialist disposal. Allow to cure prior to disposal.</td>
</tr>
<tr>
<td>Adhesives</td>
<td>Solvents, isocyanates</td>
<td>Flammable, toxic, irritant</td>
<td>Return to supplier, recycle, remove for specialist disposal. Allow to cure prior to disposal. Seek alternative less hazardous products.</td>
</tr>
<tr>
<td>Mastics / sealants</td>
<td>Solvents, bitumens</td>
<td>Flammable, toxic</td>
<td>Return to supplier, recycle, remove for specialist disposal. Allow to cure prior to disposal. Seek alternative less hazardous products. Use water.</td>
</tr>
<tr>
<td>Road surfacing</td>
<td>Tar-based emulsions</td>
<td>Toxic</td>
<td>Return to supplier, recycle, remove for specialist disposal.</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Respirable fibre</td>
<td>Toxic, carcinogenic</td>
<td>Remove under controlled conditions for specialist disposal.</td>
</tr>
<tr>
<td>Mineral fibres</td>
<td>Respirable fibres</td>
<td>Skin &amp; lung irritants</td>
<td>Remove for controlled disposal.</td>
</tr>
<tr>
<td>Treated timber</td>
<td>Copper, arsenic, chrome, tar, pesticides, fungicides</td>
<td>Toxic, ecotoxic, flammable</td>
<td>Recycle. Hazardous components bound into timber, low impact on landfill. Toxic fumes and residue produced on burning.</td>
</tr>
<tr>
<td>Fire resistant wastings</td>
<td>Halogenated compounds</td>
<td>Ecotoxic</td>
<td>Possible low impact in landfill if bonded to substrate; high impact in product form; possible toxic fumes on burning.</td>
</tr>
<tr>
<td>Paint and coatings</td>
<td>Lead, chromium, vanadium, solvents</td>
<td>Toxic, flammable</td>
<td>Possible low impact in landfill if bonded to substrate; high impact in product form; possible toxic fumes on burning.</td>
</tr>
<tr>
<td>Power transfer equipment</td>
<td>PCBs</td>
<td>Ecotoxic</td>
<td>Contaminated transformer oils to be removed under controlled conditions for specialist disposal.</td>
</tr>
<tr>
<td>Lighting</td>
<td>Sodium, mercury, PCBs</td>
<td>Toxic, ecotoxic</td>
<td>Recycle, remove for specialist disposal.</td>
</tr>
<tr>
<td>Air conditioning systems</td>
<td>CFCs</td>
<td>Ozone depleters</td>
<td>Remove for specialist recovery.</td>
</tr>
<tr>
<td>Fire fighting systems</td>
<td>CFCs</td>
<td>Ozone depleters</td>
<td>Remove for specialist recovery.</td>
</tr>
<tr>
<td>Contaminated building fabric (including contamination due to previous use)</td>
<td>Radionuclides</td>
<td>Toxic</td>
<td>Specialist decontamination prior to demolition or refurbishment.</td>
</tr>
<tr>
<td></td>
<td>Heavy metals including cadmium and mercury</td>
<td>Toxic</td>
<td>Specialist decontamination prior to demolition or refurbishment.</td>
</tr>
<tr>
<td></td>
<td>Biohazards (anthrax)</td>
<td>Toxic</td>
<td>Specialist decontamination prior to demolition or refurbishment.</td>
</tr>
<tr>
<td>Animal products (1)</td>
<td>Biohazards (anthrax)</td>
<td>Toxic</td>
<td>Specialist decontamination prior to demolition or refurbishment.</td>
</tr>
<tr>
<td>Gas cylinders</td>
<td>Propane, butane, acetylene</td>
<td>Flammable</td>
<td>Return to supplier.</td>
</tr>
<tr>
<td>Product / material</td>
<td>Potentially hazardous component(s)</td>
<td>Potentially hazardous properties</td>
<td>Treatment and/or disposal options</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Resins/ fillers, Precursors</td>
<td>Isocyanates, phthalic, anhydride</td>
<td>Toxic, irritant</td>
<td>Return to supplier, recycle, remove for specialist disposal.</td>
</tr>
<tr>
<td>Oils and fuels</td>
<td>Hydrocarbons</td>
<td>Ecotoxic, flammable</td>
<td>Return to supplier, recycle, remove for specialist disposal.</td>
</tr>
<tr>
<td>Plasterboard</td>
<td>Possible source of hydrogen sulphide in landfill</td>
<td>Flammable, toxic</td>
<td>Return to supplier, recycle, disperse within landfill.</td>
</tr>
<tr>
<td>Glass</td>
<td></td>
<td></td>
<td>Recycle. Possibly physically hazardous to handle.</td>
</tr>
<tr>
<td>Road planings</td>
<td>Tar, asphalt, solvents</td>
<td>Flammable, toxic</td>
<td>Recycle if ‘cured’ and low leachability. Separate for disposal if high leachability / solvent content.</td>
</tr>
<tr>
<td>Sub base (ash / clinker)</td>
<td>Heavy metals, including cadmium and mercury</td>
<td>Toxic</td>
<td>Recycle if low leachability. Separate for disposal if high leachability.</td>
</tr>
</tbody>
</table>

Note: (1) Horse hair was formerly used as a binder in plaster. Since the disease of anthrax was widespread up to the 19th Century, and the spores of anthrax are very robust and long-lived as well as being hazardous to human health, walls which had been plastered in/before the 19th Century must be treated with great care when they are demolished.
Annex 8

Collection Methodology for C&DW Statistics
COLLECTION METHODOLOGY FOR C&DW STATISTICS

We sent a questionnaire during 1998 to selected statistical specialists who sit on an expert working group dealing with waste statistics on behalf of the Member States, DGXI and Eurostat. Not all of those contacted responded, so the information collected is consequently incomplete. That does not detract from the value of the information which was provided, which came from:

(i) Germany;
(ii) Belgium (Flanders);
(iii) Austria;
(iv) Denmark;
(v) Finland;
(vi) Ireland;
(vii) Luxembourg.

All of the above Member States, with the exception of Finland, rely on a full scale survey to obtain their statistics. Finland uses documentation or registration systems and applies standard estimates of waste (in kg/m²) to statistics for new construction and demolition.

Belgium and Ireland send questionnaires to the building and demolition industry, whereas Germany, Austria, Denmark and Luxembourg rely primarily on questionnaires sent to waste treatment facilities and landfills. Ireland also sends questionnaires to local authorities, landfills, recycling organisations, waste contractors and others.

Answers to questions about how different waste streams are classified revealed considerable differences between Member States. In response to the question “in the case of mixed inert demolition waste (e.g. concrete and brick which requires no further separation in order to be suitable for crushing), is this recorded under 17 01 00 or 17 07 00 (or elsewhere)?” Germany, Austria and Finland said 17 01 00, Denmark and Ireland said 17 07 00 and Belgium said “not applicable”.

Clean (uncontaminated) soil and stones which have to be removed and/or re-used as a result of construction are recorded under 17 05 01 in Germany, but ignored everywhere else.

Waste which is re-used on the original site (as engineering fill, for example) is recorded in Belgium, Denmark and Finland. If it is crushed first or otherwise treated prior to use, then it is also recorded in Germany.

Only Finland currently uses the EWC categories precisely as they are defined to record C&DW. The degree of correspondence between national waste catalogue codes used in other Member States and the closest equivalent EWC codes varies considerably.

The following table presents the results from asking the question “what level of breakdown/disaggregation is available for waste recorded under EWC waste group 17 00 00”? Other materials (such as wood, glass and plastics) are likely to be recorded elsewhere in the national statistics, without reference to their origins on construction or demolition sites.
<table>
<thead>
<tr>
<th>Codes (EWC)</th>
<th>Descriptors (from EWC)</th>
<th>Member States</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 00 00</td>
<td>C&amp;DW (including road construction)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 01 00</td>
<td>Concrete, bricks, tiles, ceramics and gypsum-based materials</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 01 01</td>
<td>Concrete</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 01 03</td>
<td>Tiles and ceramics</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 01 05</td>
<td>Asbestos-based construction materials</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 02 01</td>
<td>Wood</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 02 02</td>
<td>Glass</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 02 03</td>
<td>Plastic</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 03 00</td>
<td>Asphalt, tar and tarred products</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 04 00</td>
<td>Metals (including their alloys)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 05 01</td>
<td>Soils and stones</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>17 07 00</td>
<td>Mixed C&amp;DW</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>
Annex 9

Two Options for Amending the European Waste Catalogue

Two tables to illustrate the text in Chapter 2
## TWO OPTIONS FOR AMENDING THE EUROPEAN WASTE CATALOGUE

### Figure A9.1: Option 1 for Reorganising EWC Categories Applicable to C&DW

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Categories, and materials to be recorded</th>
<th>Status (see below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17 00 00</td>
<td>construction and demolition waste (including road construction)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 01 00</td>
<td>predominantly inert concrete, bricks, tiles and ceramic materials</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 01 01</td>
<td>concrete (including reinforced concrete)</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 01 02</td>
<td>bricks</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>17 01 02 01</td>
<td>whole bricks</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>17 01 02 02</td>
<td>broken or mixed bricks</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 01 03</td>
<td>tiles and ceramics</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>17 01 03 01</td>
<td>whole tiles</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>17 01 03 02</td>
<td>broken or mixed tiles and ceramics</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 01 04</td>
<td>any mixture of concrete, bricks, tiles and ceramics plus an acceptable level of other materials (contraries)</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>17 02 00</td>
<td>wood, glass, plastics and gypsum-based construction materials</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 02 01</td>
<td>wood</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>17 02 01 01</td>
<td>untreated/uncontaminated wood</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>17 02 01 02</td>
<td>wood contaminated by preservatives or hazardous material</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 02 02</td>
<td>glass</td>
<td>U</td>
</tr>
<tr>
<td>3</td>
<td>17 02 03</td>
<td>plastic</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>17 02 03 01</td>
<td>PVC-based material</td>
<td>N</td>
</tr>
<tr>
<td>4</td>
<td>17 02 03 02</td>
<td>other plastic</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 02 04</td>
<td>gypsum-based construction material</td>
<td>M</td>
</tr>
<tr>
<td>2</td>
<td>17 03 00</td>
<td>asphalt, tar and tarred products (sub-categories as before)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 04 00</td>
<td>metals (including their alloys) (sub-categories as before)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 05 00</td>
<td>soil and dredged spoil (sub-categories as before)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 06 00</td>
<td>asbestos-based construction and insulation materials, and other insulation materials</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 06 01</td>
<td>asbestos-based construction materials</td>
<td>M</td>
</tr>
<tr>
<td>3</td>
<td>17 06 02</td>
<td>insulation materials containing asbestos</td>
<td>M</td>
</tr>
<tr>
<td>3</td>
<td>17 06 03</td>
<td>other insulation materials</td>
<td>M</td>
</tr>
<tr>
<td>2</td>
<td>17 07 00</td>
<td>mixed construction and demolition waste</td>
<td>U</td>
</tr>
<tr>
<td>3</td>
<td>17 07 01</td>
<td>mixed inert C&amp;DW not included under 17 01 00</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 07 02</td>
<td>mixed C&amp;DW containing hazardous materials</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 07 03</td>
<td>other mixed C&amp;DW</td>
<td>N</td>
</tr>
</tbody>
</table>

Status: U = unchanged classification, R = revised classification, M = moved classification, N = new classification.
Figure A9.2: Option 2 for Reorganising EWC Categories Applicable to C&DW

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Categories, and materials to be recorded</th>
<th>Status (see below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17 00 00</td>
<td>construction and demolition waste (including road construction)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 01 00</td>
<td>predominantly inert concrete, bricks, tiles and ceramic materials</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 01 01</td>
<td>concrete (including reinforced concrete)</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 01 02</td>
<td>whole bricks</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 01 03</td>
<td>broken or mixed bricks</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 01 04</td>
<td>whole tiles</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 01 05</td>
<td>broken or mixed tiles and ceramics</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 01 06</td>
<td>any mixture of concrete, bricks, tiles and ceramics plus an acceptable level of other materials (contraries)</td>
<td>N</td>
</tr>
<tr>
<td>2</td>
<td>17 02 00</td>
<td>wood, glass, plastics and gypsum-based construction materials</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 02 01</td>
<td>untreated/uncontaminated wood</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 02 02</td>
<td>wood contaminated by preservatives or hazardous material</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 02 03</td>
<td>glass</td>
<td>U</td>
</tr>
<tr>
<td>3</td>
<td>17 02 04</td>
<td>PVC-based material</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 02 05</td>
<td>other plastic</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 02 06</td>
<td>gypsum-based construction material</td>
<td>M</td>
</tr>
<tr>
<td>2</td>
<td>17 03 00</td>
<td>asphalt, tar and tarred products (sub-categories as before)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 04 00</td>
<td>metals (including their alloys) (sub-categories as before)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 05 00</td>
<td>soil and dredged spoil (sub-categories as before)</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>17 06 00</td>
<td>asbestos-based construction and insulation materials, and other insulation materials</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>17 06 01</td>
<td>asbestos-based construction materials</td>
<td>M</td>
</tr>
<tr>
<td>3</td>
<td>17 06 02</td>
<td>insulation materials containing asbestos</td>
<td>M</td>
</tr>
<tr>
<td>3</td>
<td>17 06 03</td>
<td>other insulation materials</td>
<td>M</td>
</tr>
<tr>
<td>2</td>
<td>17 07 00</td>
<td>mixed construction and demolition waste</td>
<td>U</td>
</tr>
<tr>
<td>3</td>
<td>17 07 01</td>
<td>mixed inert C&amp;DW not included under 17 01 00</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 07 02</td>
<td>mixed C&amp;DW containing hazardous materials</td>
<td>N</td>
</tr>
<tr>
<td>3</td>
<td>17 07 03</td>
<td>other mixed C&amp;DW</td>
<td>N</td>
</tr>
</tbody>
</table>

Status: U = unchanged classification, R = revised classification, M = moved classification, N = new classification.
Annex 10

Bibliography, Sources and Selected Key References
BIBLIOGRAPHY, SOURCES AND SELECTED KEY REFERENCES

The following list has been assembled to provide some guidance on technical issues and good practice related to C&DW recycling and the use of C&DW-derived aggregates. The Study Team which has assembled this report cannot vouch for the technical excellence of all of these reports, but the majority are published by or for official bodies, and can be assumed to represent good if not best practice. There is no significance whatsoever attached to the order in which the documents are listed.

The list is dominated by English (and to a lesser extend German) language reports. Apart from the fact that the Project Team is predominantly English speaking, and that any reader of this report will have to be able to read English, we decided that reports in Dutch and Danish (of which there are many) are already known to native Dutch and Danish speakers, and will never be accessible to the vast majority of the rest of us. The same applies to the smaller number of reports in most other Member State languages. We have, however, included a small number of such reports.

French speakers are encouraged to obtain Ref 7.1 (the ADEME report) which includes a detailed reference list of French language documents.

Many other references can be found in Appendix 7 to the C&DW Priority Waste Streams Programme report (Ref 1.1 below).

1 Publications from European and International Bodies:


By: Symonds Travers Morgan/Argus for Project Group to European Commission
From: European Commission, BU - 9, 2/128, DGXI.E.3, Rue de la Loi 200, Brussels, B-1049 Belgium (Contact Mrs G Bossenmeyer)
(Tel: +32 2 299 0367, Fax: 32 2 299 1068)

1.2 3 reports from the OECD (Organisation for Economic Co-operation and Development), Paris

1.2.1 Recycling Strategies for Road Works (1997)
From: National representatives for OECD publications
ISBN 92-64-15461-2
Reference: IRRD no. 887579

Available through OECD’s website (http://www.oecd.org)
Ref: ENV/EPOC/WMP(98)1/REV1

Available through OECD’s website (http://www.oecd.org)
Ref: OCDE/GD(95)26

1.3 6 reports linked to RILEM (Réunion Internationale des Laboratoires d’Essais et de recherches sur les Matériaux et les constructions). The first 4 are available through E&FN Spon, North Way, Andover, Hampshire

By: Kasai Y

1.3.2 Demolition and Re-Use of Concrete and Masonry, Guidelines for Demolition and Re-Use of Concrete and Masonry (1994) (in Proceedings of the Third International Symposium held by RILEM in Odense, Denmark, 24-27 October 1993)
By: Lauritzen E K

By: Brunner P H, Lahner T

1.3.4  RILEM Report No.6 - Recycling of Demolished Concrete and Masonry (1992)
By: Hansen T C

1.3.5  Recommendation for Concrete with Recycled Aggregates (1994)
By: RILEM Technical Committee TC-121, June 1994

By: RILEM Technical Committee TC-121

1.4  Proposal for Harmonized Guidelines for Quality Control of Recycled Materials / Empfehlungen für harmonisierte Richtlinien zur Gütesicherung von Recycling-Baustoffen (in German)
From: International Recycling Federation / Internationale Vereinigung Baustoff-Recycling, Kronenstraße 55-58, D-10118 Berlin (Contact Herr Sander or Herr Schulz)
(Tel: 00-49-30-2031.4554, Fax:00-49-30-2031.4565)

1.5  Panorama of EU Industry 1996 (1997)
Vol 1, Chapter 2-18 ‘Construction Raw Materials’ by B M Coope, Chapter 5 ‘Wooden Building Components’ by Cei-Bois
From: Eurostat Data Shop, 121 rue Joseph II, B-1049 Bruxelles, Belgium (or national distributors)
(Tel: 00-32-2-299.6666, Fax 00-32-2-295.0125)
ISBN 92-827-9304-4

2  Reports on EU-Supported Research Projects Covering More than One Member State:

By: CUR, CSTC and Eerland Recycling
From: CUR, Postbus 420, AK-2800 Gouda, The Netherlands
(Tel: 1820 396000, Fax: 1820 30046)
(Other partners in most EU Member States)

2.2  Recycling Technologies for High Quality Cement and Concrete (1992) (Report on a Brite EuRam project)
By: Urcelay C
From: Lemona Industrial SA, Alameda de Urquijo 10, Bilbao (Bizkaia), Spain
(Tel: 94 4872255, Fax: 94 4872210)
Ref no.: BE-2145
(Other partners included BRE in UK)

2.3  Recyclability in Concrete of Demolition Refuses Containing Materials Non-Compatible to the Traditional Cement Matrix
By: Dansk Vejbeton A/S et al
From: Dansk Vejbeton A/S, 21 Hellerup Lund Allee, DK-2900 Hellerup, Denmark
2.4 Study on Voluntary Agreements Concluded Between Industry and Public Authorities in the Field of the Environment  
By: Enviroplan A/S (subsequently became COWI Consulting Engineers and Planners A/S) et al  
From: European Commission DG III.01 - Industry  
Contract No ETD/95/84043

3 Publications from European Trade Associations:

3.1 Demolition and Construction Debris Recycling in Europe (1992)  
From: EDA - European Demolition Association, PO Box 90606, LP-2509 Den Haag, The Netherlands  
(Tel: 70 3286801, Fax: 70 3246147)  
ISBN 90-800376-4-8

From: Eurogypsum, 98 Rue Gulledelle, B-1200 Brussels, Belgium  
(Tel 00-32-2-775.8490, Fax: 00-32-2-771.3056)

3.3 Asphalt in Figures, 1997 (1998)  
From: European Asphalt Pavement Association, PO Box 175, 3620 AD Breukelen, The Netherlands  
(Web site http://www.eapa.org)

4 Reports from Austria:

4.1 6 reports from the Ministry of the Environment / Umweltbundesamt, Bundesministerium für Umwelt, Klagenfurt; Wien

4.1.1 Grundlagenstudie für die bundeseinheitliche Regelung der Entsorgung von Baustellenabfällen - d.s. Müll, Baustoff- und Rückstände aus der Baurestmassenaufbereitung (Recyclingreste) (1993)  
(Disposal of C&DW - residuals of C&DW treatment)  
By: Lahner T, Lechner P  
Ref: SLNr. 31409  

4.1.2 Baurestmassen - Vermeidung, Verwertung, Behandlung - Bauschutt (keine Baustellenabfälle) (1993) (C&DW prevention, recovery and treatment)  
By: Lahner T, Mostbauer P  
Ref: SLNr. 91206

4.1.3 Baurestmassen - Vermeidung, Verwertung, Behandlung - Baustellenabfälle (1994) (C&DW prevention, recovery and treatment - mixed C&DW)  
By: Lahner T  
Ref: SLNr. 91206

(C&DW prevention, recovery and treatment - concentrating on wood)  
By: Binner E, Mostbauer P  
Ref: SLNr. 17202

4.1.5 Baurestmassen : Vermeidung, Verwertung, Behandlung (1995) (C&DW: prevention, recovery, treatment)  
By: Lechner P  

4.1.6 Stoffflussanalyse und Vergleich zweier Aufbereitungstechniken für Baurestmassen (1998)  
(Analysis of material flows - comparison of two different treatment techniques)  
By: Schachermayer E  
Ref: Monographien / Umweltbundesamt, Bundesministerium für Umwelt, Jugend und Familie  
ISBN 3-85457-437-1
4.2 4 sets of good practice guidelines from Österreichischer Güteschutzverband Recycling-Baustoffe

4.2.1 Richtlinie für Recycling-Baustoffe (1993) (Guidelines for the recycling of C&DW and range of applications)


4.2.4 Richtlinie für die Aufbereitung kontaminierter Böden und Bauteile (1995) (Guidelines for the treatment of contaminated soil and construction waste)

4.3 2 reports from the Austrian Building Industry Federation / Fachverband der Bauindustrie Österreichs

4.3.1 Baurestmassen richtig behandeln : ein Leitfaden für die Baustelle (1995) (Guidelines for C&DW management)
Korneuburg: Starmühler.

4.3.2 Baurestmassentrennung auf der Baustelle - ein Leitfaden für die Baustelle (1994) (Guidelines for the separation of C&DW on construction sites)

4.4 2 reports from the Technical University of Vienna / TU Wien, Institut für Wassergüte und Abfallwirtschaft

4.4.1 Baurestmassen in Oberösterreich, Stoffbilanzen der Bauwirtschaft (BRIO-S) (1997) (C&DW in Austria)
By: Glenck E, Lahner T, Arendt M, Brunner P H

4.4.2 Güterbilanz der Bauwirtschaft -Baurestmassen in Oberösterreich (BRIO) (1996) (Materials balance in construction)
By: Glenck E, Lauber W, Lahner T, Brunner P H

4.5 4 miscellaneous reports

4.5.1 Recycling von Baureststoffen, Herstellung hochwertiger Baustoffe aus Baurestmassen, Recyclingverfahren - Verarbeitungs- und Behandlungstechnik, Anwendung neuer Technologien (1996) (C&DW recycling - production of high value construction products)
By: Deisl M

ISBN 3-85053-301-3

4.5.3 Umgang mit Baurestmassen : eine vergleichende Analyse zweier Projekte (BASS in der Steiermark und Project C&D in Auckland, Neuseeland) und der jeweiligen abfallwirtschaftlichen Rahmenbedingungen (1998) (C&DW handling in Steiermark, Austria and Auckland, New Zealand)
By: Kasper J R

4.5.4 Verwertungsmöglichkeiten für Hochbaurestmassen (1995) (Use of recycled C&DW)
By: Maydl P
5 Reports from Belgium:

5.1 3 reports from the Centre de Recherches Routières (CRC), Brussels, Belgium

5.1.1 The use of Crushed Concrete in Road Bases
Report A42

5.1.2 Plant Recycling of Bituminous Materials
Report A45

5.1.3 In Situ Recycling of Bituminous Materials
Report A48

6 Reports from Denmark:

6.1 Various reports from the Environmental Protection Agency, Strandgade 29, DK-1401, Københav K
(Tel: 32 66 01 00, Fax: 32 66 04 79)

6.1.1 English Summaries of a Number of Research Projects Relating to Building and Demolition Waste (1991-95)
By: Ministry of the Environment and Energy

By: Ministry of the Environment and Energy
Ref: Environmental Review No6, 1997

6.2 Crushed Asphalt as Unbound Roadbase (1994)
By: Berg F, Milvang-Jensen O, Moltved N (Ministry of Transport)
From: Road Directorate, Danish Road Institute, Elisagaardsvej 5, DK-4000 Roskilde
(Tel: +45 46 30 01 00, Fax: +45 46 30 01 05)
ISBN: 87-90145-04-6
ISSN: 0909-1386
Ref: Report 75
(See also Report 63E/88 - Re-Use of Concrete Pavements)

6.3 Recommendations for the Use of Recycled Aggregates for Concrete in Passive Environmental Class (1990)
From: Dansk Betonforening (Danish Concrete Association), c/o Dansk Ingeniorforening, Vester Farimagsgade 29, DK-1606 København V
(Tel: 33 15 65 65, Fax: 33 93 71 71)
Publication No. 34

7 Reports from France:

7.1 Guide des Déchets de Chantiers de Bâtiment (1997)
From: ADEME, 27 rue Louis Vicat, 75015 Paris
(Tel 01 47 65 20 00, Fax: 01 46 45 52 36)
ISBN 2-86817-269-5
(Includes a full bibliography of other French language documents)

7.2 Etude scientifique de la déconstruction sélective d’un immeuble à Mulhouse (1996) (Selective demolition study) (Franco-German collaborative research project / Forschungsbericht in Zusammenarbeit mit dem Centre Scientifique et Technique du Bâtiment, Paris, Karlsruhe)
By: Ruch M, Sindt V, Schultmann F, Zundel T, Rentz O, Charlot-Valdieu C, Vimond E
From: CSTB, 290 route des Lucioles, BP 209, 06904 Sophia Antipolis Cedex
(Tel: 04 93 95 67 08, Fax: 04 93 95 67 33)
8 Reports from Germany:

8.1 4 reports from Verband Deutscher Baustoff-Recycling-Unternehmer e.V., Godesberger Allee 99; 53175 Bonn

8.1.1 Aufbereitung zur Wiederverwendung von kontaminierten Böden und Bauteilen (1994) (Treatment of contaminated soil and construction components)
Ref: RAL-RG 501/2

8.1.2 Kontaminierte Bauteile im Hochbau (1993) (Contaminated construction components)

8.1.3 Recycling-Baustoffe für den Straßenbau (Quality criteria for recycling materials in road construction)
Ref: RAL-RG 501/1


8.2 3 reports from Verlag TÜV Rheinland GmbH, Köln

8.2.1 Recyclingpraxis Baustoffe. 2. aktualisierte und erweiterte Auflage. Hrsg: Karl O. Tiltmann (1994) (Recycling practice)
By: Kohler G

8.2.2 Abbruch und Recycling. RKW-Verlag (1990) (Demolition and recycling)
By: Willkomm W

8.2.3 Recyclinggerechtes Konstruieren im Hochbau. RKW-Verlag (1990) (Recycling-orientated construction)
By: Willkomm W

8.3 4 selected good practice guidelines (in addition to those above). These guidelines have been prepared by local/regional authorities and companies for use on construction and/or demolition sites. They provide information on how to separate C&DW, and details of treatment and disposal sites are usually included

8.3.1 Bauabfallmanagement (C&DW management for construction sites)
From: Neubaumaßnahmen Ingenieurbüro für Verfahrens-, Energie- und Umwelttechnik, RTB Umwelt GmbH Entsorgung und Verwertung (a company which has received an award for best construction site management)

8.3.2 Neue Wege auf dem Bau (Construction site management)
From: Konsortium Baustellenlogistik Spreebogen

8.3.3 Wie vermeiden wir Abfälle beim Bauen (1994) (C&DW prevention)
From: Landesinstitut für Bauwesen und angewandte Bauschadensforschung (LBB), Aachen
Ref: Ratgeber Nr.7

8.3.4 Umweltgerechter und kostensparender Umgang mit Bauabfällen (1997) (Environmentally friendly and cost-saving waste management on construction sites)
From: Zentralverband des Deutschen Baugewerbes

8.4 Abbruch, Entsorgung von Bauschutt, Recycling, Deponien (1993) (Demolition, recycling, disposal of C&DW)
From: Oberfinanzdirektion Kiel, 24096 Kiel.

8.5 Abfallvermeidung in der Bauproduktion (1994) (Waste prevention)
By: Untersuchung im Auftrag des Bundesministeriums für Raumordnung, Bauwesen und Städtebau
From: IRB-Verlag, Stuttgart

8.6 Baustoff-Recycling: Arten, Mengen und Qualitäten der im Hochbau eingesetzten Baustoffe; Lösungsansätze für einen Materialkreislauf. ecomed, Landsberg (1994) (C&DW recycling)
By: Andrä H P; Schneider R; Wickold T
8.7 Arbeitshilfen Recycling des Bundesministeriums für Raumordnung, Bauwesen und Städtebau und des Bundesministeriums der Verteidigung (Recycling guidelines)

8.8 Baustoffe unter ökologischen Gesichtspunkten - ökologische Grundsätze, Baustoffe, Schadstoffe, Wiederverwendung und Recycling.- Landesinstitut für Bauwesen und angewandte Bauschadensforschung / Fachkommission Standardisierung und Rationalisierung des Hochbauausschusses (LAG) der Argebau, Aachen 1993 - enthalten in Planungshilfen Umweltschutz der Bayerischen Finanzbauverwaltung, der Staatlichen Hochbauverwaltung des Landes Hessen und weiterer Länder (ecological aspects, re-use and recycling)

By: Bilitewski B, Gewiese A, Härdtle G, Marek K
From: 30 Erich Schmidt Verlag, Berlin, Bielefeld, München.

By: Bredenbals B, Willkomm W

By: Haeberlin N
ISSN 0940-4511

8.12 Baustoffe und Ökologie, Bewertungskriterien für Architekten und Bauherrn. Ernst Wasmuth Verlag, Tübingen (1996) (Construction materials and their ecological impact)
By: Haifele G, Ed W, Sambeth B M

By: Kohler G

8.14 Leitfaden zur Erstellung einer Qualitäts- und Umweltmanagementdokumentation für die Recycling-Baustoff-Industrie, Duisburg 1995. (Guideline for quality and environmental management)

8.15 Recyclingbaustoffe im Wohnungsbau (Recycling materials in housing construction)
From: Institut für Bauforschung e.V. Bericht F 757

8.16 Selektiver Rückbau und Recycling von Gebäuden - Dargestellt am Beispiel des Hotel Post (1994) (Selective demolition)
By: Rentz O, Ruch M, Nicolai M, Spengler T, Schultmann F
From: Ecomed Verlagsgesellschaft, Landsberg

8.17 Richtlinie für Recycling-Baustoffe (1996) (Guidelines for recycling materials)
From: Bundesverband der Deutschen Recycling-Baustoff-Industrie e.V., Duisburg

8.18 Grundsätze für die umweltverträgliche Verwendung und Wiederverwendung von Straßenbaustoffen (Environmentally sound use and re-use of road construction materials)
From: Veröffentlichungen der Forschungsgesellschaft für Straßen und Verkehrswesen e.V. Alfred-Schütte-Allee 10; 50697 Köln

By: Weber J, Palinkas Th
From: Buchreihe / UmweltZentrum Dortmund
ISBN 3-9805292-0-7

8.20 Recycling bei Sanierungsmassnahmen (1994)
8.21 From Down Cycling to Recycling of Used Building Materials in Complex Processing Centres (1994)
From: Remex GmbH, Albert-Hahn-Strasse 9, D-47269 Duisburg
(Tel: 02-03-768.030, Fax: 02-03-768.0340)

9 Reports from Italy:

9.1 La Gestione Dei Rifiuti Di Costruzione e Demolizione (1995)
From: Instituto Per L'Ambiente, via Luigi Emanueli 15, PO Box 10077, I - 20110 Milano
(Tel: 02.661301, Fax: 02.66102201)
Ref: Rapporto 95/02

By: CRESME for Fiera di Genova Riabitat Exhibition 21-24 May 1998
From: Fiera di Genova, Piazzale J F Kennedy 1, I - 16129 Genova
(Tel 00-39-10-53911, Fax: 00-39-10-539.1270, EMail fierage@fiera.ge.it)

10 Reports from the Netherlands:

10.1 3 reports available from Stichting CUR, Postbus 420, AK-2800 Gouda
(Tel 1820 39600, Fax: 1820 30046):

10.1.1 Re-Use of Asphalt with Regard to an Optimal Building Cycle (1994)
By: Veerman C P, Dutch Directorate General for Environmental Protection, Ministry for Housing,
Physical Planning and Environment
CUR-Report 94-10B. English summary available

10.1.2 Re-Use of Concrete and Brickwork with Regard to an Optimal Building Cycle (1994)
By: Veerman C P, Dutch Directorate General for Environmental Protection, Ministry for Housing,
Physical Planning and Environment
CUR Rapport 94-9A. English summary available.

10.1.3 Concrete and Masonry Rubble as Coarse Aggregates in Concrete
CUR Rapport 125.

10.2 Standaard RAW Bepalingen (1990)
From: CROW (the Centre for Research and Contract Standardization in Civil and Traffic Engineering), 1 Galvanistraat, PO Box 37, 6710 BA Ede
(Tel: 318 620410, Fax: 318 621112, Web site: http://rcn.wbinet.nl/crow)

11 Reports from Spain:

11.1 Architectural and Environmental Teaching (1997)
By: COAC, ITeC, UPC, Junta de Residus
From: Colegio de Arquitectos de Catalunya, Plaça Nova 5, 08002 Barcelona, Spain
(Tel: 93 301 5000, Fax 93 412 2395)
ISBN 84-89698-37-6
(Supported by DGXI through the LIFE Programme. Available in English and Catalan)

11.2 3 reports from the Generalitat de Catalunya, Departament de Medi Ambient, Junta de Residus, Provença 204-208, 08036 Barcelona (Tel 00-34-93-451.4135, Fax: 00-34-93-451.5954)

By: ITeC
ISBN 84-393-3236-X

11.2.2 Aprofitament de Residus en la Construcció (1995) (Using C&DW in construction)
By: ITeC
ISBN 84-393-3597-0
11.2.3 Programa de Residus de la Construcció a Catalunya (1996) (C&DW programme in Catalonia)
By: Junta de Residus with Gestora de Runes
ISBN 84-393-3906-2

11.3 Actuaciones en Infraestructuras para la Gestión de Residuos Sólidos Urbanos (1996)
(Actions to improve landfill management)
From: Ministerio de Medio Ambiente, Centro de Publicaciones, Paseo de la Castellana 67, 28071 Madrid
(Tel: 00-34-91-597-6187, Fax: 00-34-91-597.6186, EMail: mfomento@tsai.es
ISBN 84-498-0261-X

12 Reports from the United Kingdom:

12.1 The Environmental Costs and Benefits of the Supply of Aggregates - Executive Summary (1998)
By: London Economics in association with Mining and Environment Research Group, Royal School of Mines, Imperial College, London and Dr Clive Spash, Cambridge
From: Department of the Environment, Transport and the Regions, Free Publications, P.O Box 236, Wetherby, West Yorkshire LS23 7NB
(Tel: 0870 1226236, Fax: 0870 1226237)
(See below for details of the full report)

12.2 2 reports from the Department of the Environment, Transport and the Regions, Publication Sales Centre, Unit 8, Goldthorpe Industrial Estate, Goldthorpe, Rotherham S63 9BL
(Tel: 01709 891318, Fax: 01709 881673)

12.2.1 The Environmental Costs and Benefits of the Supply of Aggregates (1998)
By: London Economics in association with Mining and Environmental Research Group, Royal School of Mines, Imperial College, London and Dr Clive Spash, Cambridge
Cost: £95
ISBN: 1 85112 082 3
(See also free publications above)

By: Ecotec Research and Consulting.

12.3 Feasibility of Using Crushed Concrete Aggregate in Structural Work (1997)
By: Desai S B
From: Department of the Environment, Building Regulations Division, London
(Arising from a 2-year research project at the University of Dundee into recycled concrete aggregate for use in BS5328 designated mixes, which started in August 1995)

12.4 4 reports from the Energy Efficiency Office, ETSU (the Energy Technology Support Unit), Harwell, Oxfordshire OX11 0RA
(Tel: 01235 436747, Fax: 01235 432923)
12.4.1 Cold-Mix Recycling for Road Construction - Bardon (England) Ltd (1997)
Ref: NPFP 100

12.4.2 The Performance of Roads Reconstructed by Cold In Situ Recycling 1985-87 (1994)
Ref no.: Rep 17

12.4.3 Monitoring of Cold Road Recycling Process on a Heavily Trafficked Road (1992)
By: WS Atkins

12.4.4 Cold Road Recycling (Final Profile 60)
Ref no.: NP60

12.5 Use of Primary and Secondary Aggregates in Road Construction: Relevant Specifications
From: Highways Agency, Roads Engineering & Environmental Division, Room 4/27, St Christopher
House, Southwark Street, London SE1 0TE
(Tel: 0171 921 4762, Fax: 0171 921 4411)
(This is an INFORMAL LISTING of (1) which materials types may be used in roadworks by
Specification for Highway Works and Notes for Guidance; (2) which materials may be used
according to the Design Manual for Roads and Bridgeworks (DMRB); (3) British Standards relating
to the use of Aggregates in Roads and Bridges; and (4) Extracts from BD42/94, BD12/95, HA35/95,
(all referred to in (2))

12.6 3 official UK reports available through The Stationery Office, PO Box 276, London SW8 5DT
(Tel: 0171 873 0011, Fax: 0171 873 8200)

12.6.1 Specifications for Highway Works - Notes For Guidance (1993)
By: Department of Transport (Highways Agency)
Reference: MCHW Vol1, Vol2

12.6.2 Use of Waste and Recycled Materials as Aggregates - Standards and Specifications.
Executive Summary
By: Department of the Environment
ISBN.011 752952 3

By: Howard Humphreys and Partners for the Department of the Environment
ISBN 0-11-752972-9

12.7 2 reports from the Transport Research Laboratory, Old Wokingham Road, Crowthorne,
Berkshire RG45 6AU
(Tel: 01344 773131, Fax: 01344 770356)

12.7.1 Assessment of the Performance of Off-Site Recycled Bituminous Materials (1991)
By: Cornelius and Edwards
ISSN 0266-5247
Research Report 305

12.7.2 Alternative Materials in Road Construction - A Summary of EU RTD Project RO-97-
SC.2238
By: Reid M (TRL) - Project Coordinator

12.8 6 reports from the Building Research Establishment (BRE), Garston, Watford, Hertfordshire
WD2 7JR
(Tel: 01923 664444, Fax: 01923 664400)

By: Hobbs G
Ref no: IP1/96

12.8.2 Increasing the Use of Recycled Aggregates in Construction (1996)
Ref no: PD56/96
By: Hopton and Sym in conjunction with Collins R J (BRE)
Ref no: Note N67/95

12.8.4 The Use of Recycled Aggregates in Concrete (1994)
By: Collins R J (BRE)
Ref no: IP5/94

12.8.5 Efficient Use of Aggregates and Bulk Construction Materials Volume 1 - The Role of Specifications (1993)

12.8.6 Efficient Use of Aggregates and Bulk Construction Materials Volume 2 - Technical Data and Results of Surveys (1993)
ISBN 0-85125566-3

12.9 8 reports from the Construction Industry Research and Information Association (CIRIA), 6 Storey's Gate, Westminster, London SW1P 3AU
(Tel: 0171 222 8891, Fax: 0171 222 1708)

By: Guthrie P and Mallett H
CIRIA Special Publication 122
See also SP 508 Waste Minimisation and Recycling in Construction - Stage 2

By: Guthrie P M, Woolveridge A C and Patel V S
CIRIA Special Publication 133
ISBN: 0-86017-482-4
Price: £65 (£28 for CIRIA members)

By: Coventry S, Woolveridge C and Hillier S
ISBN: 0 86017-513-8

From: Jo Newman, County Planning Officers Society, c/o Dorset County Council, County Hall, Colliton Park, Dorchester DT1 1XJ
(Tel: 01305 224243,Fax: 01305 224914)

By: Snook K, Turner A and Ridout R
From: The Chartered Institute of Building, Englemere, Kings Ride, Ascot, Berkshire SL5 7TB
ISBN 1-85380-067-8

12.12 Aggregate Recycling and Alternative Materials in Highway Construction
From: The Institution of Highways and Transportation, Royal Spa Centre, Leamington Spa, Warwickshire
ISBN 0 902 933 13 2

12.13 2 Institution of Civil Engineers reports from Thomas Telford Services Ltd., Publications, Thomas Telford House, 1 Heron Quay, London, E14 4JD
(Tel: 0171 987 6999, Fax: 0171 538 4101)

By: Ferguson, Hermode, Nash, Sketch and Huxford (ICE)
ISBN 0-72772023-6
By: Sherwood P T
ISBN 07-277201-8X

12.14 3 reports from Nottingham Trent University, Building and Environmental Health Department, Burton Street, Nottingham NG1 4BU (Contact Mr Anthony Trevorrow) (Tel: 0115 941 8418, Fax: 0115 948 8438)

By: Trevorrow A

By: Trevorrow A

By: Trevorrow A

12.15 3 reports from the Department of Civil Engineering, City University, Northampton Square, London EC1V OHB (Contact Dr P R S Speare) (Tel: 0171 477 8145, Fax: 0171 477 8570)

12.15.1 The Use of Crushed Brick Coarse Aggregate in Concrete (1996)
By: Speare P R S, Kibriya T

12.15.2 Durability of Concrete Made Using Recycled Coarse Aggregates (1996) (Presented to IABSE 15th Congress)
By: Speare P R S, Ben-Othman B

12.15.3 Recycled Concrete Coarse Aggregates and Their Influence on Durability (1993) (Presented to Concrete 2000, Dundee)
By: Speare P R S, Ben-Othman B

From: Mr D C Harvey, County Surveyors Society Office, c/o Derbyshire CC, Planning & Highways Office, Matlock, Derbyshire DE4 3AG (Tel: 01629 580000)

From: Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford, OX5 1GB (Tel: 01865 843192, Fax: 01865 843986)
ISSN 0956-053X

By: Dengate R
From: Kvaerner Technology, Research and Development, Maple Cross House, Denham Way, Maple Cross, Rickmansworth, Herts, WD3 2SW (Tel: 01923 776666, Fax: 01923 777666)
(Paper presented at AAS Seminar in May 1997)
By: Mallett S H; Woolveridge A; Tollitt B and Burnett J
From: Aspinwall & Co., 16 Crucifix Lane, London Bridge, London SE1 3JW
(Tel: 0171 940 5400, Fax: 0171 940 5414)

12.20 Recycling of Construction Materials (1990)
By: Lindsell P
From: National Federation of Demolition Contractors, Resurgam House, 1A New Road, The Causeway, Staines, Middlesex, TW18 3DH
(Tel: 01784 456799, Fax: 01784 461118)

By: Brown B V
From: Readymix (UK) Ltd., RMC House, 53-55 High Street, Feltham, Middlesex, TW13 4HA
(Tel: 01932 568833, Fax: 0171 851 0006)

12.22 Demolition and Re-Use of Concrete and Masonry Volume 2 - Re-Use of Demolition Waste (1988)
Edited by Y Kasai
From: Chapman and Hall, 2-6 Boundary Row, London SE1 8HN
(Tel: 0171 865 0066, Fax: 0171 410 6600)
ISBN 0 412 32110 6

12.23 2 reports from Colas Ltd, Rowfant, Crawley, West Sussex RH10 4NF
(Tel: 01342 711143, Fax: 01342 711198)

12.23.1 Road Recycling - The Available Options (1996)
By: Hicks B

12.23.2 Shallow Recycling, A Cold Mix Process (1992)
By: Hicks B

By: King S (FoE)
From: Friends of the Earth, 10-12 Picton Street, Montpelier, Bristol BS6 5QA
(Tel: 0117 942 0129, Fax: 0117 942 0164)
Annex 11

Reference Economic and Population Data

Exchange rates and population figures used throughout the Report
REFERENCE ECONOMIC AND POPULATION DATA

The following figures were taken from EUROSTAT’s on-line publications and statistical indicators (http://europa.eu.int/en/comm/eurostat/indic/...).

<table>
<thead>
<tr>
<th>Country</th>
<th>1 ECU = ... currency units, 1997</th>
<th>Population (million) on 1 January 1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>13.824 Schillings</td>
<td>8.068</td>
</tr>
<tr>
<td>Belgium</td>
<td>40.5332 Francs</td>
<td>10.170</td>
</tr>
<tr>
<td>Denmark</td>
<td>7.48361 Crowns</td>
<td>5.275</td>
</tr>
<tr>
<td>Finland</td>
<td>5.88064 Markka</td>
<td>5.132</td>
</tr>
<tr>
<td>France</td>
<td>6.6126 Francs</td>
<td>58.492</td>
</tr>
<tr>
<td>Germany</td>
<td>1.96438 Marks</td>
<td>82.012</td>
</tr>
<tr>
<td>Greece</td>
<td>309.355 Drachma</td>
<td>10.487</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.747516 Pounds</td>
<td>3.652</td>
</tr>
<tr>
<td>Italy</td>
<td>1929.3 Lira</td>
<td>57.461</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>see Belgium</td>
<td>0.418</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>2.21081 Guilders</td>
<td>15.567</td>
</tr>
<tr>
<td>Portugal</td>
<td>198.589 Escudos</td>
<td>9.934</td>
</tr>
<tr>
<td>Spain</td>
<td>165.887 Pesetas</td>
<td>39.299</td>
</tr>
<tr>
<td>Sweden</td>
<td>8.65117 Crowns</td>
<td>8.844</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.692304 Pounds</td>
<td>58.902</td>
</tr>
<tr>
<td>EU-15</td>
<td>-</td>
<td>373.713</td>
</tr>
</tbody>
</table>
Annex 12

Calculations and Assumptions Used to Estimate the Cost of Crushing Inert C&DW
CALCULATIONS AND ASSUMPTIONS USED TO ESTIMATE THE COST OF CRUSHING INERT C&DW

This Annex shows how we arrived at a representative processing cost of 2.00 ECU/tonne for demolition waste which is crushed at a fixed C&DW recycling centre and 1.50-2.00 ECU/tonne using a mobile crusher at the original demolition site. These figures exclude all transport costs.

Although intended to be broadly representative for all Member States, we have declared all of our assumptions and formulae so that any reader can re-work the calculations with amended assumptions to see how much difference this makes.

Raw data for C&DW processing cost estimation

The raw data came from a variety of sources. One of the main ones was the 1997 edition of ‘Mine and Mill Equipment Costs’, a comprehensive costing guide based on extensive surveys in the USA and published by Western Mine Engineering Inc. We have also drawn on a range of manufacturers’ marketing and technical brochures for mineral and C&DW crushers and processing equipment.

The first issue addressed concerns the capital and operating costs of crushers. Although ‘Mine and Mill Equipment Costs’ contains information on the costs of operating a range of different crusher types (single-toggle ‘jaw’ crushers, double-toggle ‘jaw’ crushers and single-rotor impact crushers), the most comprehensive data on the link between model types and processing capacity is limited to single-toggle ‘jaw’ crushers. Since these are more widely used in demolition waste processing, we have used this range of crushers as a proxy for all crushers. However, we recognize that (as explained in Chapter 9) impact crushers have a rather different cost profile (in that their capital costs are generally lower but, particularly with hard materials such as concrete, their operating costs can be significantly higher).

The data in the first two tables have been extracted from similar but larger tables in ‘Mine and Mill Equipment Costs’. All of the crushers featured are single-toggle ‘jaw’ crushers, and all units and costs have been converted. The conversion from short tons (2,000 pounds) to metric tonnes (1,000kg) involves multiplying the US figures by a factor of 0.9072, and the exchange rate used for converting costs from US$ to ECU was US$ 1.13 = 1 ECU (from the same source at the same time as the exchange rates given in Annex 11). Some small rounding errors will have been introduced as a consequence.

In ‘Mine and Mill Equipment Costs’ crushers are not identified by manufacturer, but by a generalised type based on their power unit (in HP or horse power) and jaw size. Jaw size measurements comprise two measurements (both in inches, 1 inch = 25.4mm), the first being the distance between the tops of the crowns of the two plates and the second being the width between the side liners (see the line drawing in Annex 13). The outlet settings given in Figure A12.1 refer to the nominal closed size settings at the outlet of the crushers. There is a very strong correlation between this measure, the maximum size of crushed material which will be produced and the size of screen through which 50% of the crushed material will then pass. The ‘normal’ ratios are a maximum size of 160% of the nominal closed size setting, and half of the crushed material passing through a screen size of 75% of the setting.

Figure A12.1 illustrates the general relationships between power, jaw size, outlet setting and hourly processing capacity, but it should be stressed that these data are derived from mines and quarries rather than recycling installations. Both the flows and the physical characteristics of the materials being crushed can be assumed to be considerably more consistent in a mine or quarry than in a recycling centre.

In Figure A12.2, the hourly wage rate used for calculating the maintenance labour cost was US$ 23.19 (20.52 ECU at the exchange rate used), the cost of electricity was US$ 0.05/kWh and the cost of lube oil was US$ 3.55 per US gallon.
The key finding is that, over a wide range of crushers, the hourly operating cost amounts to roughly 1/10,000 of the capital cost. Most of this is accounted for by wearing parts and the labour needed to replace them. However, it is essential to remember that these costs relate simply to crushers, not to integrated machines with screens, metal separators and conveyor systems built onto a common chassis. As a rule of thumb, a commercial C&DW crusher requires roughly twice the power of a stand-alone crushing unit, and costs substantially more to buy and operate.

Although some caution is therefore essential when using these numbers to estimate the cost of crushing C&DW in Europe, in the absence of better data we have attempted to do so. However, we have assumed that the operating costs on C&DW will be double those for quarry stone (because concrete is generally much harder and more abrasive), or 2/10,000 of the capital cost, and that the hourly throughput of crushed materials will be slightly over half of the quoted figure (because this is consistent with operators’ experience in real life).

We have based our calculation on a crusher broadly similar to the 150HP 30x42 crusher. As can be seen above, this model has a nominal capacity of 181 tonnes/hour with its jaws set to a closed size setting of 100mm, whereas we have assumed no more than 100 tonnes/hour of crushed C&DW. Instead of a simple crusher costing 137,310 ECU, we have assumed a chassis-mounted crusher with a range of ancillary equipment costing 300,000 ECU.

The factors to be considered are the capital cost of machinery (including the cost of borrowing, spread over a working life of an agreed length), the operating cost and the fixed cost of owning or renting a site (applicable only in the case of a fixed recycling centre).
The assumptions in detail for a fixed C&DW recycling centre:

For a fixed C&DW recycling centre we have assumed:

- a useful working life of 8,800 hours for a crusher, based on 5 years’ working life (WL) at 220 days/year (DY) and 8 hours/day (HD);
- an interest rate (IR) of 10%;
- a processing capacity (PC) of 100 tonnes/hour;
- a capital cost (CC) of 300,000 ECU;
- an hourly operating cost of 2/10,000 of the capital cost;
- other capital and operating costs for other plant items equal to those of the main crusher;
- a land area (LA) of 4ha (40,000 m²);
- a nominal rent (R) of 200 ECU/ha/year.

We have assumed a residual value of zero at the end of the crusher’s working life. This has the advantage that it substantially simplifies the formulae which follow, even though it is not entirely realistic. However, as will be seen, the effect of this simplification is very small, since the financing costs only contribute a small fraction of the total costs.

The technical assumptions are all very ‘broad brush’ in nature, and could be considered to be +/- 100%. By contrast, the cost of land could vary by significantly more. We have assumed cheap land at approximately agricultural rent levels (or subsidised by the local authorities to a comparable level). However, paying a commercial rent on urban land (with consent for development for light industry, distribution or similar) would cost 20-30 times as much.

All of these assumptions can easily be varied to test ‘what-if’ queries.

First we present the key components of the calculation as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbols</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output over working life</td>
<td>WL x DY x HD x PC</td>
<td>5 x 220 x 8 x 100 = 880,000 tonnes</td>
</tr>
<tr>
<td>Crusher capital and financing costs over working life</td>
<td>CC [CC/2 \times IR/100 \times WL] [CC \times [1 + (IR \times WL)/200]]</td>
<td>300,000 + [150,000 x 0.1 x 5] = 375,000</td>
</tr>
<tr>
<td>Crusher operating costs over working life</td>
<td>2 x CC/10,000 x WL x DY x HD</td>
<td>2 x 30 x 5 x 220 x 8 = 528,000</td>
</tr>
<tr>
<td>Total site equipment costs over working life</td>
<td>2 x sum of two previous rows</td>
<td>2 x (375,000 + 528,000)</td>
</tr>
<tr>
<td>Land costs over working life</td>
<td>LA x R x WL</td>
<td>4 x 200 x 5 = 4,000</td>
</tr>
</tbody>
</table>

The full formula for calculating the total costs over the working life of the crusher can be written as follows:

$$\text{Cost/tonne} \times \text{WL} \times \text{DY} \times \text{HD} \times \text{PC}$$

equals

$$2 \times \text{CC} \times [1 + (\text{IR} \times \text{WL})/200 + 2 \times (\text{WL} \times \text{DY} \times \text{HD})/10,000]$$

plus

$$\text{LA} \times \text{R} \times \text{WL}$$

or as:

$$\text{Cost/tonne} = \frac{2 \times \text{CC} \times [1 + (\text{IR} \times \text{WL})/200 + 2 \times (\text{WL} \times \text{DY} \times \text{HD})/10,000] + [\text{LA} \times \text{R} \times \text{WL}]}{\text{WL} \times \text{DY} \times \text{HD} \times \text{PC}}$$
Solving this for the assumptions declared above produces an answer of:

\[
\frac{2 \times 300,000[1 + (0.1 \times 5)/200 + 2 \times (5 \times 220 \times 8)/10,000] + 4 \times 200 \times \frac{5}{5 \times 220 \times 8 \times 100}}{880} = \frac{600,000[1 + 0.0025 + 1.76] + 4,000}{880} = \frac{1657.5 + 4}{880} = 1.89 \text{ ECU/tonne}
\]

We have rounded this estimate to the nearest 0.50 ECU, which is 2.00 ECU/tonne.

Assuming a mark-up of 50% over direct costs, this would place a sales value of 3.00 ECU/tonne on the processing component of C&DW-derived aggregates. The crusher would therefore be earning around 300 ECU/day, which is 1% of its purchase cost. This would be consistent with what operators have told us is a prudent target.

**The assumptions in detail for a mobile C&DW recycling plant:**

Next we have re-run the calculation for a mobile plant costing slightly less than the fixed machine and working fewer days per year (to facilitate frequent moves between sites). The actual assumptions are:

- a useful working life of 9,000 hours for a crusher, based on 7.5 years' working life (WL) at 150 days/year (DY) and 8 hours/day (HD);
- an interest rate (IR) of 10%;
- a processing capacity (PC) of 100 tonnes/hour;
- a capital cost (CC) of 250,000 ECU;
- an hourly operating cost of 2/10,000 of the capital cost;
- other capital and operating costs equal to those of the main crusher.

Solving the cost/tonne equation for these assumptions produces the following answer:

\[
\text{Cost/tonne} = \frac{2 \times CC \times [1 + (IR \times WL)/200 + 2 \times (WL \times DY \times HD)/10,000]}{WL \times DY \times HD \times PC}
\]

\[
\frac{2 \times 250,000[1 + (0.1 \times 7.5)/200 + 2 \times (7.5 \times 150 \times 8)/10,000]}{7.5 \times 150 \times 8 \times 100} = \frac{500,000[1 + 0.00375 + 1.8]}{900,000} = \frac{500 \times 2.80375}{900} = \frac{1,401.875}{900} = 1.56 \text{ ECU/tonne}
\]

Changing the assumptions to match the characteristics of a smaller crusher will raise the costs per tonne. Based on a capital cost of 175,000 ECU and a throughput of 50 tonnes/hour the total cost per tonne rises to 2.18 ECU/tonne.

We have rounded these estimates to the nearest 0.50 ECU, which produces figures of 1.50 ECU/tonne for a large mobile crusher and 2.00 ECU/tonne for a smaller one.
Annex 13

Acronyms, Definitions and Descriptions

As used in this Report
# Acronyms, Definitions and Descriptions

Where the definitions which follow are based on legal definitions, the sources are indicated. Other definitions and descriptions have been expressed in plain English.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAS</td>
<td>Aggregates Advisory Service. An information exchange operated in the UK to promote aggregates efficiency, including C&amp;DW recycling.</td>
</tr>
<tr>
<td>Aggregates</td>
<td>Hard, granular, mainly inert construction materials. The sum of primary, secondary and C&amp;DW-derived (recycled) aggregates.</td>
</tr>
<tr>
<td>Amenity impacts</td>
<td>Similar to environmental impacts, but affecting the quality of life of people and communities. Examples include nuisance and severance.</td>
</tr>
<tr>
<td>Bottom ash</td>
<td>Granular material (also called slag) from the bottom of an incinerator or similar.</td>
</tr>
<tr>
<td>Brite-EuRam</td>
<td>A research programme covering industrial and materials technologies, run by DGXII.</td>
</tr>
<tr>
<td>C&amp;DW</td>
<td>Construction and demolition waste. Described at length in Chapter 2 of this report and defined in EWC Chapter 17.</td>
</tr>
<tr>
<td>C&amp;DW-derived aggregates</td>
<td>Aggregates made by crushing and sorting the inert fraction of C&amp;DW.</td>
</tr>
<tr>
<td>Capping layer</td>
<td>Part of the structure of roads. See road sub-base below.</td>
</tr>
<tr>
<td>CEN</td>
<td>Comité Européen de Normalisation, the European standards institution.</td>
</tr>
<tr>
<td>CFCs</td>
<td>Chlorofluorocarbons. Important greenhouse gases.</td>
</tr>
<tr>
<td>China clay</td>
<td>Natural white clay used to manufacture ceramic products (sanitary ware etc).</td>
</tr>
<tr>
<td>CIRIA</td>
<td>The Construction Industry Research and Information Association, a UK research body.</td>
</tr>
<tr>
<td>Contraries</td>
<td>Materials other than those supposed to be in the product or mixture. An example would be fragments of wood, plastic or paper in a C&amp;DW-derived aggregate.</td>
</tr>
<tr>
<td>‘Core’ C&amp;DW</td>
<td>Those types of materials which are obtained when an empty building or civil engineering infrastructure is demolished (but not necessarily obtained as a direct result of demolition). It excludes road planings, excavated soil, external utility and service connections (drainage pipes, water, gas and electricity connections) and surface vegetation, because the techniques for recovering and recycling these are quite distinct from other demolition wastes.</td>
</tr>
<tr>
<td>CUR</td>
<td>Civieltechnisch Centrum Uitvoering Research en Regelgeving, a Dutch civil engineering research institute.</td>
</tr>
<tr>
<td>DGXI</td>
<td>Directorate General XI of the European Commission, responsible for the environment, nuclear safety and civil protection.</td>
</tr>
<tr>
<td>DGXII</td>
<td>Directorate General XII of the European Commission, responsible for science, research and development.</td>
</tr>
<tr>
<td>ECU</td>
<td>European Currency Unit (see Annex 11).</td>
</tr>
<tr>
<td>Engineering fill</td>
<td>Bulky inert materials used to fill holes, trenches etc or to form a stable foundation as part of the construction process.</td>
</tr>
<tr>
<td>Environmental impacts</td>
<td>Environmental impacts are the direct and indirect impacts of any development on human beings, fauna and flora; soil, water, air, climate and the landscape; material assets and the cultural heritage; and interactions between the above. (Based on Article 1.5 of Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of certain public and private projects on the environment, published in OJ No.L 73/5 of 14 March 1997).</td>
</tr>
<tr>
<td>EU</td>
<td>The European Union.</td>
</tr>
<tr>
<td>EU-15</td>
<td>The 15 Member States of the EU.</td>
</tr>
<tr>
<td>Eurostat</td>
<td>The statistical office of the EU.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Fly ash</td>
<td>The very fine ash produced in incineration processes.</td>
</tr>
<tr>
<td>Gate price</td>
<td>The charge paid by a holder of waste before it is accepted by a waste disposal or recovery facility. The gate price excludes transport costs.</td>
</tr>
<tr>
<td>HCFCs</td>
<td>Hydrochlorofluorocarbons. Important greenhouse gases used in foams and fire fighting systems.</td>
</tr>
<tr>
<td>Impact crusher</td>
<td>A mechanical device for crushing primary aggregates or C&amp;DW. Figure A13.1 (at the end of this Annex) provides an illustration showing four toughened steel plates fixed to a rotor. These crush the material as it is forced between the rotor and the toughened steel face plates. The positions of the face plates are set by the operator.</td>
</tr>
<tr>
<td>Inert waste</td>
<td>Waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, 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. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant. (Taken from COM(97)105 final, a proposal for a Council Directive on the landfill of waste).</td>
</tr>
<tr>
<td>‘Jaw’ crusher</td>
<td>A mechanical device for crushing primary aggregates or C&amp;DW. Figure A13.2 (at the end of this Annex) provides an illustration showing a deep, symmetrical crushing chamber with no ‘dead zones’. One side is fixed while the other is moved by a cam on the rotating shaft. Both jaws are protected by thick, replaceable wearing plates. The size of the bottom opening can be set by the operator.</td>
</tr>
<tr>
<td>Member States</td>
<td>Members of the EU, i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom (UK).</td>
</tr>
<tr>
<td>MSW</td>
<td>Municipal solid waste, meaning household waste and commercial, industrial, institutional and other waste which, because of its nature or composition is similar to household waste.</td>
</tr>
<tr>
<td>PCB</td>
<td>Polychlorinated biphenyls. Hazardous chemicals typically found in old electrical transformers. Regulated by Directive 91/273/EEC.</td>
</tr>
<tr>
<td>Primary aggregates</td>
<td>Naturally occurring sand, gravel and (crushed) rock obtained by quarrying or marine dredging.</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl chloride. A plastic product used in the manufacture of window frames, pipes etc.</td>
</tr>
<tr>
<td>Quarry</td>
<td>A pit or rock face, usually open to the air, from which natural aggregates are dug or blasted.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Re-use</td>
<td>Re-use means the beneficial use of a material which might otherwise have to be discarded. There is a general distinction between re-use (which does not require any special processing before the material can be used) and recycling (which does).</td>
</tr>
<tr>
<td>Recycled aggregates</td>
<td>See C&amp;DW-derived aggregates.</td>
</tr>
<tr>
<td>Recycling</td>
<td>The use of a formerly waste material after it has been processed so that it no longer poses any significant threat to the environment.</td>
</tr>
<tr>
<td>RILEM</td>
<td>Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions, which in English is the International Union of Testing and Research Laboratories for Materials and Structures.</td>
</tr>
<tr>
<td>Road planings</td>
<td>Bituminous and asphaltic-bound materials removed from the surface of a road during repair/resurfacing.</td>
</tr>
<tr>
<td>Road sub-base</td>
<td>One of the layers of a road or highway. Figure A13.3 (at the end of this Annex) provides an illustration.</td>
</tr>
<tr>
<td>‘Scissor’ crushers</td>
<td>Large hydraulically operated shears for cutting steel and concrete beams, usually mounted on a mechanical digger or similar.</td>
</tr>
<tr>
<td>Secondary aggregates</td>
<td>Waste materials, including by-products from mining and quarrying activities, which can be used as substitutes for primary aggregates. Examples include fly ash, bottom ash, steel slag, mine tailings, stone scalps and china clay waste.</td>
</tr>
<tr>
<td>Selective demolition</td>
<td>The organised treatment and/or removal of certain materials and components prior to the demolition of the main structure. Materials may be removed because of their own economic value, or because a failure to treat and/or remove them will contaminate or otherwise subtract value from the resultant demolition waste.</td>
</tr>
<tr>
<td>Sub-base</td>
<td>See road sub-base.</td>
</tr>
<tr>
<td>Waste</td>
<td>Defined by the EU (in the Framework Directive on waste) as ‘any substance or object which the holder discards or intends, or is required, to discard’. ‘Holder’ is defined as ‘the producer of the waste or the natural or legal person who is in possession of it’. Waste is defined by the OECD as ‘materials other than radioactive materials intended for disposal’.</td>
</tr>
</tbody>
</table>
Figure A13.1: Impact Crusher

Illustration by kind permission of Svedala

Figure A13.2: ‘Jaw’ Crusher

Illustration by kind permission of Svedala

Figure A13.3: Different Road Layers

Wearing Course
Road Base
Sub-Base