ECO-REGION NW

INTEGRATED LIFE-CYCLE MATERIAL FLOWS & MASS BALANCE OF CONSTRUCTION RESOURCES: BRE INTERIM REPORT
December 2004

Client Report :
Eco-Region NW England
- integrated life cycle of material flows and mass balance of construction resources
- **DRAFT INTERIM REPORT**

Client report number 15932

Prepared for :
Biffa Environment Fund

December 2004

Last Update:

NL 6/12/2004

A Biffaward project on Sustainable Resource Use

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Executive Summary

BRE Scotland is collaborating with University of Manchester on a project entitled ‘Eco-Region North West England – integrated life cycle of material flows and mass balance of construction resources’. The project is supported financially by the Biffa Environment Fund. There are a number of project partners and sponsors.

North West England is composed of Cumbria, Lancashire, Cheshire, Merseyside and Greater Manchester. This is being considered as an Eco-Region, allowing a mass balance of the whole life cycle of the construction resources within the region to be developed. All the stages of the whole life cycle of construction are being considered, as follows:

1) Raw materials
2) Construction products
3) Current building stock
4) New planned construction
5) Construction waste
6) Demolition and secondary waste materials

For each stage, the most current and reliable data available has been collected and tabulated. If data was unavailable for NW England, corresponding data was gathered for Northern England, England, England & Wales or UK.

This report is a draft interim report and is a work in progress.

Contents

1. Introduction

BRE Scotland is collaborating with University of Manchester on a project entitled 'Eco-Region North West England – integrated life cycle of material flows and mass balance of construction resources'. The project is supported financially by the Biffa Environment Fund. There are a number of project partners and sponsors.

The idea of an Eco-Region allows the analysis of all the resource flows i.e. the development of a mass balance within a certain region. The region of North West England is considered to be composed of Cumbria, Lancashire, Cheshire, Merseyside and Greater Manchester. A mass balance of the whole life cycle of construction resources is being developed for this region. This includes the following parameters:

1) Raw materials
2) Construction products
3) Current building stock
4) New planned construction
5) Waste from construction
6) Demolition and other secondary waste materials

This report is a draft interim report and is a work in progress.

2. Methodology

The work was undertaken mainly as a desk based review of the available information. The main sources of information were as follows:

1) Publications, reports and other information from BRE, University of Manchester, other project partners and other contacts.

2) Internet World Wide Web (www) sites and search engines such as Google and Lycos.

The most current and reliable data available for the whole life cycle of construction resources in NW England was collected and tabulated for the following stages:

1) Raw materials

2) Construction products

3) Current building stock

4) New planned construction

5) Construction waste

6) Demolition and secondary waste materials

If data was not available for NW England, corresponding data was gathered for Northern England, England, England & Wales or UK.

3. Raw Materials

3.1 Production of raw materials

Data has been collected for aggregates production, imports, exports and consumed in North West England, as shown in table 1.

Table 1: Primary aggregate production, imports, exports and consumption in North West England during 2001 to 2002 (in thousands of tonnes)

Aggregate type	Aggregate production in NW England	Aggregate imports into NW England	Aggregate exports from NW England	Net imports into NW England	Total aggregate consumption In NW England	Non aggregate production in NW England (Industrial use)	Multiplier for waste and overburden (to total material moved)
Limestone	5,600	8,253	86	8,167	13,767	1,400	+ 15%
Sandstone and Igneous Rock	4,600	888	1,031	(143)	4,457	27	+ 15%
Land won Sand and Gravel	3,200	901	430	471	3,671	1,694	+ 25%
Marine Sand and Gravel	500		24	(24)	476	2	+ 7.5%
Harbour Authorities Sand and Gravel	50				50		+ 7.5%
Total (% total primary aggregate consumption)	13,950 (62%)	10,042	1,571	8,471 (38%)	22,421	3,123	
Slate	158 (135 crushed as aggregate plus 23 crude blocks)						Blocks x 15
Gypsum	175						nil

Sources:

British Geological Survey 2003 *Collation of Results of the 2001 Aggregate Minerals Survey for England and Wales.* British Geological Survey, Keyworth, Nottingham.

Dickinson, M. 2003 Director of Quarries, Burlington Slate Ltd., Kirby in Furness, Cumbria. Personal communication 27/8/2003

Lawson, N., Waghorn, D., Ravetz, J. and Douglas, I. 2003 *UK Material Flow Accounts: Review of Indirect Flow Coefficients.* Unpublished Report to the Office of National Statistics.

North West Regional Aggregates Working Party 2004 *Annual Report 2003* North West Regional Aggregates Working Party, Chester

Worsley, N. 2003 Manager, British Gypsum Ltd. Personal communication, 18/7/2004

A comparison has been carried out of aggregates produced and consumed in North West England compared with that for England and Wales, as shown in table 2, as follows:

Table 2: Comparison of aggregate produced and consumed in NW England compared with that for England and Wales

Aggregate type	Production/%	Consumption/%
Limestone, sandstone & Igneous rock (crushed rock)	7.5	15.5
Land won sand & gravel	5.1	5.7
Marine sand & gravel	3.2	3.1

It can be seen that less than half the amount of crushed rock consumed in NW England is produced there. Slightly more land won sand and gravel is consumed in NW England than is produced there whereas slightly less marine sand and gravel is consumed in NW England than is produced there. The imbalance in NW England between consumption and production of crushed rock aggregates is clearly reflected in the inter-regional imports and exports.

Some limestone and sandstone are imported into NW England, as follows:

Main sources of imports

Limestone: East Midlands (4,700), Yorkshire and Humberside (1,149) and North Wales (2,298)
Sandstone: East Midlands (114), West Midlands (219), Yorkshire and Humberside (298)

Some land won sand and gravel and sandstone are exported from NW England, as follows:

Main destinations of exports

Land won sand and gravel: West Midlands, Yorkshire and Humberside, North East and North Wales
Sandstone: Yorkshire and Humberside

The permitted reserves of crushed rock (limestone, sandstone and igneous rock) and sand and gravel in NW England have been estimated, known as the landbank, as shown in table 3.

Table 3: Landbank for NW England on 31/12/2002

	Permitted Reserves (Thousand Tonnes)	Annual Average Apportionmer (Thousand Tonnes)	Landbank (Years)
Crushed Rock	327,900	12,550	26.1
Sand and Gravel	47,300	4,650	10.2

Source: North West Regional Aggregates Working Party 2004 *Annual Report 2003* North West Regional Aggregates Working Party, Chester

In comparison, the landbank for England and Wales has been estimated to be 28.9 years for crushed rock and 11.3 years for sand and gravel.

Costings for aggregate production and transport in NW England have been estimated. The ex-quarry cost of limestone is approximately £4.60 per tonne (including £1.60 per tonne quarry tax) whereas sand and gravel is approximately £ 6.50 per tonne including quarry tax. Transport costs are estimated to be £3.00 per tonne for 10 miles, £4.40 per tonne for 25-30 miles and £7.00 per tonne for 50 miles. Aggregates tend not to transported more than 50 miles by road. If the distance is greater than 50 miles, aggregates are transported by rail, boat or barge and this is normally outside NW England. For aggregates delivered to a construction site in NW England, limestone and cheap fill tends to cost £7.50 per tonne whereas sand and gravel costs £10.00-£11.00 per tonne, depending on location and market. Source: John Dennan, Director, D Morgan Plc, personal communication 16/08/2004.

3.2 Use of raw materials

The main uses of primary aggregates in England have been collated, as shown in table 4.

Table 4: Main uses of primary aggregates in construction in England

Use	**Percentage of aggregate used/%**
Housing construction	20
Housing repair & maintenance	8
Road construction	24
Road repair & maintenance	8
Private industry	11
Private commercial	12
Public works	13
Other	4

Source: Minerals Planning Guidance 6: Guidelines for aggregates provision in England

In England, nearly one quarter of the primary aggregates is used in the construction of roads and one fifth is used in the construction of housing, these two being the major uses of primary aggregates.

The sales of primary aggregate production in NW England in 2001 by the main end uses have been collated, as given in table 5.

Table 5: Sales of primary aggregate production in NW England in 2001 by main end use

Use	Percentage of aggregate sold/%
Course and fine aggregate for concrete	25
Sand for building and asphalt	8
Coated gravel roadstone	11
Uncoated roadstone	12
Other screened and graded aggregate	17
Construction fill	25
Undifferentiated	2

Source: BGS 2003 Collation of Results of the 2001 Aggregate Minerals Survey for England and Wales

In NW England in 2001, one quarter of primary aggregates was sold for use in concrete whereas another quarter was sold for use as fill material in construction, the two uses making up half of the total sales for that year.

The production of common clay and shale in NW England in 2001 by end use is shown in table 6.

Table 6: Production of common clay and shale in NW England in 2001 by end use (in thousands of tonnes)

County	Quantity of material	End use
Lancashire	236	Bricks, pipes and tiles
Lancashire	13	Construction use
Cumbria	86	Other uses
Greater Manchester	13	Other uses
Total NW England	410	

Source: British Geological Survey 2003 *United Kingdom Minerals Survey 2002.* British Geological Survey, Keyworth, Nottingham

Since 2001 industry has contracted in a much small number of large quarry operators whose strategies are thus greater than NW England region (national and even international) so regional strategies are compromised by the companies strategy. The British Geological Survey Aggregate Mineral Survey is considered to be 90% accurate. Four annual surveys are planned, the next will be for 2005 and is due for publication in 2006. New and reduced estimates of requirements outlined in Table 8.3 of March 2004 submitted draft of Partial Review of Regional Planning Guidance for the North West (RPB13) imply less reliance on imports and greater compliance with the directive towards regional supply meeting regional demand. However, regional 'sustainability' for the supply of aggregates is a myth because it is cheaper and nearer to import aggregates in to Cheshire from North Wales and in to Greater Manchester from Derbyshire than from the north of the NW England region and market forces will dictate the origin of supply. Comment by NWRAWP on the 4sight report : Clarification was sought by industry on the information sources in the report. Industry felt it was performing better than the report illustrates. Readers of the report should beware of over-interpreting the facts and figures due to lack of reliable data.

4. Construction products

Construction products for which production data was available were bricks and pre-cast aggregate concrete blocks.

4.1 Bricks

For the year November 2001 to October 2002, there were 293,396,000 bricks estimated to be produced in NW England. For the year August 2003 to July 2004, the total deliveries of bricks into and within NW England were estimated to be 295, 978,000 bricks, i.e. the sum of the number of bricks produced in NW England and the number of bricks imported into the region from other regions of the UK. The number of bricks imported into the UK from abroad is estimated at 200 million per annum.
A reasonable estimate of the number of bricks used in the NW England is 320 million per annum at an average weight of 2.75kg per brick. Thus Brick usage in the NW England for the year August 2003 to July 2004 is estimated at 880 Mt p.a.
(Sources: J. Hattersley, The Brick Development Association, Personal Communication 3/9/2004
http://www.dti.gov.uk/construction/stats/bulletin/pdf/table10.pdf accessed 1/9/2004)

4.2 Pre-cast aggregate concrete blocks

Annual data for the production, stock and delivery of pre-cast aggregate concrete in NW England is given in table 7.

Table 7: Quantity of production, deliveries and stocks of pre-cast aggregate concrete blocks in NW England in 2001 (in thousands of square metres).

Block type	Production	Deliveries	Stock
Dense aggregate	4519	4517	590
Lightweight aggregate & aerated blocks	2056	2100	178
Total	6575	6617	768

Source: Office of National Statistics, Monthly Statistics of Building Materials and Components, December 2002, No 334.

Data to be added for timber and windows/double-glazing units

5. Current building stock

5.1 Aerial thermal surveys

BRE has undertaken aerial thermal or infra-red imaging surveys in various regions of UK to determine heat loss from buildings. The information gathered could possibly be used to determine the number and types of existing building stock in the surveyed area. However, to date BRE has not undertaken any of these surveys in NW England.

5.2 BREEAM

For more than 10 years, BRE's Environmental Assessment Method (BREEAM) has been used to assess the environmental performance of both existing and new buildings. A number of types of buildings can be assessed, as follows:

1) Homes – version of BREEAM called EcoHomes
2) Offices
3) Industrial buildings
4) Other types of buildings – bespoke assessments

BREEAM assesses the performance of a building in the following areas:

1) Management
2) Energy use
3) Health and well-being
4) Pollution
5) Transport
6) Land use
7) Ecology
8) Materials
9) Water

Marks are awarded for the performance in each area. The marks are then amalgamated to produce a single overall score rated on a scale of Fail, Pass, Good, Very Good or Excellent.

There are no results specific to NW England but data has been gathered for Northern England (NW and NE England, Yorkshire and Humberside), as summarised in table 8. These results are a measure of the environmental performance of these assessed buildings in Northern England, including some in NW England.

Table 8: Results of BREEAM assessments completed in Northern England

	No of assessments	Fail	Pass	Good	Very Good	Excellent
BREEAM Offices 1998	16	0	0	1	7	8
BREEAM Offices 2002	13	0	0	3	8	2
BREEAM Offices 2003	18	0	1	3	9	5
BREEAM Offices 2004	2	0	0	2	0	0
BREEAM Industrial	24	0	0	10	13	1
Bespoke BREEAM	1	0	0	1	0	0
EcoHomes Pre-2002	1	0	0	0	0	1
EcoHomes 2002	22	0	6	12	3	1
EcoHomes 2003	60	0	24	31	5	0

Data to be added from Dr Hiroki Tanikawa's GIS based surveys of buildings in NW England

6. New planned construction

Each year 6500 hectares of rural land in UK is developed. The UK government aims include building 3.8 million new homes in the UK by 2016 and building 60% of new development on brownfield land.

Almost 150 tonnes of materials are used to construct a typical house (BRE's Green Guide to Housing Specification). The quantities of construction materials used in each building element for typical housing and offices have been estimated and are given in tables 9 and 10.

Table 9: Quantities of materials used per building element for typical UK housing

Element	**Traditional pitched roof**	**Upper floor construction**	**Concrete ground floor construction**	**External walls**	**Internal walls**
Life cycle (in years)	60	60	25	60	60
Material (in kg/m^2)	Slate = 43.2	Plasterboard = 9.1	Mineral wool insulation = 0.9	Aerated concrete block = 50.5	Acrylic paint = 0.4
	Roofing felt = 2.4	Plywood = 10.4	Reinforcing steel = 3.4	Mineral wool insulation = 3.0	Plasterboard = 18.2
	Mineral wool insulation = 7.5	Kiln dried timber = 9.5	Precast concrete = 46.0	Very high strength mortar = 36.0	Kiln dried timber = 4.0
	Kiln dried timber – battern = 8.1		Kiln dried timber = 1.3	Plasterboard = 9.1	
	Kiln dried timber – truss = 15.1		Aerated concrete block = 50.5	Strong mortar = 24.0	
			Plywood = 10.4	Acrylic paint = 0.2	
			Aggregate = 192.2	Dense concrete block = 195.0	

Source: BRE's Green Guide to Specification

Table 10: Quantities of material used per building element for typical UK offices

Element	Low pitched roof	Upper floors	Substructural floor systems	External cavity walls	Internal loadbearing partition walls
Life cycle (in years)	25	60	30	60	60
Material (in kg/m^2)	Organic coated flat steel - 1st layer = 3.9	Plasterboard = 9.1	Chipboard = 15.4	Acrylic paint = 0.2	Acrylic paint = 0.36
	Organic coated flat steel – 2nd layer = 6.9	Aerated concrete block = 50.5	Kiln dried timber = 3.3	Strong mortar = 50.0	Plasterboard = 18.2
	Steel section = 5.0	Reinforcing steel = 3.4		Plasterboard = 9.1	Strong mortar = 11.3
	Mineral wool insulation = 7.0	Precast concrete = 48.6		Aerated concrete block = 50.5	Aerated concrete block = 50.5
	Hot dip galvanised steel = 1.0	Very high strength mortar = 57.5		Mineral wool insulation = 1.5	
	Polyester = 0.1			Brick = 174.3	

Source: BRE's Green Guide to Specification

7. Construction waste

BRE's SMARTStart™ waste auditing tool was used to determine the types and quantities of waste generated during various construction projects in the UK (Table 11).

Table 11: Types and quantities of waste generated during various UK construction projects (in m^3 of waste)

Waste type	Office construction (mean of 2 projects)	Residential construction (mean of 6 projects)	Road construction (mean of 3 projects)
Ceramics	2.64	25.82	0.00
Concrete	26.57	37.56	15.10
Electrical equipment	91.37	54.14	0.00
Furniture	9.63	15.58	0.00
Inert	1.15	105.24	15.83
Insulation	591.60	334.29	0.00
Metals	547.59	153.85	0.00
Miscellaneous	391.65	581.22	0.00
Packaging	577.00	414.66	0.00
Plaster/cement	293.65	779.42	0.00
Plastics	141.35	189.83	0.00
Timber	923.73	465.15	0.00
Liquids and Oils	0.00	0.29	0.00
Hazardous	4.85	0.04	5.08
Mean EPI	12.85	11.68	5.17
Mean KPI	243.15	84.40	66.20

Note: EPI = Environmental Performance Indicator in m^3 of waste per $100m^2$ floor area, KPI = Key Performance Indicator in m^3 of waste per £100,000

It can be seen that the type of waste generated depends on the type of construction project being undertaken.

8. Demolition and other secondary waste materials

Estimates of the arisings and uses in construction of recycled and secondary materials in England and Wales have been gathered and are summarised in table 12. Some of these materials are wastes generated from construction activities but others are by-products of other industrial processes.

Table 12: Estimated arisings and uses in construction of recycled and secondary materials in England and Wales in 2001 to 2003 (in thousands of tonnes)

	Used as aggregates in England	Used as non-aggregates in England	Total arisings in England	Usable Stockpiles In England	Used as aggregate in NW England	Used as non-aggregate in NW England	Total arisings in NW England	Usable Stockpiles In NW England
Recycled Material								
Construction and Demolition Waste (in 2003)	39,600*	36,290 (includes 16,430 to exempt sites)*	90,930* (includes soil and disposal as waste to landfill)	No reliable estimates	4,520*	4,810 (includes 2,890 to exempt sites)*	11,050* (includes soil and disposal waste to landfill)	
Bituminous road planings (in 2001)	6,500		6,900		216		230	
Secondary Material (in 2001-2002)	Used as aggregates in England and Wales	Used as non-aggregates in England and Wales	Total arisings in England	Usable Stockpiles In England and Wales	Used as aggregate in NW England	Used as non-aggregate in NW England	Total arisings in NW England	Usable Stockpiles In NW England
Blast furnace slag	1,100	1,900	3,000	No reliable estimates				
Steel slag (Oxygen and electric arc furnace)	1,260	20	1,280	No reliable estimates				
China clay waste	2,280		22,600	45,000 – 100,000				
Colliery spoil	810		7,520	15,000				

Pulverised fuel ash (PFA)	1,660	830	4,870	55,000	112	100	300	12,000
Furnace Bottom Ash (FBA)	980		980	No Reliable estimates	70			
Spent railway ballast	1,240		1,300	negligible	200		210	
Slate waste	580		6,330	456,500	135		350	3,000
Waste Glass	90	650	2,200	200-300	10	90	290	
MSW incinerator bottom ash	380		620	negligible			100	
Scrap tyres	90	170	400	No Reliable estimates	10	20	50	
Fired ceramic waste	90 - 100		100	Working stockpiles only				
Spent foundry sand	180		900	No Reliable estimates				
Total Secondary material	21,430	5,228	102,040	1,225,800 to 1,170,700 known stockpiles	537	210	1,300	15,000

* See Appendix 1

Sources for Table 12 and notes on recycled and secondary material:

British Geological Survey 2003 *United Kingdom Minerals Survey 2002.* British Geological Survey, Keyworth, Nottingham

Dickinson, M. 2003 Director of Quarries, Burlington Slate Ltd., Kirby in Furness, Cumbria. Personal communication 27/8/2003

Douglas, I., Manning, D., Lawson, N. and Vetterlein, J. 2002 *Management of Contaminated Construction and Demolition Waste for Recycling. Final Report to the Engineering and Physical Sciences Research Council, December 2002.*

Highways Agency 2003 *Building Better Roads: Towards Sustainable Construction, December 2003.* www.highways.gov.uk/aboutus/corpdocs/building_better_roads/02.htm

Jones, A. 2004 Manager, Fiddlers Ferry Power Station, Warrington, Cheshire. Personal communication 16/8/2004

Lawson, N., Douglas, I., Garvin, S., McGrath, C., Manning, D. and Vetterlein, J. 2001 Recycling construction and demolition wastes- the case for Britain. *Environmental Management and Health. 12 (2)* 146-157

North West Regional Aggregates Working Party 2004 *Annual Report 2003* North West Regional Aggregates Working Party, Chester.

Office of the Deputy Prime Minister 2004 *Survey of Arisings and Use of Construction, Demolition and Excavation Waste as Aggregates in England in 2003* Office of the Deputy Prime Minister, London.

Office of the Deputy Prime Minister 2002 *Survey of arisings and use of secondary materials and use of secondary materials as aggregates in England and Wales in 2001*. ODPM, London.

Smith, R.A., Kersey, J.R and Griffiths, P.J. 2003 *The Construction Industry Mass Balance: resource use, wastes and emissions.* Viridis Report VR4 (Revised).

A significant proportion of total arisings of secondary and recycled materials are not reused in construction in UK. However some are, as outlined, as follows:

Construction and Demolition (C&D) waste is increasingly used as aggregate in construction. This is likely to be encouraged by increases in the rate of the Landfill Tax and the introduction of the Aggregates Levy. The estimated composition of construction and demolition waste is given in table 13.

On site crushing of C&D waste, including stacking for storage typically costs £2.00 per ton. The value of C&D Waste is usually £1.00 per ton below cost of primary aggregate and subject to market conditions, for example, much increased demand in winter for use for constructing farm tracks. Much C&D Waste is taken to exempt sites and transfer stations. C&D Waste also often left on site for future developer for fill/site modelling.
Source: John Dennan, Director, D Morgan Plc, personal communication, 16/08/2004.

Table 13: Estimated composition of construction and demolition waste

Construction waste	**%**
concrete, bricks, blocks, aggregate	35
metals	28
excess mortar/concrete	12
timber & products	8
plastic packaging & plastic products	9
plasterboard & plaster	3
paper and cardboard	2
vegetation	1
soil	1
Demolition waste	
concrete	36
masonry	22
paper, cardboard, plastic & other.	15
asphalt	13
wood based	3

Construction and demolition waste arisings: housing 40%, other 60%.
Sources:

Hobbs G and Collins R. 1997 *Demonstration of reuse and recycling of materials: BRE energy efficient office of the future.* Information paper IP3/97, CRC 1997. Building Research Establishment, Garston.

Construction Industry Research & Information Association (CIRIA) 1997 *Waste minimisation and recycling in the construction industry. Funders report/CP/44.* CIRIA, London.

Bituminous road planings are primarily reused in road repair schemes and as capping layers, preferably on site as arising.

Blast furnace slag and steel slag from the iron and steel making industry are reused in asphalting and road stone in areas in which they arise.

China Clay waste stockpiles are all in SW England and some now lie under areas of nature conservation interest. China clay waste has an established sand and aggregate use. The feasibility of moving substantial quantities of material by rail and sea to bulk fill projects in the NW England is currently being investigated.

Colliery spoil stockpiles are at working mines and most are used as bulk fill in site restoration. However, the aggregates levy has improved the commercial feasibility of using minestone as aggregate.

Pulverised Fuel Ash (PFA) from power stations is most commonly used as a cement substitute in concrete and as a fill material. Some PFA may be recoverable from some old landfills

Case study: PFA generated at Fiddlers Ferry Power Station,Cheshire

Arisings of PFA in 2003 were 300,000 tons p.a. Sales at Fiddlers Ferry average 200,000 tonnes per annum, 50% being used for for cement production at Clitheroe, Lancashire and the rest as fill and for concrete block making. The stockpile is 12 million tonnes. There is sufficient storage to outlast the life-time of the power station which is estimated at another 12 years.

A potential use of up to 1 million tonnes of PFA would be to fill subsidence causing voids in Northwich salt caverns. In 2001, Fiddlers Ferry lost the sale of 200,000 tons PFA for fill at new Junction 8 on adjacent M62 to the Highways Agency who accepted a cheaper quote from the developer of a sand quarry at Croft (Warrington). Because of the value of the subsequent hole, the sand quarry developers were able to undercut the Fiddlers Ferry quotation.
Source: Andrew Jones, Scottish and Southern Energy, Fiddlers Ferry Power Station, personal communication 16/8/04

Furnace Bottom Ash (FBA) from power stations is used as an aggregate in the manufacture of lightweight pre-cast aggregate concrete blocks and in blended cements.

Spent Railway Track Ballast is used as a graded aggregate after crushing

Slate waste exists in long-term stockpiles in North Wales (c453 million tonnes), Cornwall (c12 million tonnes) and Cumbria (c 5 million tonnes). The introduction of the Aggregate Levy makes transporting and reuse as aggregate more commercially feasible.

Waste glass's main use is to reuse container glass in manufacturing new containers. Waste glass can also be used as a substitute for aggregate in asphalt for road construction, in concrete, in loose fill and in back fill.

Municipal Solid Waste (MSW) Incinerator Bottom Ash (IBA) is generated from combusting waste in municipal incinerators. The main uses of IBA as an aggregate in asphalt in road construction and in pre-cast aggregate concrete blocks. Other applications include bulk fill, road base material and daily cover at landfill sites. Factors such as increased cost of disposal, exemption from aggregates levy and increased arisings should increase the use of MSW incinerator bottom ash as an aggregate, so long as regulatory constraints driven by negative publicity over dioxins do not become over-onerous.

Scrap tyre rubber, in the form of crumb, is used as a substitute for aggregate in surfacing sport and play areas and in road surfacing. Road surfacing is still in the trial stage in the UK but is now well

established in France. The resultant surface is quieter and less reflective than asphalt but is 10% more expensive. Principal non-aggregate use is as fuel for cement kilns.

Fired ceramic waste is used as bulk fill for roads and paths.

Spent foundry sand Many smaller geographically scattered stockpiles exist at casting works but high transport costs restrict use. Anecdotal evidence suggests that there are some substantial dedicated landfills of spent foundry sand at major casting works, possibly amounting to several million tonnes. The main use of spent foundry sand is in the manufacture of pre-cast aggregate concrete blocks and in ready-mix concrete. A comparatively smaller quantity is used in asphalt manufacture.

9. Discussion

All the stages of the whole life cycle of construction resources in NW England have been considered, as follows:

1) Raw materials
2) Construction products
3) Current building stock
4) New planned construction
5) Construction waste
6) Demolition and secondary waste materials

For each stage, the most current and reliable data available has been collected and tabulated. If data was unavailable for NW England, data was gathered for Northern England, England, England & Wales or UK.

10. Conclusions

11. References

Appendix 1

Construction and demolition waste (C&D waste):-

*Bands of confidence for the arisings used as aggregates in England are ± 13% at 90% confidence level (ODPM 2004).

Remediation of C&D waste is thought to be costly. Recycling is constrained by regulatory concerns such as health and safety and environmental issues, including proximity to a residential area and potential nuisance. The low quality of the product, transportation costs and the potential cost/benefit against virgin materials restrict commercial opportunities for recycled C&D waste. Transportation in excess of 50 miles is not considered cost effective. Perhaps the principal financial constraint to recycling C&D waste, particularly C&D waste that might contain contaminants, is the lack of time imposed by tight site redevelopment schedules set by market forces. Time and cost constraints mean that hard materials are rarely tested for either contaminants or for their engineering properties. Where a specified quality is critical, clients generally do not want to rely on recycled materials. Recycled C&D waste is rarely used directly in construction and people in the construction industry consider that current regulatory guidelines are ambiguous; for example within a single body, different advice might be given in different cases or circumstances. There also needs to be a clear understanding of the roles and responsibilities of Local Authorities and the Environment Agency.

The extensive statutory guidelines concerning exemptions at times appear to be ambiguous and lacking in cohesion. There is scope for, and evidence of, confusion being caused to (and by) landfill managers due to the use of the term 'exempt' (see Appendix 1). The result is the abuse of these exemptions. 16,430,000 tons in England (± 38% at 90% confidence level) and 2,890,000 tonnes in the North West (± 38% at 90% confidence level) are spread on registered exempt sites.

The two main drivers in the recycling of C&D waste are regulatory requirements and the commercial viability of a recycled product. Recycling C&D waste is part of the land remediation process. There is a need to identify and publicise sampling methods appropriate to the examination and classification of C&D waste as part of the demolition, contaminated land and brownfield site remediation process. Nevertheless, in future the combination of the aggregate levy and increased landfill taxes will result in a growing demand for recycled C&D waste. Thus, it might be appropriate for Local Authorities to set up easily accessible, controlled and regulated "borrow mounds" of surplus C&D waste which could be temporarily landscaped and then used as an alternative to newly quarried material as and when local demand arises.

C&D waste used as non aggregates is recycled as soil, backfilled in quarry voids and used for landfill engineering or restoration.

Relevant comments regarding recycling C&D Waste:

In the context of waste management: "all C&D Waste is reused and is not a problem". Quote by Paul Needham, Senior Waste Management Officer, Environment Agency (NW Region) January 2004

"Highways Agency specifications severely restrict our recycling activities". Quote by Barry Connell, Connell Brothers Demolition Contractors, Manchester, January 2004. (Connell Bros. is a large, serious, professional and responsible demolition contractor).

Furthermore, A 2002 behavioural survey (Douglas et al, 2002) found abuse of exemptions, ambiguity in the interpretation of exemption guidelines and lack of EA personnel to 'police' exempt sites.

The Office of the Deputy Prime Minister 2002 in their Survey of arisings and use of construction and demolition waste in England and Wales in 2001 states: “There is scope for, and evidence of, confusion being caused to (and by) landfill managers due to the use of the term ‘exempt’. In this report it refers to sites registered by the EA as exempt from waste management licensing, whereas it is increasingly being used by landfill operators in relation to areas within the sites, and materials which have been agreed with HM Customs and Excise to be exempt from landfill tax”. “The key to increasing the proportion of hard C&D waste recycled as aggregate is to improve separation of these materials from soil and other potentially deleterious materials. If more C&D waste is diverted from landfills and registered exempt sites, some material which is currently used for landfill engineering or for engineering purposes on registered exempt sites may have to be replaced with low-grade primary aggregates or mineral wastes. It is possible that up-grading newly available C&D waste for aggregate use will require considerable effort, and that leaving matters as they are would actually be more efficient from a resource use standpoint. Some quarries and similar workings would also have problems complying with their planning requirements if a significant proportion of clean materials were to be diverted for recycling”. However, the report concludes that “little evidence of hard C&D waste which could easily be turned into aggregate being disposed of to landfill”.

Office of the Deputy Prime Minister 2002 *Survey of arisings and use of construction and demolition waste in England and Wales in 2001.* www.odpm.gov.uk accessed 5/8/2004

Secondary Material for aggregates

The North West Regional Aggregates Working Party (NWRAWP) has identified a gap in the information relating to production and reuse of secondary material for aggregates. Construction activities are high whilst production of primary and marine aggregates is down, imports remain steady and the Aggregates Levy has caused a displacement of primary aggregates with secondary aggregates. There is a lack of data to explain how the demand for construction materials is being met. NWRAWP is thus seeking to undertake a small-scale regional pilot study of Cheshire.

The survey will provide information for RPG13 targets and for the preparation of the Local Development Frameworks.

Appendix 2

Notes on regulations concerning the management of construction and demolition waste.

Governmental strategy and guidance

- The Government's Waste Strategy for 2000 for England and Wales (6) identifies landfill as the least desirably option to tackle waste and an immediate need to stimulate waste minimisation.
- The consultation paper on sustainable construction 'Opportunities for Change' (7) highlights the need for incentives to encourage the use of recycled materials and acknowledges the importance of economic considerations.
- The Government is seeking to improve the efficiency of the construction industry through its strategy for more sustainable construction 'Building a Better Quality of Life', 2000 (8). The strategy emphasises the importance of reducing C&D waste at all stages of construction by focusing on the need to consider long term design, construction and disposal decisions so that the use of material resources is optimised. .
- The 1996 UK Government White Paper *Making Waste Work* (9) had targets for increasing the use of waste and recycled materials as aggregates to 30 million tonnes per year by 2006.

Regulations affecting the process of recycling C&DW

Responsibility of the Local Authority:

- Town and Country Planning Act 1990- land use policy and powers to control development, including crushing facilities.
- Town and Country Planning (Environmental Impact Assessment, EIA) Regulation 1999. This is mainly concerned with asbestos products present in buildings and waste disposal installations.
- Planning Policy Guidance (PPG). The most relevant PPG note concerning C&D waste is PPG10 "Planning and Waste Management."

Responsibility of the Health and Safety Executive (HSE):

- The Control of Asbestos at Work Regulations 1987. (only if contaminated)
- Control of Substances Hazardous to Health (COSHH) 1990. (only if contaminated)
- Construction (Design and Management) Regulations 1994 consider historical usage for potential contamination during redevelopment projects. However, these regulations also imply that sustainability is built in to eventual deconstruction which could eventually lead to increased reuse of C&DW.

Responsibility of the Environment Agency (EA):

- The Environment Protection Act (EPA) 1990, which led to
- Waste Management Licensing Regulations 1994 which encompass activities involving disposal or recovery of waste, including exemption certificates (Appendix 1).

Exemptions from Waste Management Licensing

The waste management licensing system is covered in Sections 33, 35 to 44 and 74 of the EPA 1990, and implemented through the Waste Management Licensing (WML)

Regulations 1994. The system requires anyone who keeps, treats, or disposes of waste, to hold a waste management licence, subject to certain exemptions. It is the main means by which the permitting requirements of the EC Framework Directive on waste have been implemented in the UK.

Exempt activities:

5.36 Schedule 3 to the WML Regulations 1994 (as amended) provides exemptions from waste management licensing to encourage reuse and recycling of waste. The controls specified in the exemptions are intended to reflect the inherent risk of the activity based on the type of waste and the scale of the exemption:

- paragraph 9 relates to the storage and spreading of waste soil rock ash or sludge to land for land reclamation or improvement;
- paragraph 13 relates to the manufacture of aggregates from construction and demolition waste at the site where the waste is created. The storage of that waste can be the subject of an exemption if the quantity of waste stored does not exceed 50,000 tonnes on the case of roadstone manufactured from road planings and 20,000 tonnes in any other case;
- paragraph 19 relates to the storage of waste arising from demolition or construction activity or other excavations which consist of ash, slag clinker, rock, wood or gypsum – if the waste is used for construction on site or brought on to the site and stored for no more than three months;
- paragraph 24 states that where crushing, grinding or other size reduction of waste bricks, tiles or concrete under an authorisation granted under Part 1 of the EPA takes place, then the storage, at the place where the process is carried on of any such wastes which are intended to be crushed, is exempt from licensing if the total quantity of such waste stored at any one time does not exceed 20,000 tonnes.

5.37 Environmental objectives must be met for exemptions to apply. These are set out in paragraph 4 of schedule 4 and are:

- risk to water, air, soil, plants or animals;
- causing nuisance through noise or odour;
- adversely affecting the countryside or places of special interest.

Duty of care with respect to waste:

5.38 Under section 34 of the EPA 1990, any person who imports, produces, carries, keeps, treats or disposes of controlled waste has a 'duty of care' to:

prevent the escape of waste from his control or that of any other person;

ensure that, on transferring the waste, the transfer is only to an authorised person or to a person for authorised transport purposes and that there is a written description of the waste.