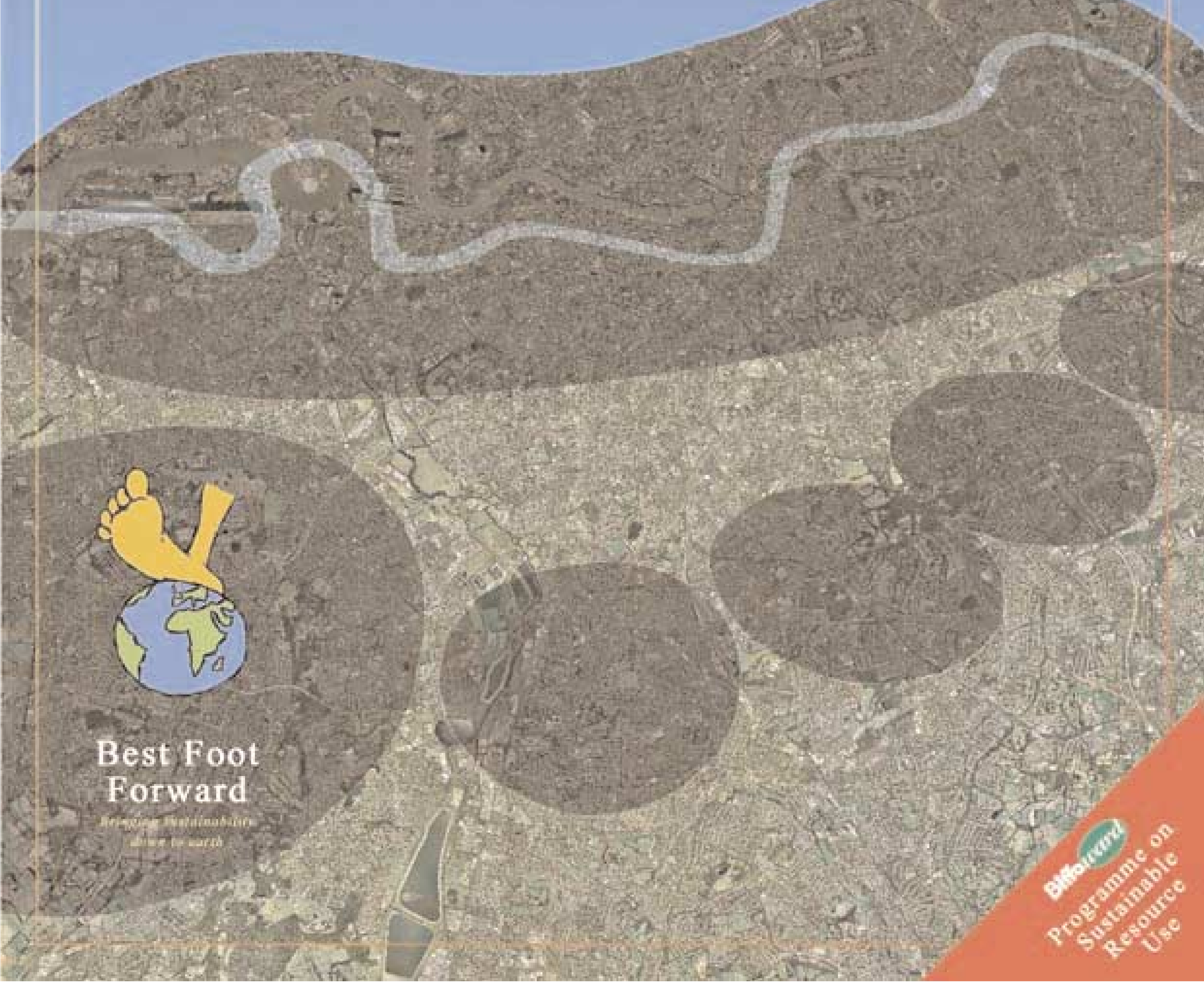
City Limits

A resource flow and ecological footprint analysis of Greater London



Best Foot Forward

Biffaward Programme on Sustainable Resource Use

Project Partners

Chartered Institution of Wastes Management Environmental Body

IWM (EB) is a registered environmental body that sponsors original research, development, education and information dissemination projects in furtherance of professional and sustainable waste management practices.

The Institution of Civil Engineers

www.ice.org.uk

The Institution of Civil Engineers (ICE) is the pre-eminent engineering institution in the world. It has 78,000 members and provides a voice for civil engineering, professional development and promoting best practice in the industry. In 2000, ICE and CIWM agreed to instigate and co-ordinate a programme of activities funded by landfill tax credits, of which *City Limits* forms part.

Biffaward

www.biffaward.org

In 1997 Biffa Waste Services agreed to donate landfill tax credits to the Royal Society for Nature Conservation (RSNC) to administer under the fund name Biffaward. To date, Biffaward has distributed more than £44m million to 554 projects throughout the UK.

The Chartered Institution of Wastes Management

www.ciwm.co.uk

The Chartered Institution of Wastes Management (CIWM) is the pre-eminent body in the UK engaged in waste management issues. It represents over 4,000 professional waste managers and aims to protect and enhance the environment through developing scientific, technical and management standards. *City Limits* is a natural follow-on to CIWM's Millenium Competition and its interest in improving the quality of data available for strategic decision-making in the management of London's wastes.

Greater London Authority

www.london.gov.uk

The Mayor and the London Assembly constitute a strategic citywide government for London, and is the statutory authority for the Greater London region. Responsibilities include the police, transport, fire and emergency planning, regeneration, planning, sustainability and environmental issues, cultural affairs and health concerns.

Best Foot Forward Ltd

www.bestfootforward.com

Best Foot Forward Limited (BFF) is a sustainability consultancy based in Oxford. BFF have developed the EcoIndex™ methodology, based on ecological footprinting, which is used to calculate the environmental impact and sustainability of a product, organisation, process or activity. BFF's ecological footprint of the Isle of Wight was voted Overall Winner at the Biffaward Awards 2001.

City Limits

A resource flow and ecological footprint analysis of Greater London

Commissioned by

IWM (EB)

Chartered Institution of Wastes Management Environmental Body

Prepared by

Best Foot Forward Ltd

www.citylimitslondon.com

12th September 2002

Biffaward Programme on Sustainable Resource Use

This report forms part of the Biffaward Programme on Sustainable Resource Use. The aim of this programme is to provide accessible, well-researched information about the flows of different resources through the UK economy based either singly, or on a combination of regions, material streams or industry sectors.

Information about material resource flows through the UK economy is of fundamental importance to the cost-effective management of resource flows, especially at the stage when the resources become 'waste'.

In order to maximise the Programme's full potential, data will be generated and classified in ways that are both consistent with each other, and with the methodologies of the other generators of resource flow/waste management data.

In addition to the projects having their own means of dissemination to their own constituencies, their data and information will be gathered together in a common format to facilitate policy making at corporate, regional and national levels.

Acknowledgments

Steering Group

IWM (EB) wish to acknowledge the generous help and support of the project Steering Group.

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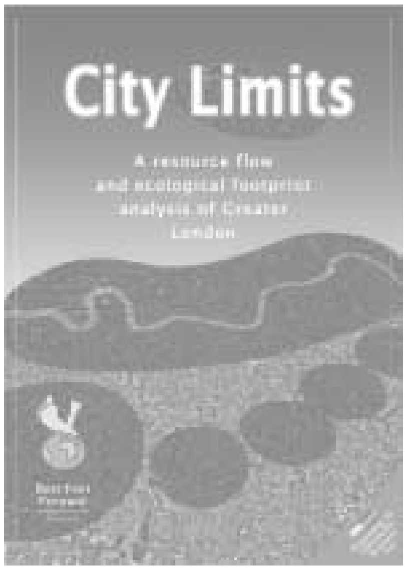

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Foreword

The publication of this study of London's ecological footprint is particularly timely following as it does the United Nations' *World Summit on Environment and Development* in Johannesburg. It became clear 10 years ago at the *Earth Summit* in Rio that we cannot continue to use global resources at current levels without putting future generations and global ecosystems at risk.

Recent estimates suggest that on a global scale we are now using resources faster than they can be replenished. We are eating into the earth's capital assets, which will inevitably reduce options for future generations.

This study of London's footprint is particularly important because it is the first such analysis of a major world city. For the first time we have an overall picture of London's metabolism, how resources are used and where action might be taken to increase our efficiency and become more sustainable. The report reinforces the challenges that face us but also provides vital clues to ways in which we can reduce our impact on the wider world.

In my draft London Plan published in June I set out my vision for London over the next twenty years. It is based on three interwoven themes of economic growth, social inclusivity and fundamental improvements in London's environment and use of resources.

This vision seeks to achieve the maximum possible from the forces to which the city is subject and which it can influence. It is a challenging vision involving clear choices, priorities, resources, determination and the resolution of conflict. But the alternative - a failure to secure economic growth and to match it with social inclusion and sustainable use of resources - would have serious long-term consequences for London, and the wider world.

This vision underlies all my strategies. Alongside the London Plan I am producing five environmental strategies on Air Quality, Biodiversity, Energy, Noise and Municipal Waste Management. These collectively show how London can develop sustainable solutions and this study of London's footprint will be particularly valuable in enabling all of us to find possible solutions.

For all these reasons I welcome the publication of this study and I commend it to everyone involved in achieving my vision of making London an exemplary, sustainable world city.

Ken Livingstone

Mayor of London

We cannot continue to use global resources at current levels without putting future generations and global ecosystems at risk.

Executive Summary

Chairman's Statement

The main aim of this project was to research and analyse resource use data for London. Resource flow and ecological footprint analyses served to provide information on which to make evidence-based policy. The results show that changes are necessary if London is to become a sustainable city. Scenario results indicate that a combination of consumption reduction and technological innovation can achieve the resource efficiency improvements required to realise a sustainable London by 2050.

Deciding the detail of how we might achieve the necessary changes needs to involve society as a whole. This is essentially a political process and the report does not, therefore, make specific policy recommendations. It is hoped however that the findings of this study will assist in the formation of effective policies and help all of us understand the action needed to achieve ecological sustainability.

Another aim of the project was to assess the availability and quality of data necessary for this type of analysis. While more research and better datasets would greatly assist in assessing and monitoring our progress towards sustainability, the report shows that there is already enough data in the public domain to reliably indicate that London lifestyles are not currently sustainble. We therefore hope that this study both stimulates further data research and inspires future analyses.

On behalf of IWM (EB) I would like to thank all involved in the project - the funders, the project team and all those who provided data or otherwise helped.

I commend the report to you and hope that it stimulates real debate and change.

Oswald A Dodds

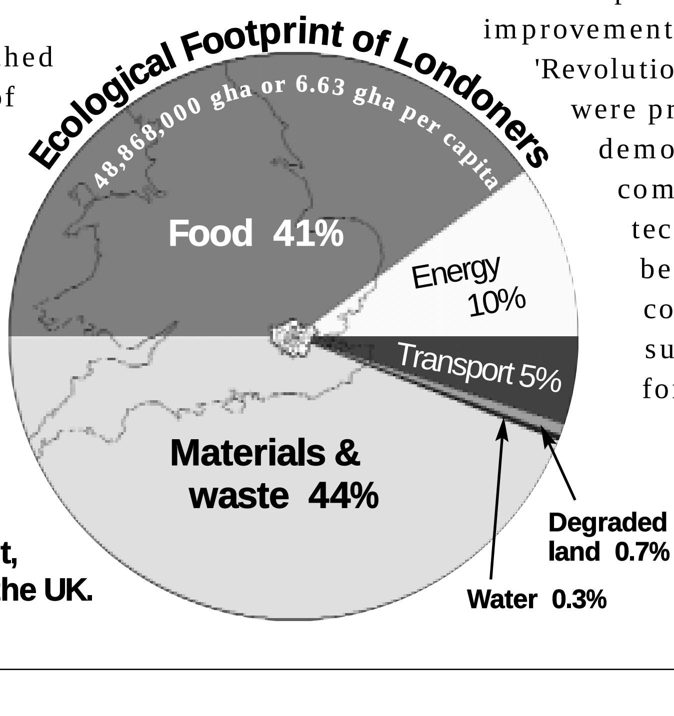
Oswald A. Dodds MBE
Chairman IWM (EB)
September 2002

The *City Limits* project set out to achieve the following objectives:

- **To quantify and catalogue the energy and materials consumed by London and Londoners, and where possible map the flows of these resources.**
- **To calculate the ecological footprint of the citizens of London.**
- **To compare the ecological footprint of Londoners with other regions.**
- **To compare the ecological footprint of Londoners with the globally available 'earth share' to estimate ecological sustainability.**
- **To quantify the ecological sustainability of a range of improvement scenarios.**
- **To assess the availability and quality of data required to carry out this type of analysis, and in certain instances make recommendations to improve data requirements for resource flow and ecological footprint analyses.**

The main findings of the project were:

- The population of Greater London in 2000 was 7.4 million.
- Londoners consumed 154,400 GigaWatt hours (GWh) of energy (or 13,276,000 tonnes of oil equivalent), which produced 41 million tonnes of CO_2.
- Londoners consumed 49 million tonnes of materials. On a per capita basis, this represents 6.7 tonnes.
- 27.8 million tonnes of materials were used by the construction sector.
- 26 million tonnes of waste was generated, of which 15 million tonnes was generated by the construction and demolition sector, 7.9 million tonnes by the commercial and industrial sector and 3.4 million tonnes by households.
- 6.9 million tonnes of food was consumed, of which 81% was imported from outside the UK.
- Londoners travelled 64 billion passenger-kilometres (pass-km), of which 69% was by car.
- Water consumption reached 876,000,000,000 litres, of which 28% was leakage.
- The ecological footprint of Londoners was 49 million global hectares (gha), which was 42 times its biocapacity and 293 times its geographical area. This is twice the size of the UK, and roughly the same size as Spain.
- The ecological footprint per London resident was 6.63 gha. This compares with the UK average ecological footprint of 6.3 gha, and exceeds the global 'earthshare' of 2.18 gha.
- The ecological footprint of London tourists was estimated at 2.4 million gha, which equates to an additional 0.32 gha per Londoner.
- The predicted 'earthshare' in 2050 is estimated at 1.44 gha per capita. For Londoners to be ecologically sustainable by 2050, a 35% reduction by 2020 and an 80% reduction by 2050, of their ecological footprint will be needed.
- Ranges of 'business as usual' and 'evolutionary' scenarios were prepared to reflect current practice and existing improvement targets. 'Revolutionary' scenarios were prepared to demonstrate that a combination of technological and behavioural changes could achieve interim sustainability targets for 2020.



Ecological footprint of Londoners, by component, showing actual size and the UK.

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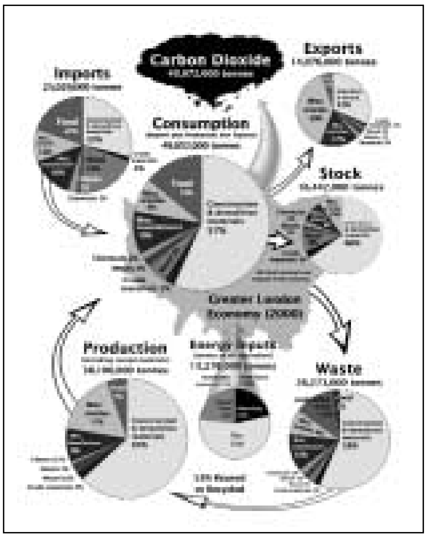

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Introduction

Greater London

Greater London, situated in south-east England, is the largest and most populated city in the European Union. It has a population of more than 7.4 million (ONS, 2001c), 12% of the United Kingdom's (UK) total, who reside and work in 33 unitary boroughs. The Corporation of London, which oversees the historic City of London (Square Mile), makes up the 34th borough. London's boroughs are covered by the Greater London Authority (GLA), which is a strategic citywide government.

As with New York and Tokyo, London is classified as a 'world city', providing employment to 4 million people (Corporation of London, 2001a). It is an internationally recognised centre for finance and business, design, media, fashion, entertainment, and a growing Internet sector. London is responsible for nearly a fifth of the UK's gross domestic product (GDP), with the financial and business sectors comprising 40% of London's wealth (ONS, 2000b).

From here on, Greater London will be referred to as London.

The 34 boroughs within Greater London's boundaries are: Barking & Dagenham, Barnet, Bexley, Brent, Bromley, Camden, City of London, Croydon, Ealing, Enfield, Greenwich, Hackney, Hammersmith & Fulham, Haringey, Harrow, Havering, Hillingdon, Hounslow, Islington, Kensington & Chelsea, Kingston upon Thames, Lambeth, Lewisham, Merton, Newham, Redbridge, Richmond upon Thames, Southwark, Sutton, Tower Hamlets, Waltham Forest, Wandsworth, City of Westminster.

London's history, which spans more than 2,000 years, as well as its cosmopolitan status, attracts over 25 million tourists each year (ONS, 2001b). Visitors and residents usually enter London through one of five airports, four main national rail stations and on many roads. Within London, a large public transport network carries people to and from their destinations - whether by London Underground, black cab or bus. Over 70% of Londoners arrive in the City of London by public transport (Corporation of London, 2001a).

Demographically, London is a young city. This is reflected in its household statistics - London has one of the lowest average household sizes in the country. Londoners live in more than 3 million dwellings; half are flats (ONS, 2000b).

Even though London's GDP per capita is more than 40% higher than the UK average, it contains some of the most socially deprived areas in the country (ONS, 2000b) From wealthy to deprived areas, London's diverse population is served by over 2,000 schools (DfES, 2001), 40 tertiary institutions (GLA, 2002c) and 50 hospitals (London Medicine, 2002).

The above description conjures up an image of a vast built-up, urban metropolis, yet 30% of London's total area is dedicated to parkland (Corporation of London, 2001a). The Thames River contributes 2,160 hectares (Dawson and Worrell, 1992) to the total City's land area of 175,000 hectares (Environment Agency, 2000d). London has 59 local nature reserves, 35 Sites of Special Scientific Interest, 3 World Heritage Sites and over 19,000 listed historic buildings. London's 800 conservation areas make up 10% of the total for England and Wales (ONS, 2000b).

Project Context

Each year London consumes thousands of GigaWatt hours of energy and millions of tonnes of materials and food. A lot of which is discarded as waste. Despite London's noted prominence as a 'progressive' city, no-one has comprehensively documented London's natural resource accounts. Exactly how much is used? How many tonnes of timber, paper, metals or stone? How much glass and metal is in the waste stream? Can it be recycled? Most importantly, what could a sustainable London look like?

The aims of *City Limits* were to try and answer some of these questions by:

- Cataloguing and quantifying the resources consumed by Londoners, and where possible map the flows of these resources
- Calculating the ecological footprint of London and its citizens
- Comparing the ecological footprint of Londoners with other regions and the world
- Comparing the ecological footprint of Londoners with the globally available 'earthshare' to estimate ecological sustainability, and
- Quantifying the ecological sustainability of a range of improvement measures (scenarios).

It is generally acknowledged that working towards sustainability will involve more sustainable consumption patterns and improved resource efficiency. Resource flow and ecological footprint analyses, and the data on which they are based, provides the quantification of current and possible resource consumption patterns.

Deciding the detail of how we might achieve the necessary changes needs to involve society as a whole. This is essentially a political process and the report does not, therefore, make specific policy recommendations. It is hoped however that the findings of this study will assist in the formation of effective policies and help all of us understand the action needed to achieve ecological sustainability.

Whereas, previous studies have focussed on waste, '...perhaps society has been looking at materials flows from the wrong end altogether' (Von Wëizsacker, Lovins and Lovins, 1998). Resource flow analysis is key to moving from sustainable waste management to sustainable resource management. It identifies consumption categories and links them to waste categories, which can be used for the identification of opportunities for waste minimisation, reuse and recycling.

Ecological footprint analysis has proven to be a powerful tool for measuring and communicating sustainable resource use. The ecological footprint of an individual or population relates consumption of natural resources to ecological sustainability by aggregating impacts to the common currency of land and sea global hectares (gha). This indicator of demand (the 'footprint') can be compared with global supply (the availability of productive area) to estimate sustainability, which can then be monitored over time to determine trends.

Historically, data on resource flows and waste arisings through the United Kingdom (UK) economy has been limited. This is still true, particularly for consumption of materials at a regional level. Part of this project aimed to identify sources of useful data and potential ways of improving data availability in the future.

Report Structure

The *City Limits* report has been sub-divided into two sections: results and methodology.

Due to the importance of the resource flow and ecological footprint analyses **results (page 7)**, they have been represented in the first section of this report. The resource flow analysis results estimate the flow of resources through London, by component, and include a number of vignettes, which highlight interesting consumption patterns. A discussion on materials eco-efficiency concludes this section.

The ecological footprint analysis results follow, and present ecological footprints for various components analysed in the resource flow.

A sustainability assessment of London, which analyses the biocapacity of London, follows on from the ecological footprint results. This section illustrates comparisons between Londoners' ecological footprint and other regions and cities. Scenarios are presented in the final section of the results. The scenarios are component focussed, and illustrate possible situations in London by 2020.

The **methodology (page 39)** section supports the resource flow and ecological footprint analyses, and scenario results. The first section of the methodology concentrates on methodological applications, which were applied to both the resource flow and ecological footprint analyses, and also covers data collection, quality and availability. The methodological introduction is followed by detailed discussions on the methodologies used in the resource flow and ecological footprint analyses and scenarios.

Results

Resource Flow Analysis Results

This *City Limits* resource flow analysis estimated the flow of resources through London for the year 2000.

It covers the following areas:

- **Direct energy:** Consumption of electricity, gas, liquid fuel and other energy sources.
- **Materials:** Production, consumption, stock and waste for minerals, metals, glass, wood and other raw materials.
- **Waste:** Discarded materials by type and sector, and management method.
- **Food:** Consumption by food type, such as vegetables, meat, dairy products and cereals.
- **Transport:** Car, rail, bus, air and other modes of transport.
- **Water:** Water consumption, by sector and leakage.
- **Land:** Land usage.

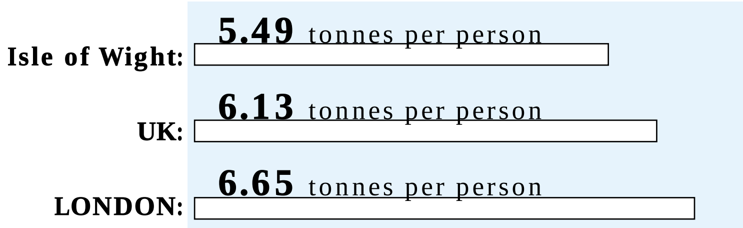
Table 1: Energy consumed in London, by fuel type and CO_2 emissions

Energy type		Consumption (GWh)	Consumption ('000s of tonnes)	CO_2 emissions ('000s of tonnes)
Electricity		**32,848**	**2,824**	**14,434**
of which...	Domestic	17,335	1,490	7,617
	Commercial	13,728	1,180	6,032
	London Underground	1,095	94	481
	Overground rail	690	59	303
Gas		**85,494**	**7,351**	**17,266**
of which...	Domestic	49,450	4,252	9,987
	Commercial	36,043	3,099	7,279
Liquid fuels		**35,733**	**3,072**	**9,224**
of which...	Petrol	17,503	1,505	4,630
	Diesel	9,744	838	2,441
	Aviation fuel	3,635	313	936
Oil		**4,852**	**417**	**1,217**
of which...	Domestic	188	16	47
	Commercial	4,664	401	1,170
Renewable energy		**205**	**17**	**6**
of which...	Solar	4	<1	<1
	Incineration (excl. bio-MSW)	45	4	5
	Anaerobic digestion (electricity)	49	4	0
	Anaerobic digestion (heat)	43	4	0
	Electricity from landfill gas	64	6	0
	Small/micro-scale hydro power	<1	<1	<1
	Wind	0	0	0
	Fuel cells	0	0	0
Solid fuels		**128**	**11**	**42**
of which...	Domestic coal	0	0	<1
	Commercial coal	128	11	42
Total		**154,407**	**13,276**	**40,972**

Sources: AEAT, 2001; GLA, 2002a and Scullion, 2001

Note: Due to the rounding off of figures, totals may not add up

Figure 1: A comparison of materials consumption between the Isle of Wight, the UK and London



Sources: BFF & Imperial College of Science & Technology, 2000 and Wuppertal Institute for Climate, Environment & Energy, 2001

Direct Energy

In 2000, London consumed 154,400 GWh of energy. Carbon dioxide (CO_2) emissions associated with this energy consumption were 40,972,000 tonnes. Gas was the highest category of consumption, at 85,494 GWh (17,266,000 tonnes of CO_2). Although liquid fuel was the second highest energy type consumed (35,733 GWh), electricity consumption produced the second highest level of CO_2 emissions. Table 1 shows energy consumed in London, with associated CO_2 emissions.

Material Flows (including Food)

In 2000, Londoners consumed 49 million tonnes of materials and food. Table 2 provides a summary of material categories and flows analysed. It is possible that, as economic data was used to derive these figures, this is an over estimate due to double counting (see The Double Counting Demon in the Methodology section).

At 27.8 million tonnes, the construction sector consumed the most materials. This sector also produced the most waste (14,756,000 tonnes) and contributed the most to stock in the form of buildings, roads and other construction projects (13,024,000 tonnes).

The consumption of materials in the miscellaneous manufactures and miscellaneous articles[1] categories were nearly 5 million and 4 million tonnes respectively. Waste figures for these two categories were also high, with 3.2 and 2 million tonnes respectively.

In comparison, with resource flow studies of the UK (based on the Wuppertal Institute for Climate, Environment & Energy, 2001) and the Isle of Wight (BFF & Imperial College of Science & Technology, 2000), London has the highest average consumption of materials per capita, with 6.7 tonnes per capita per annum (see Figure 1). This is higher than the UK average (6.1 tonnes per capita per annum), while the Isle of Wight was significantly lower (5.5 tonnes per capita per annum). This variation could be due to methodological differences[2].

Tables 3 and 3a-g provide a more comprehensive breakdown of London's material categories and flows. The significant impacts made by the miscellaneous manufactures materials on London's resource flow are highlighted here (Table 3f). Unfortunately, these categories were the most difficult to separate. However, it was possible to identify some materials in the miscellaneous manufactures category; notably paper products and plastics. Although it was not possible, within the scope of this project, to identify all manufactured goods, some key materials and products were identified and are represented in the priority waste streams (Table 5).

Table 2: A summary of material flows through London (Figures in '000s of tonnes)

Material category	Production	Imports	Exports	Apparent consumption	Waste	Stock
Construction	24,067	8,143	4,430	27,779	14,756	13,024
Crude materials	884	462	183	1,163	595	568
Wood	102	2,565	255	2,412	574	1,838
Metals	830	451	307	974	642	332
Chemicals	312	820	287	845	462	383
Misc. manufactures	3,404	3,960	2,395	4,969	3,269	1,700
Misc. articles	6,424	3,043	5,458	4,010	2,051	1,958
Unidentified waste					3,361	-3,361
Sub-total (excl. food)	**36,024**	**19,444**	**13,315**	**42,152**	**25,710**	**16,442**
Food	2,076	5,585	761	6,900	562	**
Total (incl. food)	**38,100**	**25,029**	**14,076**	**49,052**	**26,273**	**16,442**

** Data was either not available or was confidential and suppressed **Note:** Due to the rounding off of figures, totals may not add up

Table 3: A detailed breakdown of resource flows through London, by material category in tables 3a, 3b, 3c, 3d, 3e, 3f and 3g

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total materials	**36,024**	**19,444**	**13,315**	**42,152**	**25,710**	**16,442**

Note: Due to the rounding off of figures, totals may not add up

* Data on materials and products that were not available or could not be identified, and in some instances included double counting

** Data was either not available or was confidential and suppressed

Table 3a: Construction materials

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total construction materials	**24,067**	**8,143**	**4,430**	**27,779**	**14,756**	**13,024**
Sand, gravel & clay	**8,341**	**41**	**837**	**7,544**		
of which… Sand	3,32	9	12	3,325		
Gravel	4,232	27	754	3,505		
Clay	781	5	72	714		
Other crude minerals	**5,659**	**3,426**	**2,258**	**6,827**		
of which… Rock & stone	3,295	157	44	3,408		
Minerals	179	50	165	65		
Plasters	66	4	3	67		
Unidentified / other*	2,119	3,214	2,047	3,286		
Cements & lime	**6,194**	**1,349**	**491**	**7,052**		
of which… Cement	1,460	116	72	1,503		
of which… Cement clinker	**	22	16	6		
White Portland cement	**	6	<1	5		
Blended cement	872	84	33	923		
Alumina cement	**	<1	3	-2		
Hydraulic cements	116	<1	1	116		
Other cement	470	3	18	455		
Lime	76	<1	8	68		
of which… Quicklime	48	<1	3	45		
Slaked lime	28	<1	5	23		
Hydraulic lime	<1	<1	<1	<1		
Unidentified / other*	4,658	1,233	411	5,480		
Other building materials	**3,873**	**3,327**	**844**	**6,356**		
of which… Ready-made concrete	3,764	**	17	3,747		
Bricks, tiles, blocks & other	1,686	4	38	1,653		
Glass	**	**	**	656		
of which… Flat glass	221	151	49	323		
Hollow glass	249	107	41	315		
Glass fibres	17	10	16	11		
Other glass	5	17	13	8		
Unidentified / other *	**	**	**	300		

Table 3b: Crude materials

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total crude material	**884**	**462**	**183**	**1,163**	**595**	**568**
Pulp	**	**304**	**4**	**300**		
Rubber	**134**	**128**	**67**	**195**		
of which… Other rubber products	74	42	21	96		
Retread / rebuilt tyres	7	<1	<1	7		
Rubber tyres & tubes	53	85	46	91		
of which… Cars	26	29	15	39		
Buses & lorries	27	23	27	23		
Bicycles	**	<1	<1	<1		
Scooters & motorcycles	**	<1	<1	<1		
Other tyres & tubes	**	33	4	29		
Unidentified / other *	**	**	**	**668**		

Table 3c: Wood

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total wood	**102**	**2,565**	**255**	**2,412**	**574**	**1,838**
Other wood, timber & cork				**2,249**		
Wood packaging				**163**		
of which… Commercial & industrial				163		
Other				**<1**		

Table 3d: Metals

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total metals	**830**	**451**	**307**	**974**	**642**	**332**
Ores	**	**	**	**255**		
of which… Ferrous	**	**	**	**172**		
Non-ferrous	**	**	**	**83**		
Steel & iron	**	**	**	**642**		
Other metals	**	**	**	**77**		
of which… Aluminium	**	**	**	**35**		
Antimony	**	**	**	**<1**		
Cadmium	**	**	**	**<1**		
Copper	**	**	**	**14**		
Lead	**	**	**	**15**		
Magnesium	**	**	**	**<1**		
Nickel	**	**	**	**1**		
Tin	**	**	**	**<1**		
Zinc	**	**	**	**11**		

Table 3e: Chemicals and fertilisers

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total chemicals & fertilisers	**312**	**820**	**287**	**845**	**462**	**383**
Fertilisers	**	**77**	**11**	**66**	**	
Chemicals	**312**	**743**	**276**	**779**	**	

Table 3f: Miscellaneous manufactures

(In '000s of tonnes)		Production	Imports	Exports	Apparent consumption	Waste	Stock
Total miscellaneous manufactures		**3,404**	**3,960**	**2,395**	**4,969**	**3,269**	**1,700**
Plastic		**536**	**385**	**230**	**691**	**	
of which...	Builders' ware of plastic	56	54	30	80		
	Other plastic products	37	99	32	104		
	Plastic packing goods	208	92	86	214		
	Plastic plates, sheets, tubes & profiles	236	139	82	293		
Paper & paperboard		**2,027**	**1,241**	**359**	**2,909**	**	
of which...	Paper & paperboard	1,024	1,075	285	1,814		
	Cartons, boxes, cases & other containers	601	2,800	16	614		
	Household & sanitary goods & toilet requisites	145	79	29	195		
	Corrugated paper & paper-board, sacks & bags	161	8	9	160		
	Other articles of paper & paperboard	81	8	4	84		
	Paper stationery	**	42	11	31		
	Wallpaper	15	2	6	10		
Unidentified / other*		**841**	**2,334**	**1,806**	**1,369**	**	

Table 3g: Miscellaneous articles and unidentified waste

(In '000s of tonnes)	Production	Imports	Exports	Apparent consumption	Waste	Stock
Total miscellaneous articles	**6,424**	**3,043**	**5,458**	**4,010**	**2,051**	**1,958**
Unidentified waste					**3,361**	

Sources: CIPFA, 2001; CSRGT, 2000; Enviros RIS, 2000a; Environment Agency, 2000d; GLA, 2001a; ICER, 2000; ISSB Ltd, 2002; ONS, 2000c-au; WasteWatch, 2002

Note: Due to the rounding off of figures, totals may not add up

* Data on materials and products that were not available or could not be identified, and in some instances included double counting

** Data was either not available or was confidential and suppressed

Bottled water

Londoners consume approximately 94 million litres of mineral water per annum. Assuming all bottles were 2 litres, this would give rise to 2,260 tonnes of plastic waste. A bottle of* Evian, *the top-selling brand, travels approximately 760 km from the French Alps to the UK.

Source: *Brita Water Filters, 2001*

94,000,000 litres

Food flows

London consumed 6.9 million tonnes of food in 2000 (0.94 tonnes per capita), of which 81% was imported from outside the UK. An additional amount was likely to have been imported into London from within the UK. It was not possible to identify this amount. Just over 560,000 tonnes of food was disposed of as waste. Soft drinks and beverages was the highest consumption category, at 843,000 tonnes, closely followed by milk and cream, with 764,000 tonnes (see Tables 4a and 4b).

Table 4a: Food flows through London

Total food	**Food flow** ('000s of tonnes)
Production	2,076
Imports	5,585
Exports	761
Estimated consumption	6,900
Waste	562

Table 4b: Food consumed in London, by type

	Estimated consumption ('000s of tonnes)
Total food	**6,900**
Human consumption	**5,035**
of which...	
Milk & cream	764
Cheese	48
Meat	385
Fish	72
Eggs	63
Fats	68
Sugar & preserves	43
Potatoes	334
Other vegetables	461
Fruit	532
Bread	281
Other cereals	310
Tea	11
Coffee	6
Miscellaneous	293
Soft drinks & beverages	843
Alcoholic drinks	334
Confectionery	24
Starch & starch products	177
Production of ethyl alcohol from fermented materials	-12
Non-human consumption	**346**
of which...	
Animal feed	21
Pet food	325
Unidentified	**1,519**

Sources: CIPFA, 2001; Environment Agency, 2000d; GLA, 2001a; MEL Research, 1998; ONS, 2000k - ab; ONS 2001d

Table 5: Priority waste streams in London, by type and management method

Priority waste stream	Consumption	Waste	Landfilled	Recycled	Other***
	(Figures in '000s of tonnes)				
Batteries (lead-acid)	**27**	**24**	**	**	**
of which... Lead/acid batteries	15	14	**	**	**
Domestic Nicad batteries	11	10	**	**	**
Construction & demolition materials	**27,779**	**14,756**	**4,030**	**10,694**	**32**
WEEE products	**147**	**135**	**88**	**47**	**
of which... Fridges & freezers	23	18	4	13	**
Washing machines	28	20	5	17	**
Television sets	13	7	2	5	**
IT equipment	30	23	18	5	**
Personal computing	45	30	24	6	**
Other	7	38	36	<1	**
Fluorescent tubes	**2**	**2**	**	**	**
of which... Linear fluorescent and similar	1	1	**	**	**
Compact fluorescent (all types)	<1	<1	**	**	**
High intensity	<1	<1	**	**	**
End of life vehicles (ELV)	*** 531**	**321**	**	**	**
Rubber tyres & tubes	**91**	******** 54**	**	**	**
of which... Cars	39	**	**	**	**
Buses & lorries	23	**	**	**	**
Bicycles	<1	**	**	**	**
Scooters & motorcycles	<1	**	**	**	**
Other tyres & tubes	29	**	**	**	**

Sources: Environment Agency, 2000d; ICER, 2000; ONS, 2000ak-am

* Figure based on the number of newly licensed vehicles in 2001

** Data was either not available or was confidential and suppressed

*** Includes thermal, transfer, treatment and unrecorded (only refers to commercial & industrial waste)

**** Figure based on the number of licensed vehicles

London's waste management infrastructure

London's waste is collected daily by approximately 500 collection vehicles, barges, containers and specialist transporters. The waste is transported to 17 main municipal solid waste (MSW) transfer stations, 45 collection authority civic amenity sites, 2 incinerators, 23 recycling centres, 2 compost centres, 18 landfill sites and 2 energy-from-waste plants.

In 1998/99, 76% of the MSW generated in London was disposed in its neighbouring counties. 70% of this waste travelled more than 120km. For every million tonnes of waste generated in London, approximately 100,000 waste vehicle journeys were required.

The River Thames is also used to transport waste, with 18% of waste travelling this way. On an average day, 2,500 tonnes of MSW are transported on barges to Essex, with each barge journey equivalent to 80 or 90 waste vehicle journeys.

Source: Read, 2000

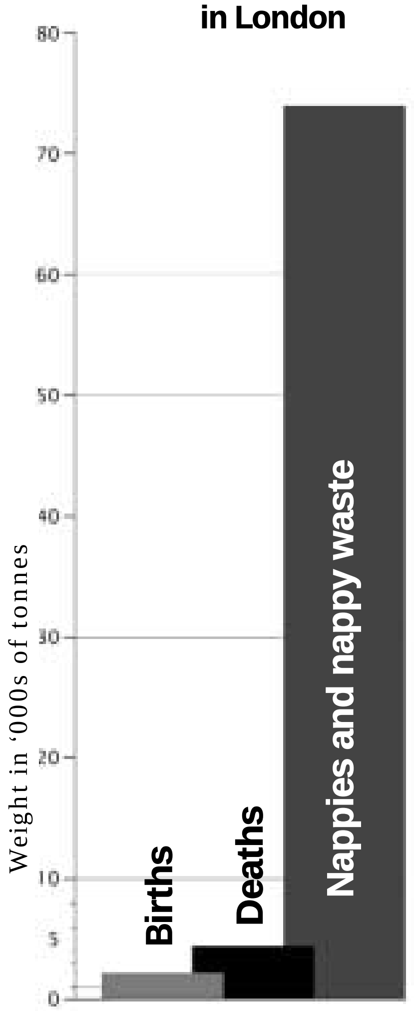
Priority waste streams

The European Commission has identified eleven priority waste streams[3] deemed to be particularly harmful to the environment (DETR, 2000c).

Table 5 lists six of the eleven priority waste streams, and includes London's consumption and waste generated in these streams. Interestingly, there is minimal stock build up of these items, indicating that consumption is primarily for the replacement of products.

Births, deaths and nappies

Figure 2: Births, deaths and nappies over a year in London



The number of live births in London for 2001 was 594,634. This equates to a total weight of 2,022 tonnes (assuming the average weight of a newborn is 3.4kg). The number of registered deaths in London for 1999 was 61,716. This equates to a total weight of 4,320 tonnes (assuming the average adult weight is 71kg).

In Britain, over 8 million disposable baby nappies are used every day. Approximately 1.7 million of these nappies are used in London, which equates to around 202 tonnes of waste per day (74,000 tonnes per annum). 75% (55,000 tonnes) of this is sewage.

Sources: ONS, 2000b and 2002; Vizcarra, 1994 and WEN, 2000

Waste

In 2000, London generated over 26 million tonnes of waste (3.56 tonnes per capita), of which:

- **14.9 million tonnes was generated by the construction and demolition sector**
- **7.9 million tonnes by the commercial and industrial sector, and**
- **3.4 million tonnes by households**

Detailed information on waste generated by the construction and demolition sector was not available. However, we were able to identify paper and packaging as the largest component of waste generated by the commercial and industrial and household sectors (Table 6).

Table 6: Waste generated in London, by sector and type

Waste sector & type	('000s of tonnes)
Total waste	**26,273**
Household waste	**3,400**
of which...	
Wood	25
Tyres	**
WEEE	67
Food	301
Paper & card	961
Metals	272
Packaging	663
Other materials	1,111
Commercial & industrial sector	**7,891**
of which...	
Wood	250
Tyres	54
WEEE	68
Food	262
Paper & card	883
Metals	252
Packaging	827
Other materials	5,297
Construction & demolition sector	**14,981**
of which...	
Wood	300
Tyres	**
WEEE	**
Food	**
Paper & card	**
Metals	118
Packaging	**
Other materials	14,563

Sources: CIPFA, 2001; Environment Agency, 2000d; Enviros RIS 2000a; GLA, 2001a; ICER, 2000; ISSB Ltd, 2002; MEL Research, 1998; WasteWatch, 2002

** Data was either not available or was confidential and suppressed

Of all the materials and products represented in Table 7, construction and demolition waste had the highest reuse and recycling rate (73%). Paper and card was the only other waste type where more than half was recycled. Only 0.15% of plastic was recycled. Recycling and other waste management methods for waste generated in London are also shown in this Table 7.

Table 7: Waste generated in London, by type and management method

Waste type		Arisings	Landfilled	Recycled	Other***
			Management method		
		(Figures are in '000s of tonnes)			
Construction & demolition waste******		**14,756**	**4,030**	**10,694**	**32**
of which…	Construction & demolition	14,563	3,932	10,631	**
	Commercial & industrial	162	90	41	32
	Household	30	8	22	**
Glass		**459**	******	******	******
of which...	Construction & demolition	**	**	**	**
	Commercial & industrial	167	**	**	**
	Household	292	**	58	**
Crude materials		**595**	**351**	**92**	**153**
Metals		**642**	**319**	**316**	**7**
of which…	Construction & demolition	118	60	58	**
	Commercial & industrial	252	24	220	7
	Household	272	235	37	**
Food		**562**	**383**	**145**	**35**
of which…	Construction & demolition	**	**	**	**
	Commercial & industrial	262	165	62	35
	Household	301	218	83	**
Paper & card (excl. pulp)		**1,844**	**852**	**931**	**61**
of which…	Construction & demolition	**	**	**	**
	Commercial & industrial	883	42	780	61
	Household	961	809	152	**
Wood		**574**	**473**	**99**	**3**
of which…	Construction & demolition	300	246	54	**
	Commercial & industrial	250	202	45	3
	Household	25	25	**	**
Plastic		**524**	**366**	**<1**	**158**
of which…	Construction & demolition	**	**	**	**
	Commercial & industrial	210	130	<1	79
	Household	315	235	<1	79
Fertilisers		**462**	**29**	**133**	**300**
of which…	Construction & demolition	**	**	**	**
	Commercial & industrial	462	29	133	300
	Household	**	**	**	**
Miscellaneous manufactures*		**901**	**463**	**355**	**83**
Miscellaneous articles		**2,051**	**1,209**	**316**	**527**
Unidentified waste / other		**2,902**	**1,847**	**758**	**756**
	Total waste generated	**26,273**	**10,320**	**13,839**	**2,113**

* Miscellaneous manufactures excludes paper and plastic

** Data was either not available or was confidential and suppressed

*** Includes thermal, transfer, treatment and unrecorded (only refers to commercial & industrial waste)

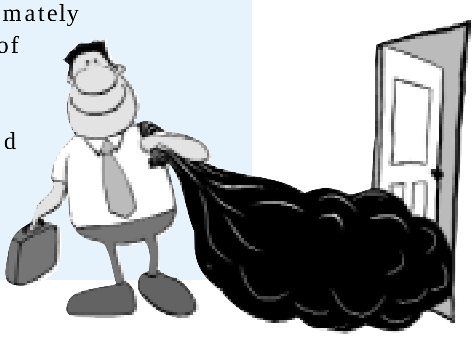
**** Construction & demolition waste does not include glass, which has been taken out and presented individually. Data on glass waste management was scarce. Note this reduces the total unidentified waste, but not landfilled, recycled and other data

Sources: CIPFA, 2001; Environment Agency, 2000d; Enviros RIS 2000a; Garnett, 1999; GLA, 2001a; ICER, 2000; ISSB Ltd, 2002; MEL Research, 1998; WasteWatch, 2002

Packaging waste

A typical London household generates around 3-4 kg of packaging waste per week. It is estimated that London households produce approximately 663,000 tonnes of packaging waste per annum, of which 67% is food packaging.

Source:
INCPEN, 2001



Transport

Londoners travelled over 64 billion passenger kilometres (pass-km) in 2000, of which the major contribution was attributed to cars and vans (44 billion pass-km). CO_2 emissions from cars and vans totalled 8.9 million tonnes. Pass-km and CO_2 emission contributions, by transport mode, in London are shown in Table 8.

Table 8: Transport in London, by mode and CO_2 emissions

Transport mode	Pass-km ('000s)	CO_2 emmisions ('000s of tonnes)
Total	**64,846,104**	**10,931**
Car & van	44,037,121	8,858
Air	923,891	329
National rail	4,455,666	571
Bus & coach	3,764,256	143
London Underground	6,614,988	634
Taxi & minicab	1,963,960	395
Bicycle	444,229	n/a
Walking	2,641,993	n/a

Sources: DTLR, 2001 and McGinty and Williams, 2001

Water

In 2000, water consumption in London reached 866,000 Megalitres (Ml), of which 50% (432,000 Ml) was delivered to households for consumption (see Table 9). The volume of water lost through leakages (239,000 Ml) was more than the total amount of water used by the commercial and industrial sector (195,000 Ml).

Table 9: Water consumed in London, by sector

Consumption by sector	Megalitres (Ml)
Total water	**866,000**
Household water	**432,000**
of which... Metered	52,000
Un-metered	380,000
Commercial & industrial	**195,000**
of which... Metered	186,000
Un-metered	9,000
Leakages	**239,000**

Source: Rice, 2002

Land Use

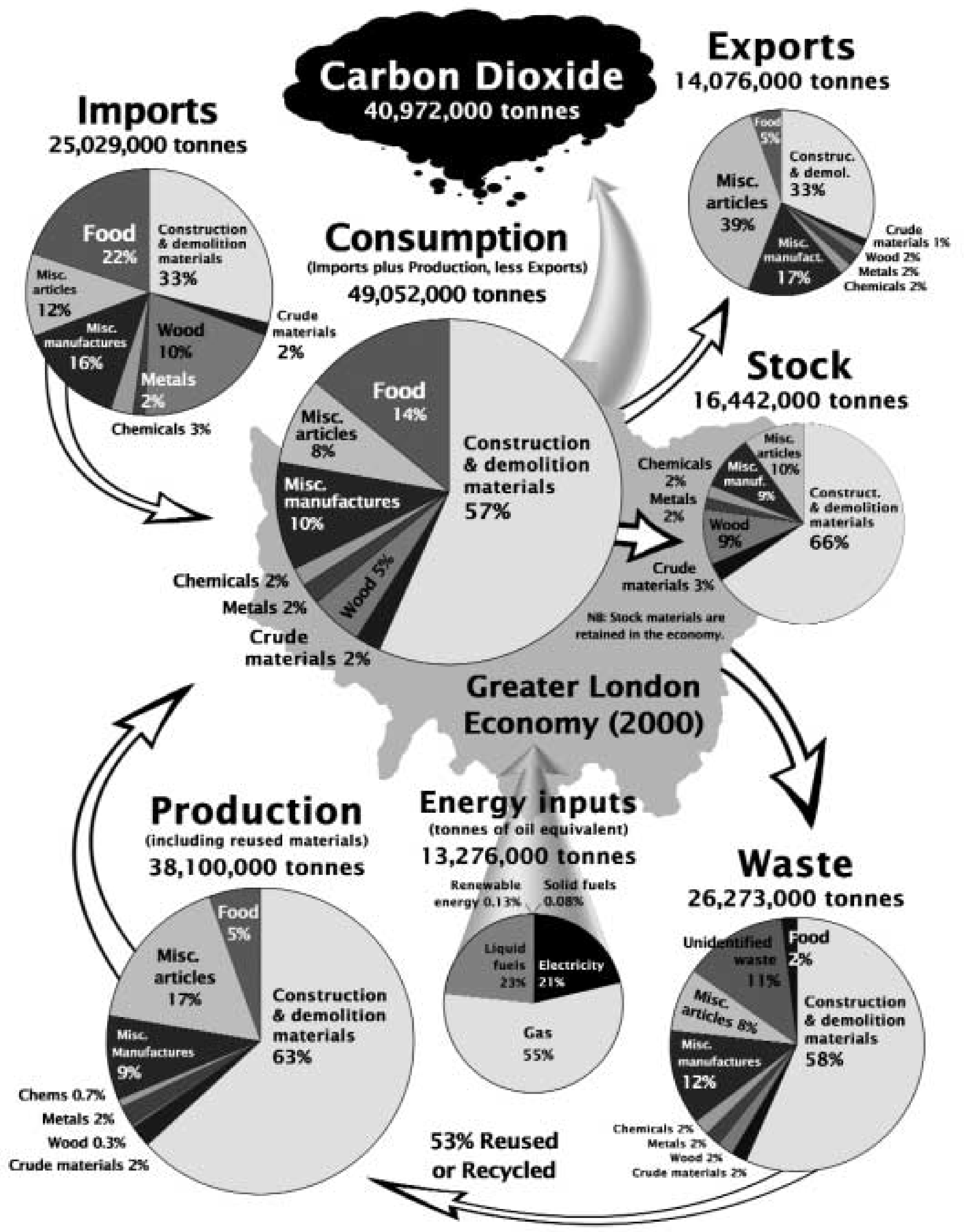
Table 10 provides a break down of land use in London. More than half the total land area is urbanised (110,000 ha). Managed grasslands are the second largest land use type (42,000 ha), with sea/estuary areas representing the smallest contribution of 1,000 ha.

Table 10: Land area in London, by use

Land type	Area (ha)
Total	**175,000**
Sea / estuary	1,000
Arable farmland	9,700
Managed grassland	42,000
Forestry & woodland	6,800
Semi-natural vegetation	3,700
Urban	110,000
Inland water	1,800

Source: Environment Agency, 2000d

Figure 3: Summary resource flows through London in 2000



The City of London

The City of London, also known as The Square Mile, is an historic landmark within Greater London. Today it is home to one of the world's largest financial and business sectors, and makes a substantial input into the UK economy. In 1998, the financial sector contributed 5.8% of the UK's GNP, and overseas earnings.

In 1996/7 commercial properties generated 93% of the 59,000 tonnes of waste generated in the City. 57% of this waste was paper and paper products and 19% glass bottles.

The City has an estimated resident population of 11,000. However, the weekday population can exceed 250,000. 90% use public transport to commute into the City. More than 250,000 vehicles enter the City daily, with one in twenty City workers arriving by car or taxi. Of the four main bridges in the City, Blackfriars is the busiest, with a crossing on average of 54,000 vehicles per day.

The City is renowned for its markets. Billingsgate is the largest UK inland fish market, covering an area of just over 5 hectares (ha), with an average of 35,000 tonnes of fish and fish products sold each year. An estimated 25% of the fish is imported from abroad. Meat is sold in the 800 year old Smithfield Market, with approximately 85,000 tonnes of produce being sold each year. Fruit, vegetables and flowers can be purchased at New Spitalfields, the UK's leading horticultural market. It covers an area of 12.5 hectares.

The Corporation of London owns and manages over 10,000 acres of open spaces in and around London. The City is also home to approximately 1,000 trees with an annual planting of around 250,000 bedding plants.

Sources: Corporation of London, 2000a, 2001a & b and 2002a-c & d

Photo: Tim Nunn, 1998

The eco-efficiency of materials

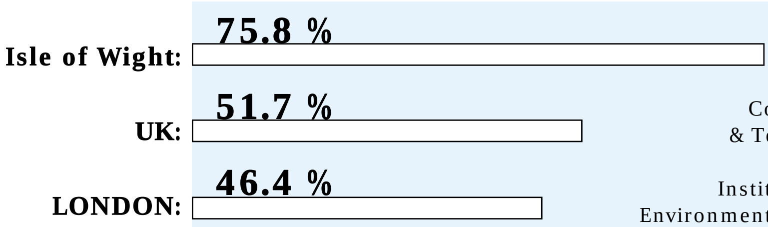
Eco-efficiency is a concept that has traditionally been applied at the product or company level. The World Business Council on Sustainable Development (WBCSD) described eco-efficiency as, '... progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity'(1999).

Eco-efficiency can be calculated by dividing a product or service value by its environmental influence. Product and service value indicators can be in the form of products or services produced and sold. Environmental influence indicators are usually associated with energy and materials consumption.

Applying these principles, eco-efficiency indicators can be derived for a particular region. For example, the product and service value is taken as London's stock accumulation and food consumption (16.4 million tonnes and 6.3 million tonnes respectively) and the environmental influence taken as the materials consumed (49 million tonnes).

Using the above principles, London's eco-efficiency was calculated at 46.4%. This means that of all the materials consumed in London in 2000, less than half was consumed as food or remained in the economy, while the rest was discarded as waste. Figure 4 illustrates London's eco-efficiency in relation to the Isle of Wight and the UK. London's eco-efficiency is lower than the UK average. Of the three studies compared the Isle of Wight was substantially more efficient at utilising its material resources, with an efficiency of 75%. This is mainly because, on a per capita basis, the Isle of Wight generates significantly less waste (1.35 tonnes) than London (3.56 tonnes).

Figure 4: A comparison of eco-efficiency between the Isle of Wight, the UK and London in 2000



Sources: BFF & Imperial College of Science & Technology, 2000 and Wuppertal Institute for Climate, Environment & Energy, 2001

Ecological Footprint Analysis Results

Ecological Demand: The Ecological Footprint

The ecological footprint of Londoners, aligned with the responsibility principle, gave a per capita ecological footprint of 6.63 gha (excluding biodiversity considerations). Although this result remains subject to an uncertain degree of double counting within the materials and waste component, *City Limits* still presents the ecological footprint as a conservative estimate of human impact upon the earth. It is recommend that further research work on the use of economic data and its compatibility with the ecological footprint should be undertaken.

The ecological footprint of Londoners was

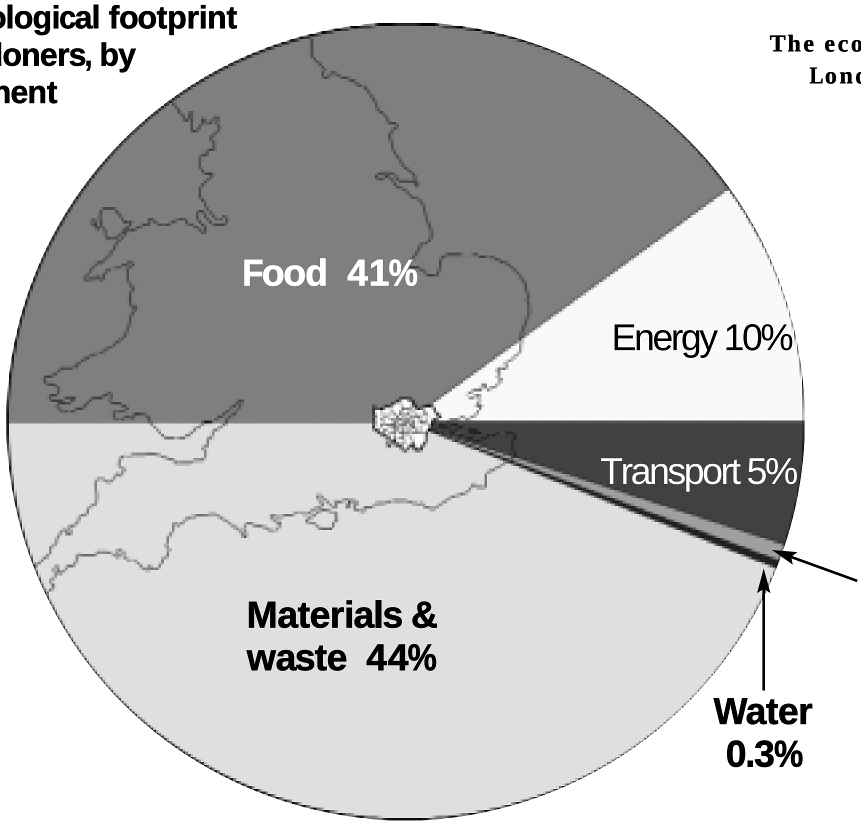
48,868,000gha

or 6.63 gha per capita

Table 11: The ecological footprint of Londoners, by component

Component	Total footprint (gha)	Ecological footprint per capita (gha)
Direct Energy	5,073,000	0.69
Materials & waste	22,465,000	3.05
Food	20,685,000	2.80
Transport	2,503,000	0.34
Water	160,000	0.02
Built land	348,000	0.05
Sub-total	**51,234,000**	**6.95**
Tourism's ecological footprint @ 4.62%	-2,367,000	-0.32
Total ecological footprint	**48,868,000**	**6.63**

Figure 5: The ecological footprint of Londoners, by component



The ecological footprint of Londoners is 293 times the size of London. The area of London and the UK are superimposed for a clearer comparison.

Note: refer to text for details of what data are included in each category.

Materials and waste, at 3.05 gha per capita, and food, at 2.80 gha per capita, were by far the largest components of the ecological footprint. Table 11 shows the total ecological footprints for each component.

In line with the *Living Planet Report* (Loh, 2000), an ecological footprint component addressing biodiversity conservation was added. This assumed that 12% of the world's ecosystems will preserve global biodiversity. Responsibility for this percentage was placed in relation to the size of the Londoner's individual ecological footprint. Therefore, if Londoners' biodiversity responsibility is included, the total ecological footprint becomes 55,531,000 gha, which is equivalent to a per capita footprint of 7.53 gha.

Table 12: The direct energy ecological footprint of Londoners, by component

Component				Ecological footprint (gha)
Gas				**2,794,000**
	of which...	Domestic		2,341,000
		Commercial		453,000
Grid electricity (including renewable grid electricity)				**2,265,000**
	of which...	Domestic		1,745,000
		Commercial		520,000
Petroleum				**14,000**
	of which...	Oil		14,000
		of which...	Domestic	12,000
			Commercial	2,000
Solid fuel (coal)				**50**
	of which...	Domestic		0
		Commercial		50
Renewables (excuding renewable grid electricity)				**1,000**
	of which...	Solar		10
		of which...	Domestic PV*	0
			Commercial PV*	10
			Domestic solar water heating	0
			Other solar water heating	0
Incineration				**1,000**
	of which...	Incineration of biosolids		1,000
		Anaerobic digestion		0
		of which...	Electricity	0
			Heat	0
			Landfill gas	0
			Small or micro-scale hydro power	0
			Wind	0
			Fuel cells	0
		Total		**5,073,000**

* PV = Photovoltaics

Direct Energy Footprint

The ecological footprint of direct energy in London, during the year 2000, was 5,073,000 gha (0.69 gha per capita). Table 12 shows the component breakdown of the direct energy ecological footprint. Direct energy accounted for all non-transport energy consumption and included commercial services. The ecological footprint of producing gas, electricity, oil and coal, as well as the forest needed to assimilate the CO_2 emissions from all energy sources, was included.

The largest component in direct energy was gas, which accounted for 2,794,000 gha (55%). The second highest component was grid electricity, which accounted for 2,265,000 gha (45%).[4]

Materials and Waste Footprint

The ecological footprint for materials and waste was 22,465,000 gha (3.05 gha per capita). Table 13 shows the breakdown of the materials and waste components. All materials that were consumed, remained in the economy or were discarded as waste by Londoners, during 2000, were accounted for. The ecological footprint of material extraction/harvesting, production and transport were included, as well as waste management and the benefits of recycling and reuse.

The largest contribution to the materials and waste component was miscellaneous manufactures (which includes paper and plastic), which accounted for 12,208,000 gha (54%).

Table 13: The sub-components of the materials and waste ecological footprint

Category			Ecological footprint (gha)
Construction materials			
Ready-made concrete			266,000
Plasters			2,000
Cement			240,000
Bricks, tiles & blocks			152,000
Lime			60
Flat glass			312,000
Hollow glass			113,000
Glass fibres			9,000
Other glass			8,000
Other cement			876,000
Other building materials			43,000
Sub total			**2,021,000**
Landfill			3,000
Other			20
Recycling savings			-860,000
Industrial materials			-16,000
Total construction materials			**1,149,000**
Crude materials			
Pulp			1,048,000
Rubber			1,107,000
of which...	Other rubber products		548,000
	Retreading & rebuilding of rubber tyres		41,000
	Rubber tyres & tubes		519,000
	of which...	Cars	224,000
		Buses & lorries	130,000
		Bicycles	3,000
		Scooters & motorcycles	1,000
		Other tyres & tubes	162,000
Unidentified crude materials / other*			2,907,000
Sub total			**5,062,000**
Landfill			200
Other			100
Recycling savings			-177,000
Total crude materials			**4,885,000**
Wood, timber & cork			
Packaging			161,000
of which...	Commercial & industrial		160,000
	Other		5000
Other wood, timber & cork			2,220,000
Sub total			**2,380,000**
Landfill			300
Other			100
Recycling savings			-98,000
Total wood, timber & cork			**2,283,000**

* Data on materials and products that were not available or could not be identified, and in some instances included double counting

Table 13 continued: The sub-components of the materials and waste ecological footprint

Category		Ecological footprint (gha)
Metals		
Iron & steel		883,000
Other metals		437,000
of which...	Aluminium	322,000
	Antimony	100
	Cadmium	0
	Copper	58,000
	Lead	18,000
	Magnesium	2,000
	Nickel	4,000
	Tin	1,000
	Zinc	32,000
Ores		23,000
of which...	Ferrous	15,000
	Non-ferrous	7,000
Sub total		**1,342,000**
Landfill		200
Other		0
Recycling savings		-395,000
Industrial materials		-152,000
Total metals		**795,000**
Chemicals & fertilisers		
Fertiliser		33,000
Chemicals		1,497,000
Sub total		**1,530,000**
Landfill		20
Other		9,000
Recycling savings		-48,000
Industrial materials		-1,291,000
Total chemicals & fertilisers		**200,000**

Table 13 continued overleaf...

In the ecological footprint of a product or material both consumption and per unit impact of the material are accounted for. Different materials have different ecological footprints depending on, for example, the amount of energy used to produce the material. Therefore 'big hitters' in consumption terms, as indicated by tonnages consumed, may not be 'big hitters' in impact, as indicated by the ecological footprint (see Figures 6 and 7).

Table 13 continued: The sub-components of the materials and waste ecological footprint

Category		Ecological footprint (gha)
Miscellaneous manufactures		
Plastic		2,783,000
of which...	Plastic plates, sheets, tubes & profiles	321,000
	Plastic packing goods	419,000
	Other plastic products	864,000
	Builders' ware of plastic	1,179,000
Paper & paperboard		9,597,000
of which...	Paper & paperboard	6,667,000
	Cartons, boxes, cases & other containers	1,530,000
	Household & sanitary goods & toilet requisites	541,000
	Corrugated paper & paperboard, sacks & bags	399,000
	Other articles of paper & paperboard	310,000
	Paper stationery	114,000
	Wallpaper	37,000
Unidentified / other miscellaneous manufactures		4,710,000
Sub total		**17,089,000**
Landfill		1,000
Other		9,000
Recycling savings		-1,120,000
Industrial paper		-2,435,000
Industrial other miscellaneous manufactures		-1,336,000
Total miscellaneous manufactures		**12,208,000**
Miscellaneous articles		
Miscellaneous articles		3,117,000
Sub total		**3,117,000**
Landfill		1,000
Other		16,000
Recycling savings		-62,000
Total miscellaneous articles		**3,071,000**
Unidentified waste materials		
Unidentified waste materials		2,613,000
Sub total		**2,613,000**
Landfill		1,000
Other		23,000
Recycling savings		-149,000
Total unidentified waste materials		**2,487,000**
Materials and waste component sub total		**27,079,000**
Unidentified industrial materials		**-4,614,000**
	Grand Total	**22,465,000**

Figure 6: Ecological footprint 'big hitters' compared with their tonnages

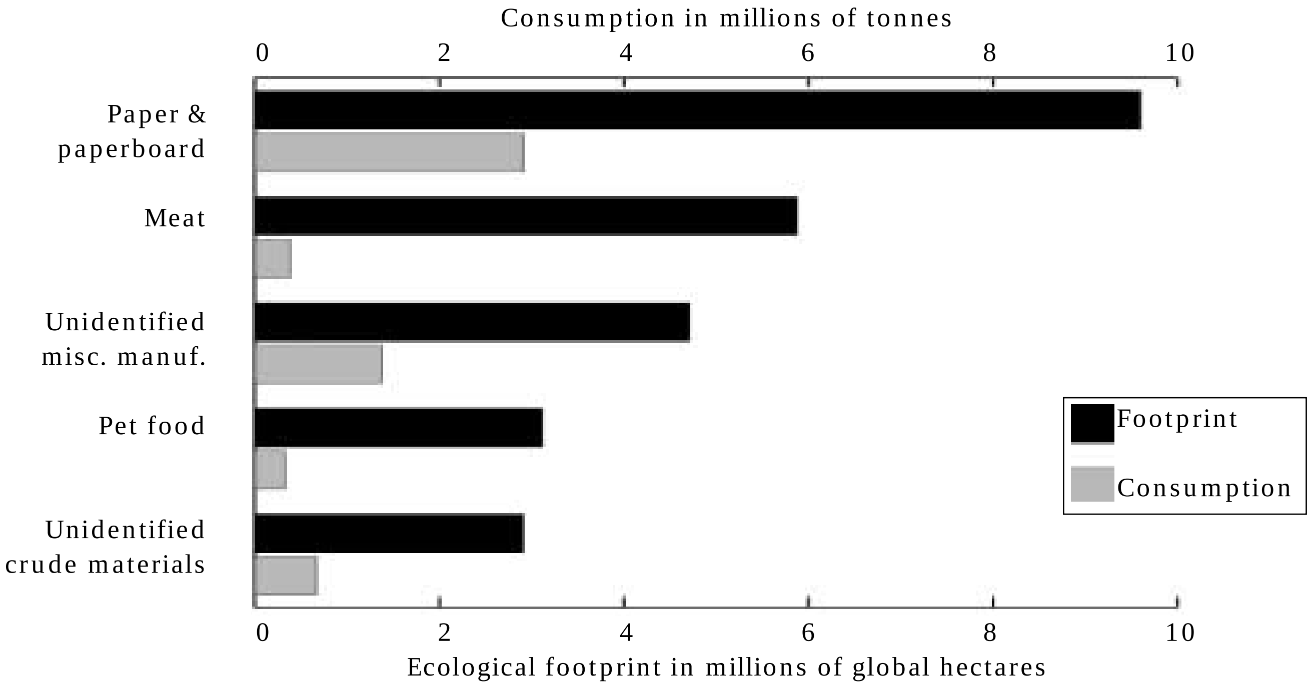
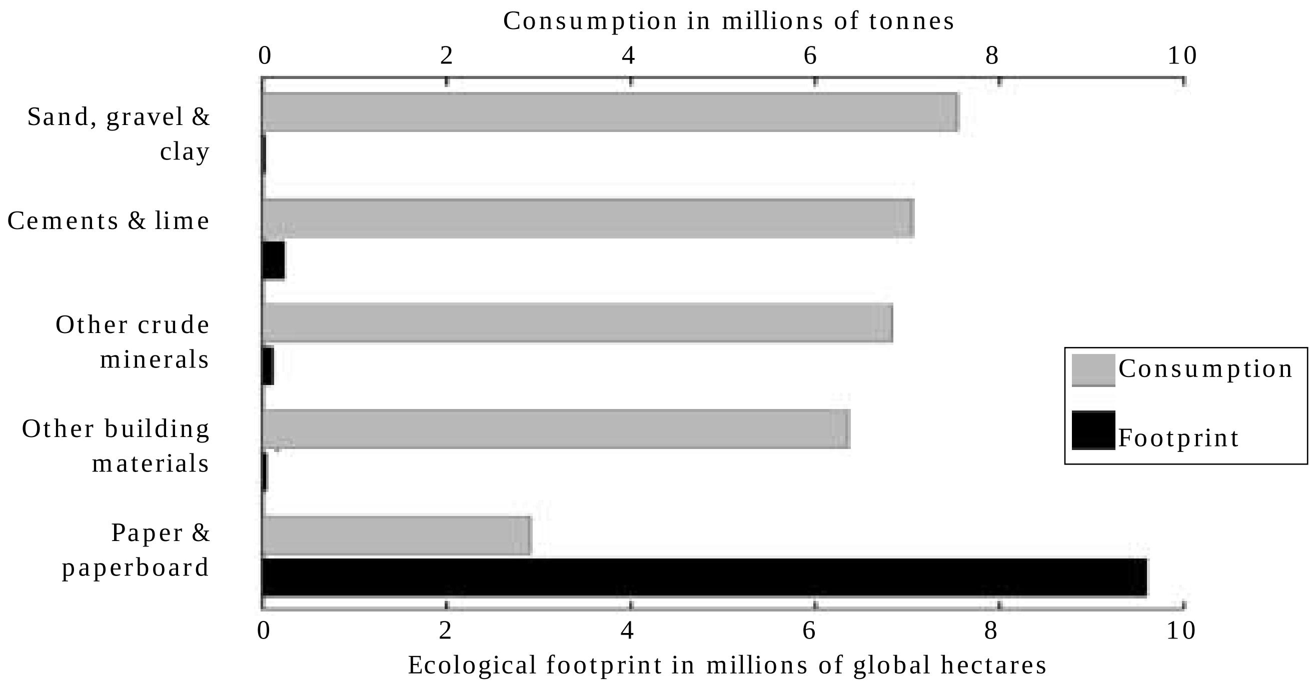


Figure 7: Consumption 'big hitters' compared with their ecological footprints



For example, while construction materials accounted for 66% of tonnes consumed, it represented only 5% of the materials and waste ecological footprint. Miscellaneous manufactures however, accounted for 12% of tonnes consumed, but 54% of the materials and waste ecological footprint.

Figure 6 shows the top five materials by impact (largest ecological footprint), and Figure 7 shows the top five materials by tonnages consumed.

Table 14: The food ecological footprint of Londoners, by component

Food type	Ecological footprint (in '000s of gha)
Human consumption	**17,907**
Milk	2,466
Cream	97
Cheese	612
Meat	5,876
Fish	360
Eggs	407
Fats	972
Sugar & preserves	18
Potatoes	101
Other vegetables	259
Fruit	239
Bread	882
Other cereals	1,044
Tea	32
Coffee	33
Other beverages	969
Miscellaneous	1,642
Soft drinks	211
Alcoholic drinks	658
Confectionery	211
Starch & starch products	941
Production of ethyl alcohol from fermented materials	-125
Non-human consumption	**3,146**
Animal feed	28
Pet food	3,118
Subtotal	**21,053**
Landfill	<1
Other	<1
Recycling savings due to composting	-369
Total	**20,685**

Food Footprint

The ecological footprint for food consumed by Londoners was 20,685,000 gha (2.80 gha per capita). Table 14 shows the component breakdown of the food ecological footprint. The food component accounted for all foods consumed, inside and outside the home. The ecological footprint of harvesting, production and transport was included, as well as food wasted, its management and the benefits of composting.

The largest component in the food ecological footprint was meat consumed, which accounted for 5,876,000 gha (28%). The second largest component was pet food, which accounted for 3,118,000 gha (15%). Milk accounted for 2,466,000 gha (12%).

Personal Transport Footprint

The ecological footprint of personal transport in London was 2,503,000 gha (0.34 gha per capita). Table 15 shows the component breakdown of the personal transport ecological footprint. The personal transport component accounted for all passenger transport, by mode of travel, in London. The ecological footprint included manufacturing and maintenance of vehicles, fuel used and relative area of degraded land (for roads, runways and tracks).

The largest component was car travel, which accounted for 2,109,000 gha (84%). The second largest component was rail (including over- and underground), which accounted for 278,000 gha (11%).

Water Footprint

The ecological footprint of water consumed in London was 160,000 gha (0.02 gha). Table 16 shows the component breakdown of the water ecological footprint. The water component included energy required to collect, treat and supply water and wastewater.

The largest component was domestic water consumed, which accounted for 80,000 gha (50%) of the water ecological footprint.

Table 16: The water ecological footprint of Londoners, by sector

Water demand	Ecological footprint ('000s of gha)
Domestic	80
Commercial & industrial	36
Leakage	44
Total	**160**

Built Land Footprint

The ecological footprint of built (and degraded) land use in London was 348,000 gha (0.05 gha per capita). The built land component included areas that have been built on and areas, which have had their bioproductivity degraded, for example, through contamination or erosion. However, available data only covered areas designated as urban, and not degraded.

Tourism Footprint

The ecological footprint of tourism in London was estimated at 2,367,000 gha. Tourism was calculated as a percentage of overall consumption (see the Ecological Footprint Methodology section), and was therefore not included in other components, such as direct energy or transport. It was assumed that tourists consumed an average mix of resources consumed in London.

The ecological footprint of tourism was subtracted from the first stage of analysis to derive a final ecological footprint of Londoners (see Table 11). It should be noted that in Table 11 the per capita tourism entry (0.32 gha) represents the ecological footprint, which tourism adds to each Londoners ecological footprint.

Table 15: The personal transport ecological footprint of Londoners, by mode

Transport mode		Ecological footprint ('000s of gha)
Cars		2,109
Bicycles		5
Buses/coaches		38
Rail		278
of which...	Overground	135
	Underground	143
Air		73
	Total	**2,503**

Ecological Sustainability Assessment

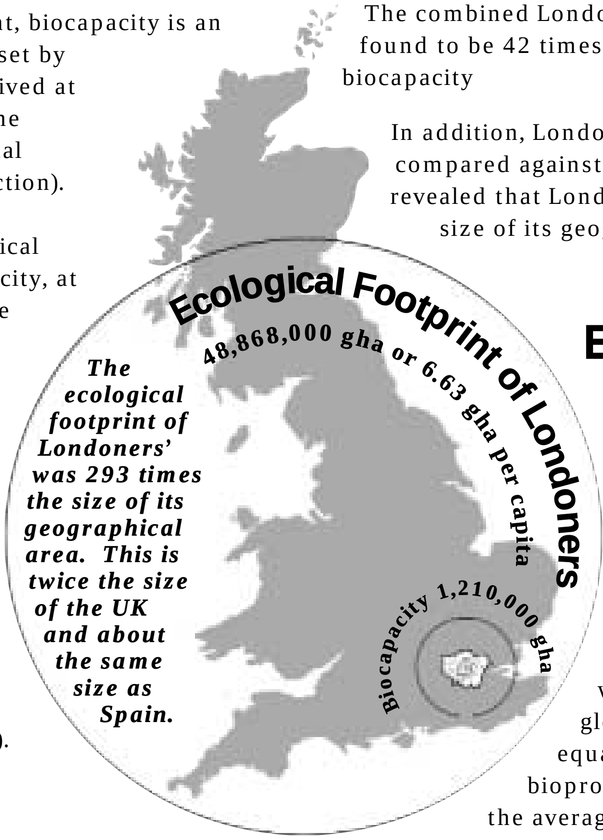
The Ecological Sustainability of London

While the ecological footprint is an indicator of the demands placed on the environment, biocapacity is an indicator of supply. Biocapacity is set by political boundaries and can be derived at any scale (see Ecological Supply: The Biocapacity Analysis in the Ecological Footprint Analysis Methodology section). It is possible to estimate ecological sustainability by deriving an ecological 'benchmark', by comparing biocapacity, at the regional or global scale, with the ecological footprint.

Comparing the ecological footprint of Londoners with the biocapacity of London is indicative of the level to which current ecological demand could be met by local resources.

The combined Londoners' ecological footprint was found to be 42 times the size of London's local biocapacity

In addition, Londoners' ecological demand was compared against London's geographical size, which revealed that Londoners' footprint was 293 times the size of its geographical area.



Ecological Supply: The Biocapacity of London

The biocapacity of London was derived by analysing the land resources identified in the resource flow analysis (see Table 3), and converting them into gha (Table 17).

Ecological Supply: The Biocapacity of the World

To assess the ecological sustainability of Londoners in the global context, their ecological footprint was compared to global ecological supply. Global ecological supply was derived by assuming that the global population is entitled to an equal share of the Earth's bioproductive resources. This is termed the average 'earthshare', and was 2.18 gha per capita in 2000 (Loh, 2000).

Table 18 shows that a Londoner's total demand of 6.63 gha was much greater than the per capita 'earthshare' of 2.18 gha. This indicates that on a global scale, current London lifestyles are not ecologically sustainable.

Table 17: The biocapacity of London

Land type	Total biocapacity (gha)	Biocapacity per capita (gha)
Arable farmland	87,000	0.012
Managed grassland	114,000	0.016
Forestry & woodlands	15,000	0.002
Urban*	983,000	0.133
Semi-natural vegetation	10,000	0.001
Inland water	100	0.00002
Sea	60	0.00001
Total	**1,210,000**	**0.16**

* The biocapacity of urban land was included to illustrate potential bioproductivity

Table 18: The ecological sustainability of Londoners

	gha per capita
Ecological footprint	**6.63**
Local biocapacity	**0.16**
Average earthshare	**2.18**

Comparisons with Other Ecological Footprints

Data used for the *City Limits* resource flow and ecological footprint analyses captured a far greater amount of information than previous regional studies. To make a fair comparison between London's findings and other regions and cities within the UK, its ecological footprint was adjusted. (See Comparison of Londoners' Ecological Footprint to Other Studies in the Ecological Footprint Analysis Methodology section).

London in the World

The *Footprint of Nations* accounts (Wackernagel *et al*, 2000), based on 1996 data, give an ecological footprint for the UK of 6.3 gha per capita (not including biodiversity considerations). Comparing this with the ecological footprint of a Londoner, at 6.63 gha, shows that consumption of resources is above the UK average. However, the UK average per capita ecological footprint could have grown over the period 1996-2000.

Figure 8: The ecological footprints of 152 nations and the World. (Loh, 2000)

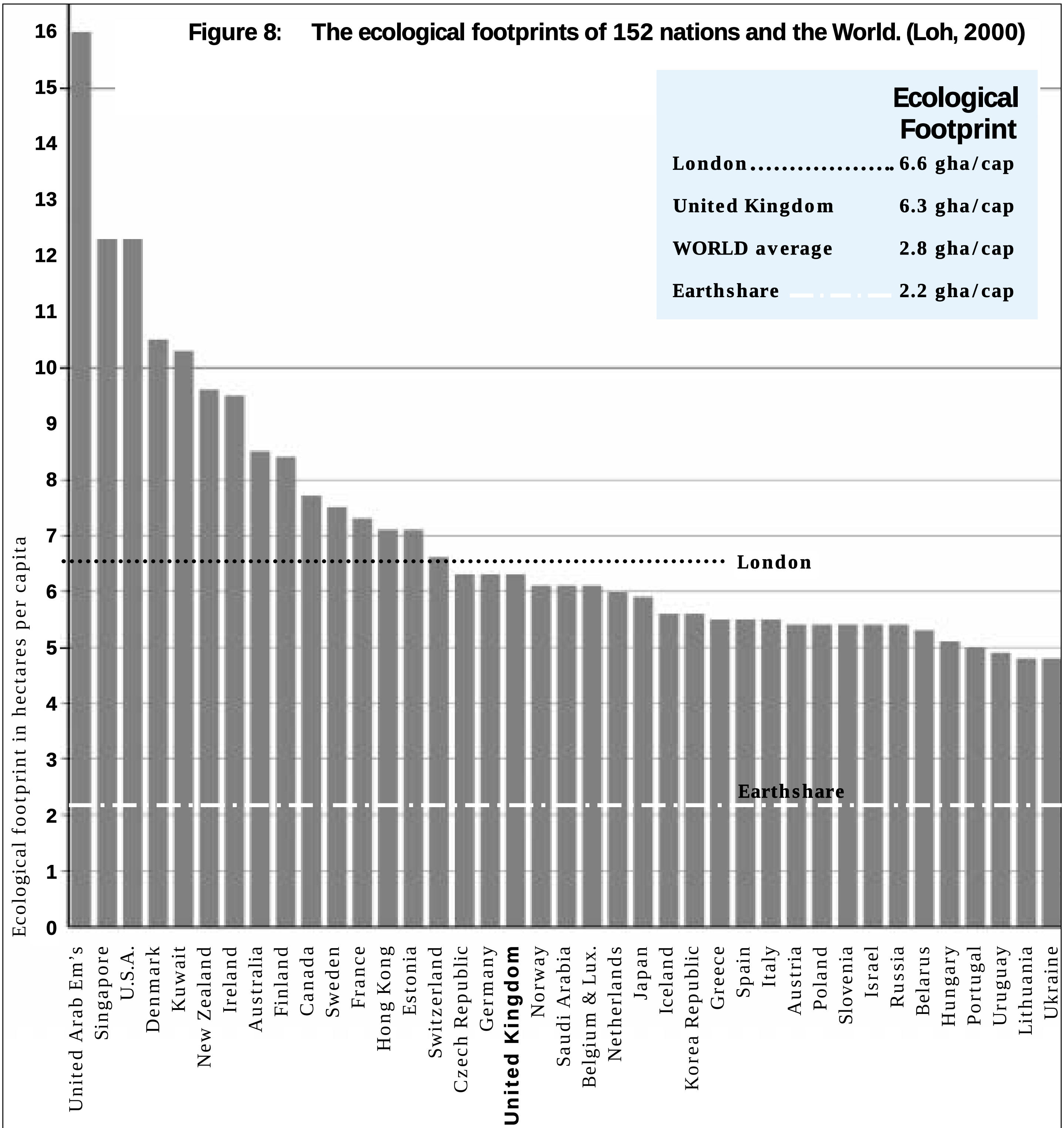


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Figure 9: A comparison of the ecological footprints of Guernsey, Herefordshire, the Isle of Wight, Oxfordshire and Wales in relation to London

In 1996, fifteen industrialised nations had per capita ecological footprints larger than the UK. 135 nations had smaller ecological footprints, with the Czech Republic and Germany having footprints the same size as the UK (See Figure 8).

London and other regions

Five other comparable regional studies, using year 2000 data, have been undertaken: Guernsey (Barrett, 1998), Herefordshire (BFF, 2001), the Isle of Wight (BFF & Imperial College of Science & Technology, 2000), Oxfordshire (BFF, 1999) and Wales (WWF Cymru, 2002). Figure 9 shows the ecological footprint comparisons of these studies.

Figure 8 part 2 of 4: The ecological footprints of 152 nations

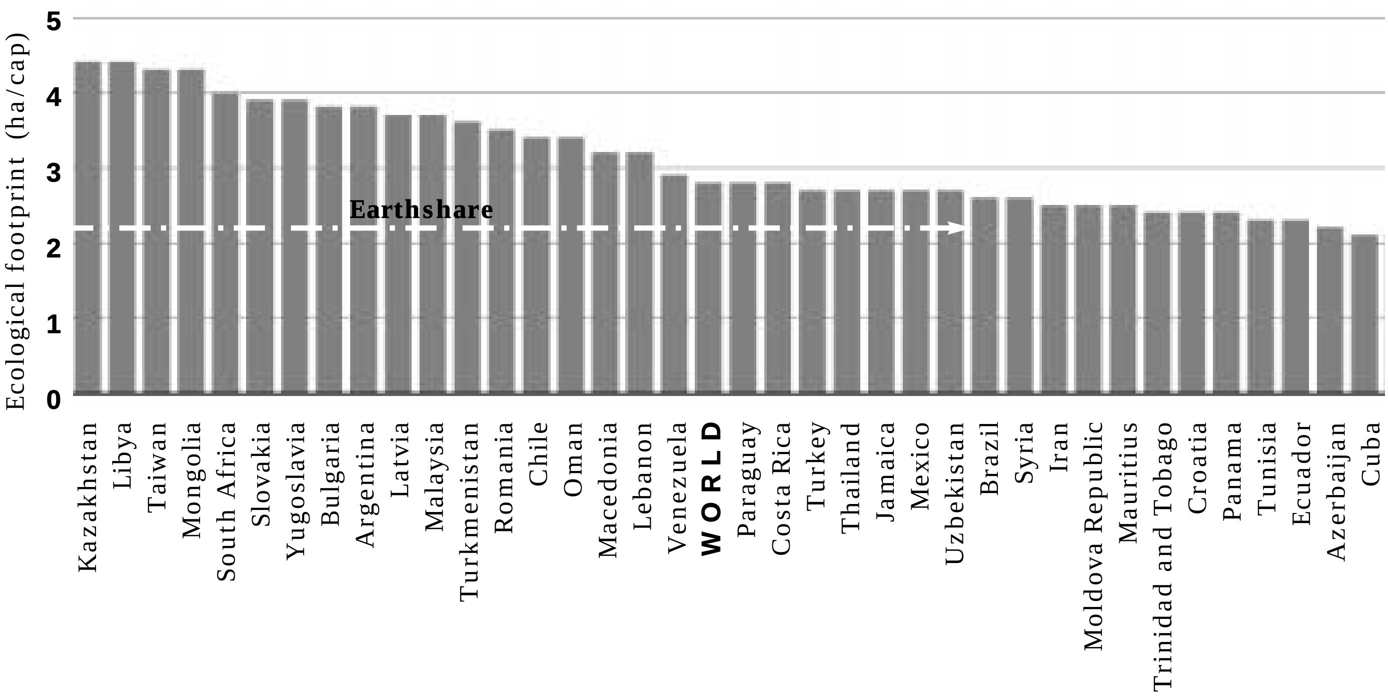

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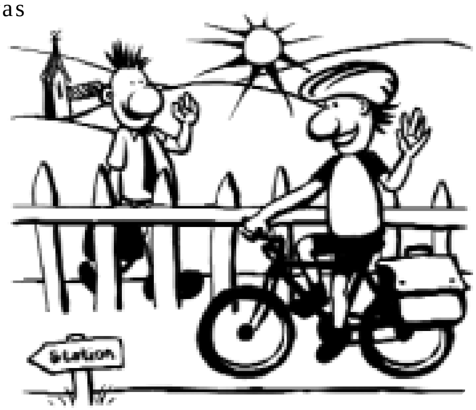
Table 19: London's personal transport use, by mode, in comparison to other UK regions

Transport mode	Guernsey	Herefordshire	Isle of Wight	London	Oxfordshire	Wales
	(Figures in passenger-kilometers, per person per year)					
Cars	6,000	8,000	7,000	6,000	4,000	11,000
Buses/coaches	200	1,000	100	500	300	1,000
Rail	0	1,000	10	2,000	300	1,000
Total	6,000	10,000	7,000	9,000	5,000	12,000

Sources: Barrett, 1998; BFF, 1999; BFF & Imperial College of Science & Technology, 2000; BFF, 2001 and WWF Cymru, 2002

Note: This data may be incomparable due to the wide range of sources used. Transport data tends to be less reliable at more local levels due to differences in the data methodologies employed.

The materials and waste component was the largest for Oxfordshire, London, Wales and the Isle of Wight, with food, the largest component for Guernsey and Herefordshire. However, Londoner's transport ecological footprint is considerably smaller than all of the other studies. This low transport ecological footprint is possibly due to a high use of public transport, with above average occupancies.



London's bus occupancy rate is 28 persons compared to the UK average of 12 persons (Morrey, 2002). A comparison of transport usage between the regions is shown in Table 19. Londoners' energy footprint is higher than the other regions except for Oxfordshire and Guernsey. This is primarily due to a high consumption of domestic gas and grid electricity (Table 20). The smallest energy component was for the Isle of Wight.

Figure 8 part 3 of 4: The ecological footprints of 152 nations

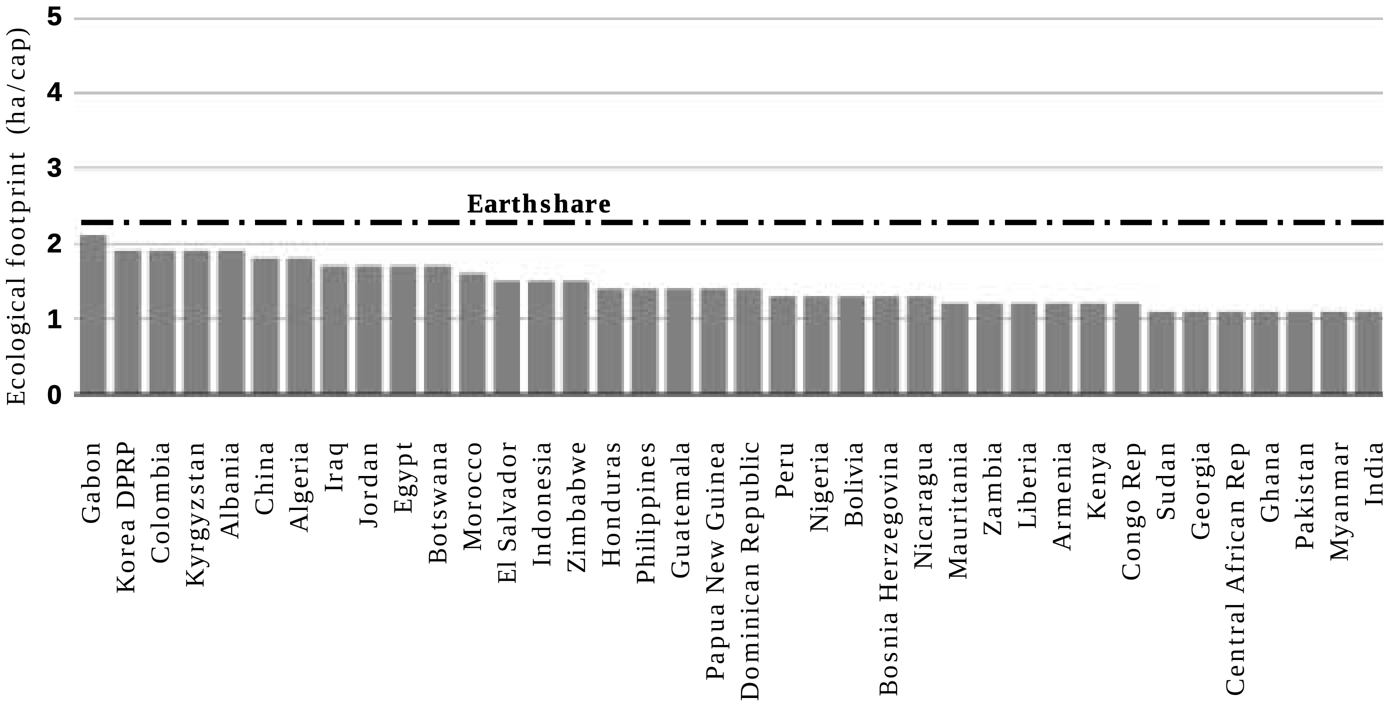


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Table 20: London's domestic gas and grid electricity consumption, in comparison to other regions

Region	Domestic gas (MWh / capita)	Domestic grid electricity (MWh / capita)
Guernsey	4.99	5.08
Herefordshire	3.32	1.88
Isle of Wight*	0.72	2.14
LONDON	6.71	2.35
Oxfordshire	6.84	1.90
Wales	4.04	1.66

Sources: Barrett, 1998; BFF, 1999; BFF & Imperial College of Science & Technology, 2000; BFF, 2001; GLA, 2002a and WWF Cymru, 2002

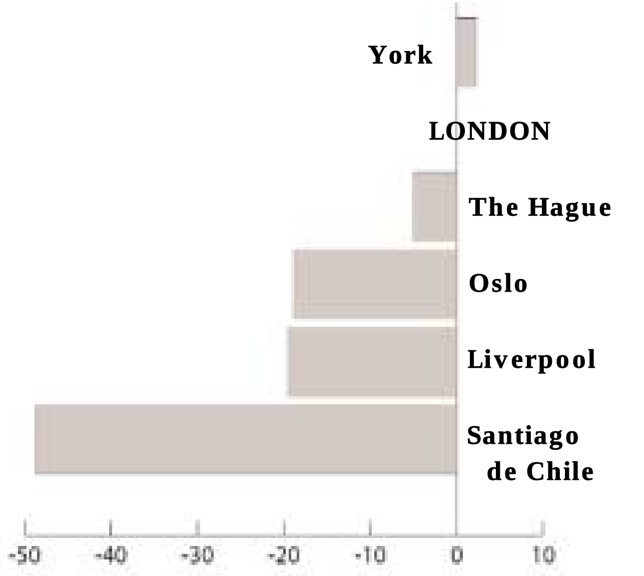
* Underestimate as gas consumption data was incomplete

London and other cities

A number of other ecological footprint studies of cities have been undertaken. Unfortunately, they do not all use the same methodology or boundaries, and some are therefore not directly comparable.

Figure 10 presents London in relation to international and UK cities with roughly comparable footprints. These cities were selected as their methodologies are thought to be largely equivalent to *City Limits*.

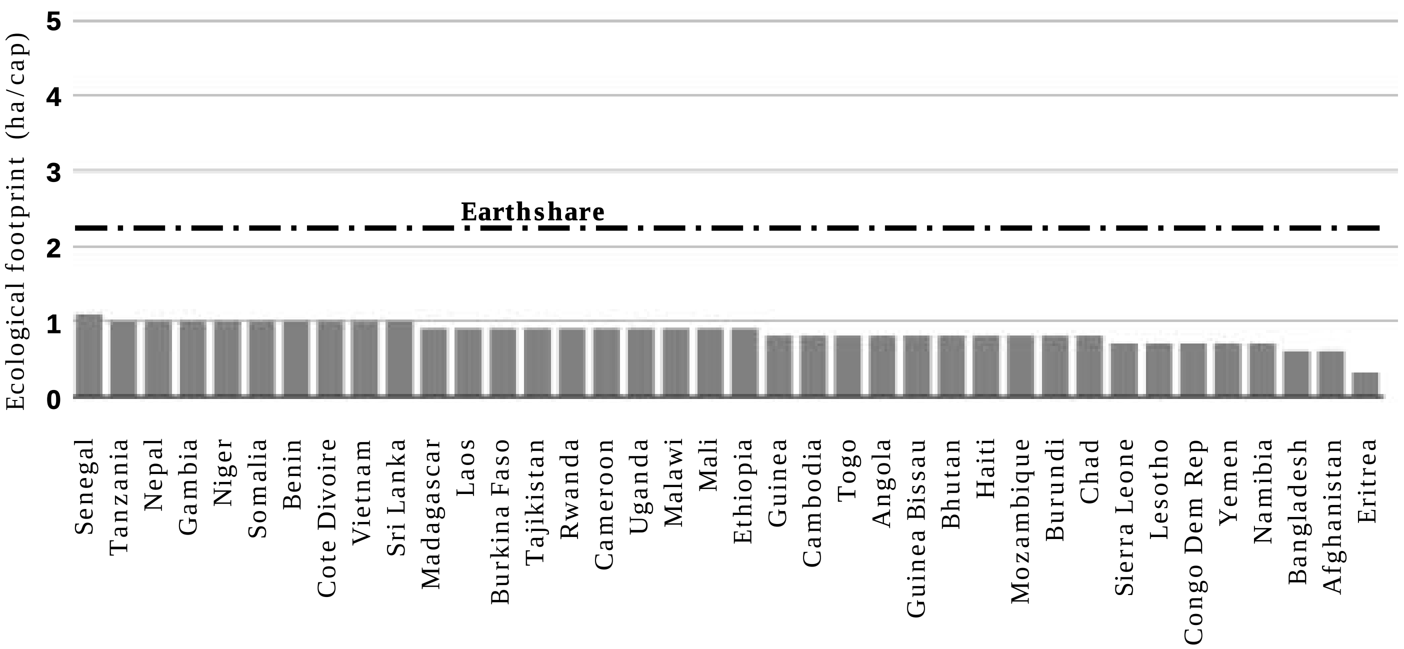
Figure 10: A comparison of the ecological footprints of other cities in relation to London



Sources: Aall and Norland, 2002; Barrett and Scott, 2001; Barrett *et al*, 2002; The Hague City Council, 1998 and Wackernagel *et al*, 1998.

Variation between these particular studies relates mainly to the use of different equivalence factors and local versus global yields.

Figure 8 part 4 of 4: The ecological footprints of 152 nations



Scenario Results

The scenarios developed for *City Limits* were:

- **Electricity**
- **Household waste**
- **Passenger transport**
- **Transportation of food**
- **Household water consumption**

The *City Limits* scenarios attempt to provide quantifiable answers to three questions:

1. If London continues to consume resources in line with trends of the last few decades, how far from sustainability will London be in 2020? ('business as usual' scenario)

2. How much closer to sustainability would current policy targets take London by 2020? ('evolutionary' scenario)

3. What would London and its residents need to do to achieve interim 2020 targets to put the city on track for a sustainable future by 2050? ('revolutionary' scenario)

The evolutionary scenarios are based on existing policy targets. These policy targets apply to particular sub-components (electricity, household waste and passenger transport). Therefore, all the scenarios were developed on a sub-component basis. A business as usual, evolutionary and revolutionary scenario is presented for each sub-component considered.

An analysis of all the sub-components was beyond the scope of this project (and in many cases data was unavailable), therefore a total ecological footprint for 2020 under business as usual or evolutionary conditions could not be presented.

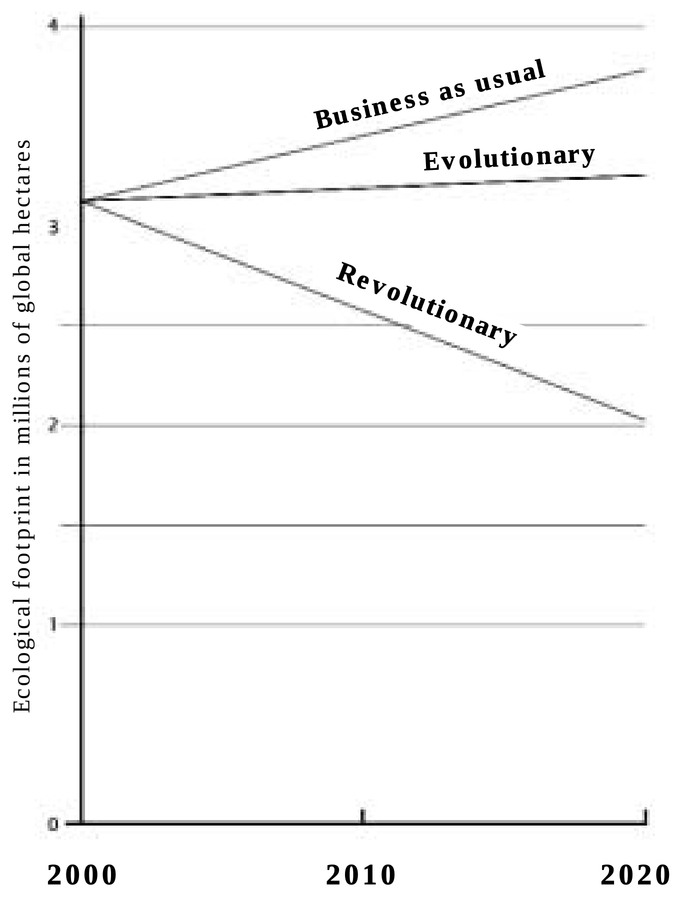
For the revolutionary scenarios, a target of 35% reduction by 2020 for each sub-component was chosen. This was based on the requirement of an 80% reduction in the ecological footprint to achieve ecological sustainability by 2050 (see Scenario Methodology for calculation details). It should be emphasised that in order to achieve a 35% reduction in the total ecological footprint of Londoners, this target reduction would have to be applied to all sub-components. Alternatively, each component or sub-component could be reduced to a different degree. For example, if it were possible to reduce the portion of the ecological footprint attributable to energy use by more than the required 35%, this would alleviate the pressure on other components.

To help make such an interaction between components more tangible, an interactive spreadsheet was produced to accompany this report, which allows the reader to try out various options for London in 2020. The spreadsheet can be downloaded from the *City Limits* website www.citylimitslondon.com.

Electricity

Electricity consumption for London, in 2000, was 31,000 GWh (excluding electricity used for transport) (see Table 1). Of this, 932 GWh was renewable grid electricity and 205 GWh was sourced from renewable energy schemes, such as electricity from landfill gas and anaerobic digestion. Figure 11 illustrates the ecological footprint implications of the business as usual, evolutionary and revolutionary electricity scenario assumptions.

Figure 11: The ecological footprints of Londoners electricity use, based on business as usual, evolutionary and revolutionary assumptions



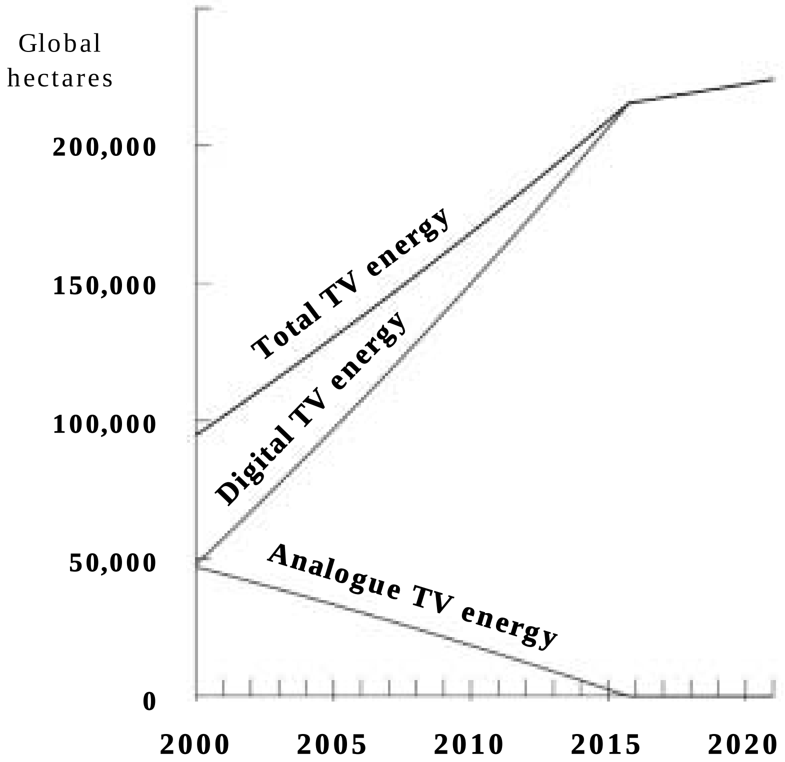
Digital television

30% of UK households have digital television. This figure is expected to increase to 50% or more by 2006, when analogue televisions are likely to become obsolete.

As digital television boxes typically remain on standby, the UK's energy demand is expected, as a result, to increase to an estimated 9.4 TWh per annum (Anon, 2002). This increase is reflected in Figure 12, which assesses London's demand for analogue and digital television.

on / off

Figure 12: The ecological footprints of future TV viewing by Londoners



Business as Usual assumptions

· If London's energy consumption continues to grow at a rate of 1.02% year on year (GLA, 2002a), then London will consume 37,882 GWh of electricity by 2020.

· If the renewables contribution to grid electricity remains at the same proportion of energy consumed (932 GWh) for 2000, then 3% (1,127 GWh) of grid electricity will be provided by renewables in 2020.

· If the trend for growth in renewable energy schemes continues (2.5% year on year (AEAT, 2001)), then 321 GWh of London's other energy demand will be met by renewable schemes in 2020.

Evolutionary assumptions

Based on the assumption that in 2020 London's demand for electricity could reach 37,882 GWh, the following evolutionary scenarios can be applied:

· 5,931 GWh (10%) of grid electricity would need to be sourced from renewable energy, and

· 3,301 GWh (9%) of electricity would need to be sourced from renewable energy schemes.

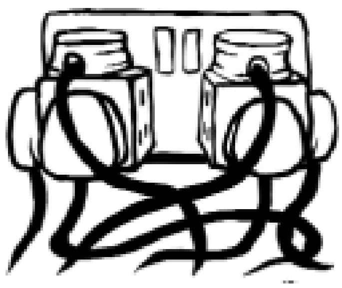
Revolutionary assumptions and requirements to reduce the ecological footprint of electricity by 35% by 2020

Based on the assumption that in 2020 London's demand for electricity could reach 37,882 GWh, the following revolutionary scenarios can be applied:

· 3,790 GWh (10 %) of electricity could be sourced from renewable energy schemes,

· 14,450 GWh (38%) of grid electricity could be sourced from renewable energy, and

· The remaining 52% of London's energy demand could be supplied by 'brown' grid electricity.



Household Waste

Total household waste generated by Londoners in 2000 was 3,400,000 tonnes (see Table 6), of which 9% (297,000 tonnes) was recycled. Figure 14 shows the ecological footprint implications of the business as usual (13a), evolutionary (13b) and revolutionary (13c) household waste scenario assumptions.

Business as Usual assumptions

· If London's household waste arisings continue to grow at a rate of 3.34% year on year (Enviros RIS, 2000a), then London households will generate 5,672,000 tonnes of waste by 2020.

· Household recycling rates for different materials will remain the same as 2000 rates, which were estimated as follows: paper and card (20%), plastic (film and dense) (0.15%) and glass (20%) (Enviros RIS, 2000a and CIPFA, 2001), ferrous metals (13%), aluminium (13%) and compostables (3.5%) (MEL Research, 1998).

Figure 13a shows the ecological footprint implications of the household waste business as usual assumptions.

Evolutionary assumptions

Based on the assumption that in 2020 London's households will generate an estimated 5,672,000 tonnes of waste, the following evolutionary scenarios can be applied:

· The GLA 2010 target of 30% household waste arisings recycled, and a 2015 target of 33% (GLA, 2001a) is extrapolated to 36% in 2020,

· The 2010 household waste recycling target of 30% could be achieved by implementing the following recycling rates: paper and card (42%) and glass (40%) (based on MEL Research, 1998); plastic (0.15%); ferrous metal (50%), aluminium (100%) and compostables (49%) (BFF estimates), and

· A 2020 household waste recycling target of 36% could be achieved by implementing the following recycling: paper and card (50%), plastic (10%), glass (50%), ferrous metal (50%), aluminium (100%) and compostables (55%) (all BFF estimates).

Figure 13a: The ecological footprints of Londoners future household waste arisings, by material, based on business as usual assumptions

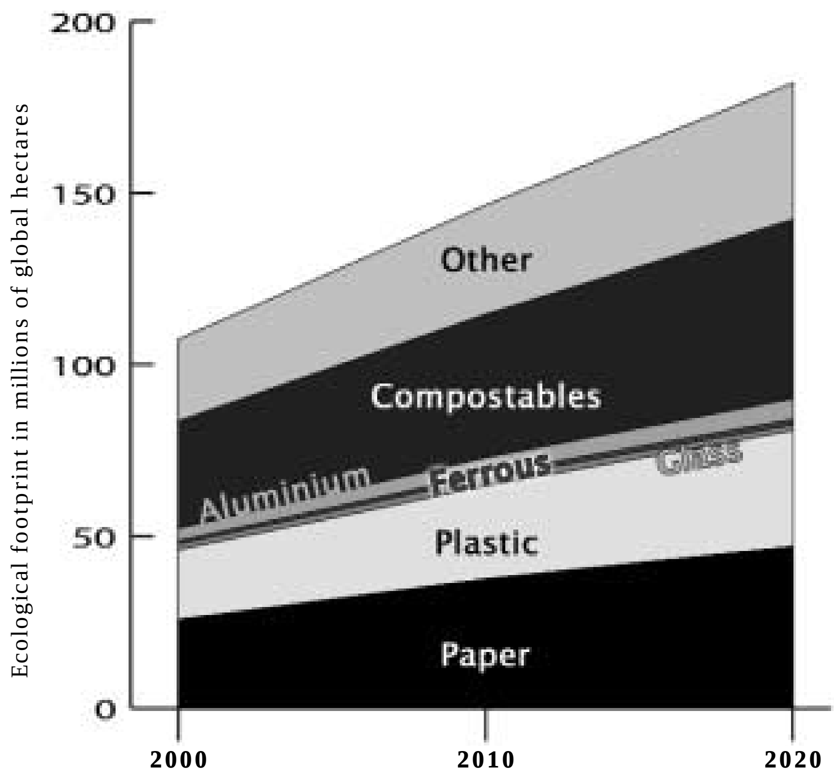
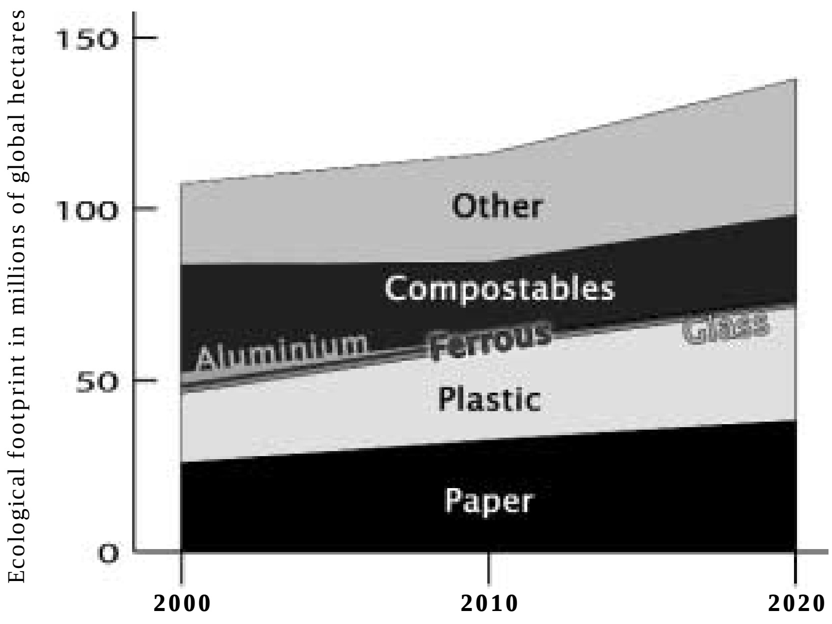


Figure 13b: The ecological footprints of Londoners future household waste arisings, by material, based on evolutionary assumptions



Note: If the 2020 recycling target is achieved, yet waste arisings go unchecked, London will need to dispose 3,628,000 tonnes of household waste. This is more than the amount disposed in 2000 (3,103,000 tonnes).

Note: The household recycling rates suggested for different materials are not the only way to achieve the GLA 30% and 36% extrapolated recycling targets. However, these rates were chosen on the basis of technical feasibility.

Figure 13b shows the ecological footprint implications of the household waste evolutionary assumptions.

Figure 13c: The ecological footprints of Londoners future household waste arisings, by material, based on revolutionary assumptions

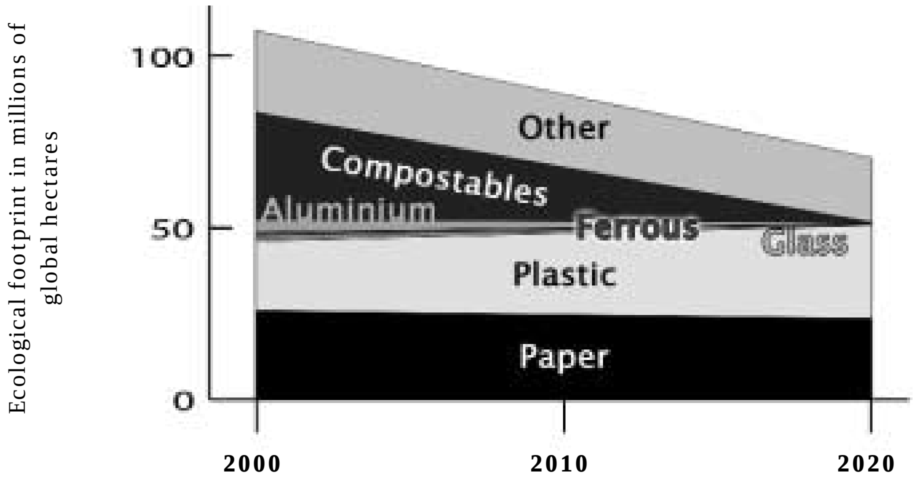
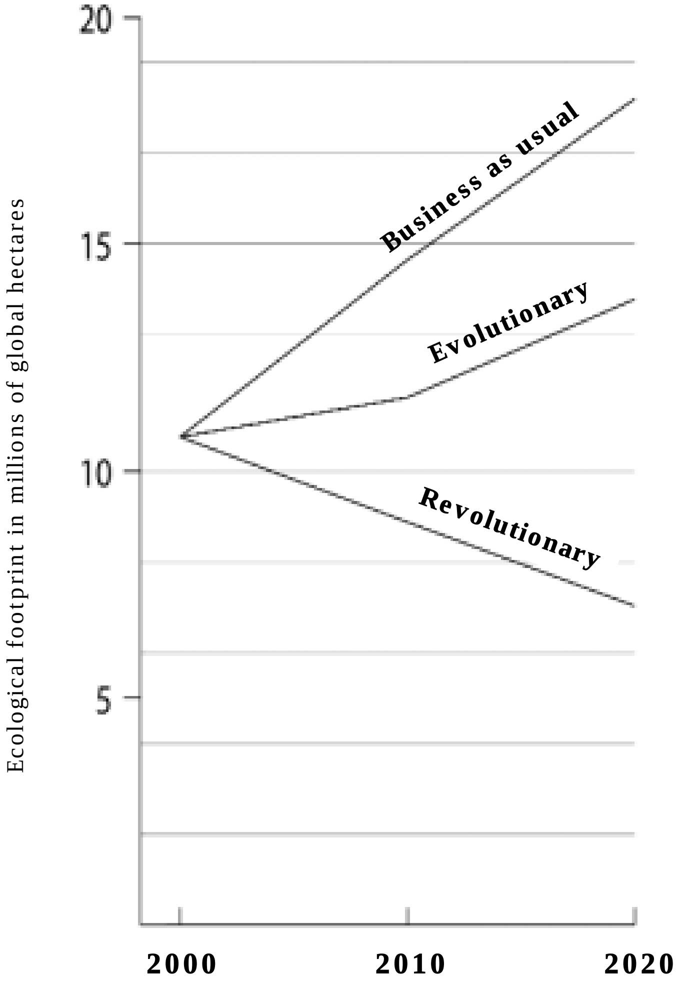


Figure 14: The overall ecological footprints of Londoners future household waste arisings, based on business as usual, evolutionary and revolutionary assumptions



Revolutionary assumptions and requirements to reduce the ecological footprint for household waste by 35% by 2020

Based on the assumption that in 2020 London households will generate an estimated 5,672,000 tonnes of waste, the following revolutionary scenario can be applied:

· A 100% household waste recycling rate for paper and card, plastic, glass, ferrous metal, aluminium and compostables, and a 66% recycling rate for 'other' materials.

Note: This recycling rate is unlikely to be technically feasible, which indicates that waste minimisation must be a priority for future waste management considerations.

Figure 13c shows the ecological footprint implications of the household waste revolutionary assumptions.

Passenger Transport

In 2000, Londoners travelled almost 65 billion passenger-kilometres (pass-km), of which almost 50 billion pass-km were attributed to road traffic (car, van, taxi, bus and coach) (see Table 8). Figure 15 shows the ecological footprint implications of the business as usual, evolutionary and revolutionary passenger transport scenario assumptions.

Business as Usual assumptions

· If London's private car usage continues to grow at a rate of 1.55% year on year (Environment Agency, 2001b) (with a 2000 car occupancy average of 1.2 persons (Morrey 2002)), then London's car and van pass-km will increase from, 44 billion pass-km in 2000 to 58 billion pass-km by 2020.

· In 2000, 4.5 billion pass-km were travelled by national rail. If London's rail usage continues to grow at a rate of 1.43% year on year (based on DETR, 2000b), then London's national rail pass-km will increase to, 5.8 billion pass-km by 2020.

· In 2000 3.8 billion pass-km, were travelled by bus and coach. If London's bus and coach usage continues to grow at a rate of 0.2% year on year (based on trend data (ONS, 2000b)), then London's bus and coach pass-km will increase to, 5.2 billion pass-km by 2020.

· In 2000, 6.6 billion pass-km were travelled on the London Underground. If London Underground's usage continues to grow at a rate of 1.5% year on year (based on DETR, 2000b), then London Underground's pass-km will increase to, 8.6 billion pass-km by 2020.

· In 2000 1.9 billion pass-km, were travelled by taxi and minicab. If London's taxi and minicab usage continues to grow at a rate of 2.67% year on year (based on trend data Noble and O'Hara, 2001), then London's taxi and minicab pass-km will increase to 2.6 billion pass-km by 2020.

Evolutionary assumptions

Based on the rate of growth of all modes of transport, the following evolutionary scenarios can be applied:

· Reducing road transport vehicle-km to 1996 levels (28 billion vehicle-km) by 2010 (Road Traffic Reduction (National Targets) Act, 1998), and stabilised thereafter to 2020. This can achieved by:

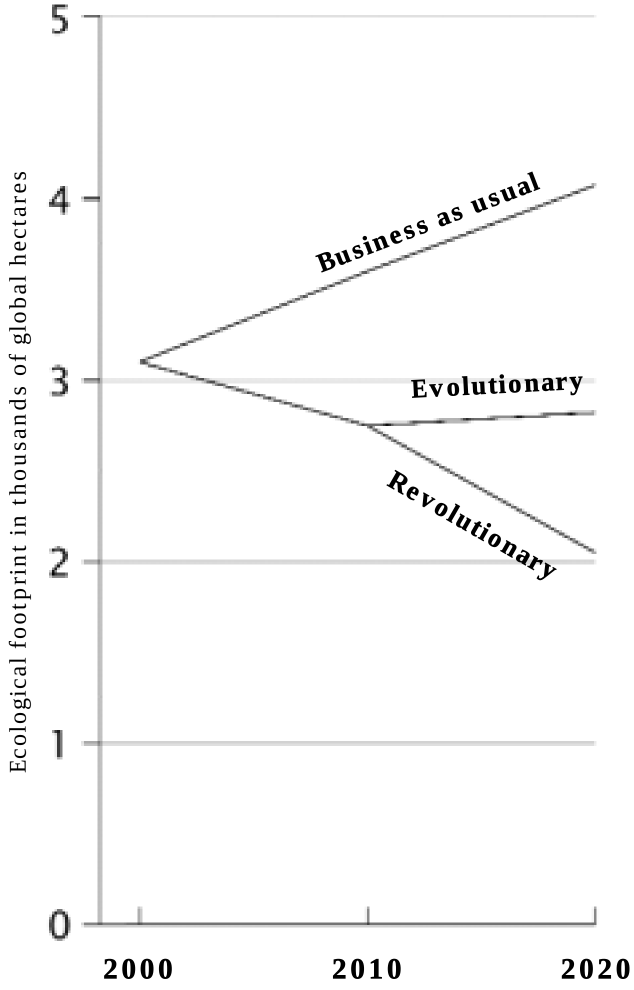
· Switching all car journeys under 3.2 km (5.3 billion pass-km) to cycling (based on TfL, 2000a & b)

· Switching 50% of car commuter journeys (6 billion pass-km) to rail (over- and underground)

· Switching 10% of bus and coach journeys to walking, and

· Raising the average car occupancy from 1.2 persons to 1.3 by 2010, and to 1.6 by 2020.

Figure 15: The ecological footprints of Londoners future transport demand, based on business as usual, evolutionary and revolutionary assumptions



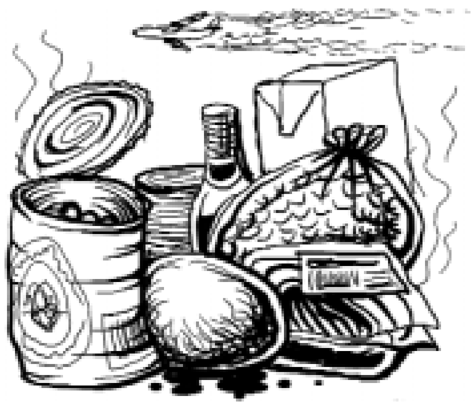
Revolutionary assumptions and requirements to reduce the ecological footprint for transport by 35% by 2020

If passenger transport demands continue to grow at current rates (see Passenger Transport business as usual assumptions), then it will not be possible to achieve a 35% reduction in London's transport ecological footprint by implementing simple modal switches, especially if current technologies are assumed. Therefore, the following revolutionary scenario has been selected (based on business as usual demand for 2020, and the implementation of modal switches and occupancy increases are the same as the Passenger Transport evolutionary scenario assumptions):

· Switching 50% of car and van pass-km to a low carbon fuel, such as solar generated hydrogen fuel cells, by 2020.

Transportation of Food

In 2000, Londoners consumed 5,035,000 tonnes of food (excluding animal feed) (see Table 4b), of which 25,940,000 million tonnes (excluding agricultural products) was 'lifted' (lifted onto a vehicle) (based on ONS, 2001d and CSRGT, 2000). It can be estimated that each tonne of food consumed in London is 'responsible' for approximately 5 'lifts' (probably as a result of processing in the supply chain). Each 'lift' had an estimated haul length of 128 km (DTLR, 2002), for example, each tonne of food consumed in London was transported approximately 640 km. It can therefore be assumed that 3,558,650,000 tonne-km of road freight was required to supply Londoners' food demands. Figure 16 shows the ecological footprint implications of the business as usual, evolutionary and revolutionary food transport scenario assumptions.



Business as Usual assumptions

If London's food 'lifted' continues at its current rate, it is estimated to increase to 34.71 million tonnes by 2020 (based on DTLR, 2002), of which some of this growth will be attributed to an increase in food consumption (estimated to rise to 5,467,000 tonnes by 2020 (based on trend data, (Jones, 2001)) and an increase in the number of 'lifts'. It is assumed that the average haul length per tonne 'lifted' will increase to 164km by 2020 (BFF estimation).

Evolutionary assumptions

Based on the assumption that in 2020 food 'lifted' in London will remain the same as 2000 (25,940,000 million tonnes), with an increase in food consumption to 5,467,000 tonnes by 2020, and is offset by a corresponding decrease in food 'lifted', or a reduction in food wastage. The following evolutionary scenarios can be applied:

· Average haul length per tonne lifted reduced to 1995/6 levels (117km) by 2020 (based on DTLR, 2002), and

· Switching road freight to rail so that 8% (260,230,000 tonne-km) of food freight is transported by rail (Transport 2000, 2002).

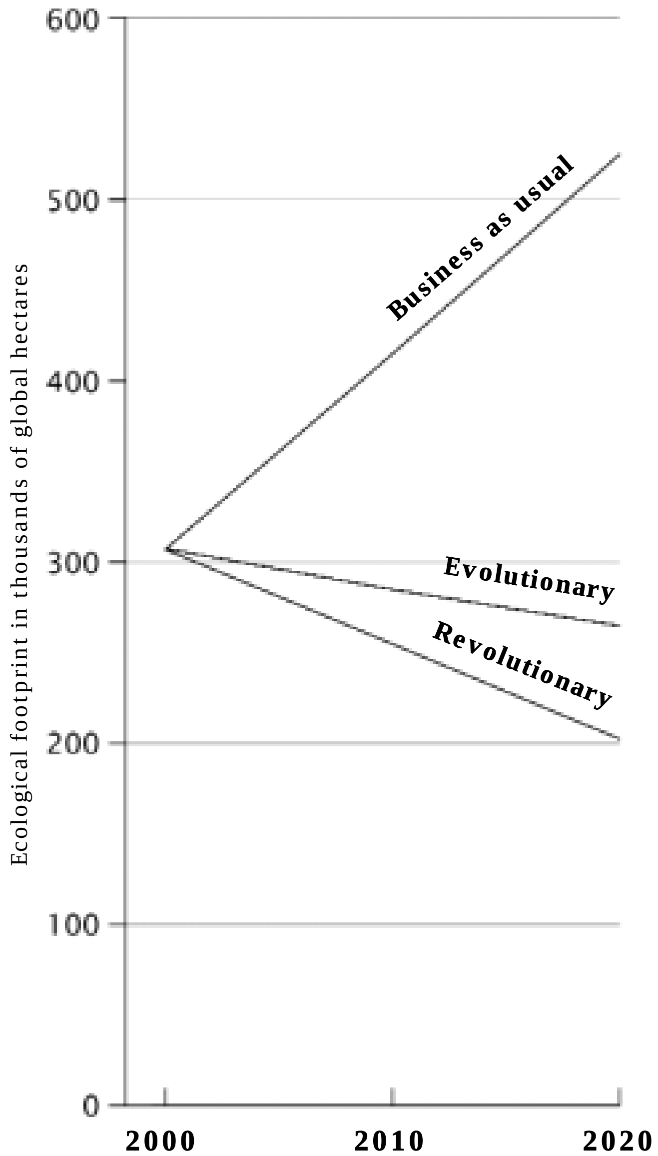
Revolutionary assumptions

Based on the assumption that in 2020 food 'lifted' in London will remain the same as 2000 (25,940,000 million tonnes), with an increase in food consumption to 5,467,000 tonnes by 2020, and is offset by a corresponding decrease in food 'lifted', or a reduction in food wastage. The following revolutionary scenarios can be applied:

· Average haul length per tonne 'lifted' is reduced to 95 km (based on a further reduction on 1990's haul length of 110km per tonne 'lifted', which is approximately equal to the 1980 level)(based on DTLR, 2002), and

· Switching road freight to rail so that 15% (396,180,000 tonne-km) of food freight is transported by rail (a BFF estimate).

Figure 16: The ecological footprints of Londoners future food transport demand, based on business as usual, evolutionary and revolutionary assumptions



Household Water Consumption

London's total water consumption, in 2000, was 866,000 Megalitres (Ml), of which 432,000 Ml was household consumption and 195,000 Ml commercial and industrial consumption (see Table 9). The scenarios suggested below, look at possibilities for reducing domestic, commercial and industrial usage, as well as a reduction in leakage from the public water supply. Figure 17 shows the ecological footprint implications of the business as usual, evolutionary and revolutionary household water scenario assumptions.

Business as Usual assumptions

If London's demand for water continues to grow at a rate of 0.3% year on year (Environment Agency, 2001b), then London's household water demand will increase to 918,000 Ml by 2020.

Evolutionary assumptions

Based on the assumption that in 2020 London's water demand will be 918,000 Ml, the following evolutionary scenarios can be applied:

· The implementation of household water consumption measures, such as installing water-saving 'hippos' in toilet cisterns, and switching from baths to showers, could lead to a reduction in London's domestic water consumption of 82,000 Ml by 2020.

· The implementation of a 66% reduction in commercial water demand, could save 84,000 Ml by 2020 (based on KMCOC, 2002), and

· A reduction in water leakage of 20% could save 51,000 Ml by 2020.

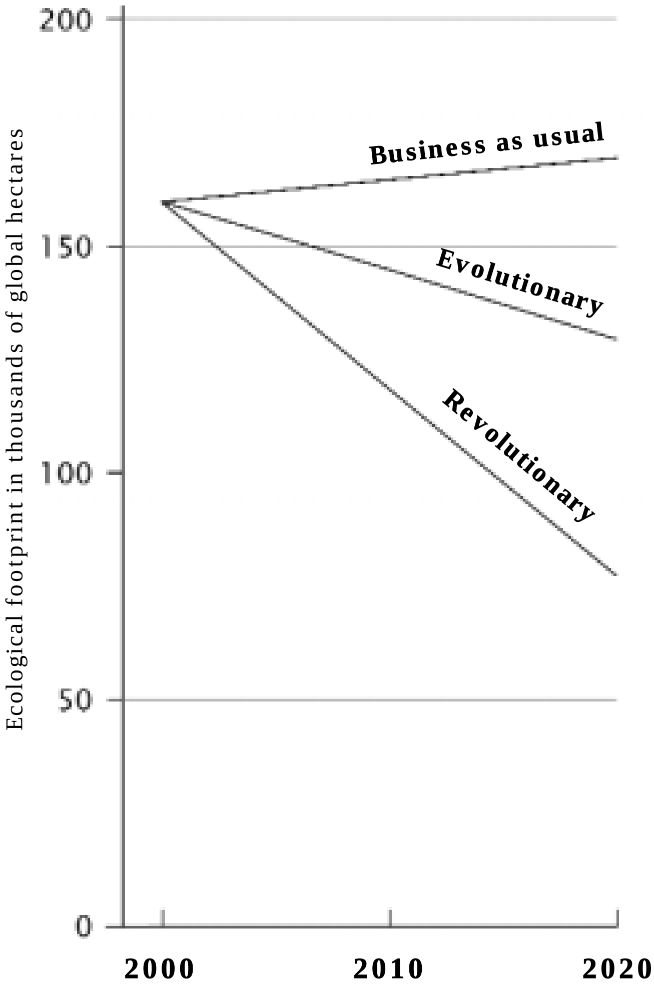
Revolutionary requirements and assumptions

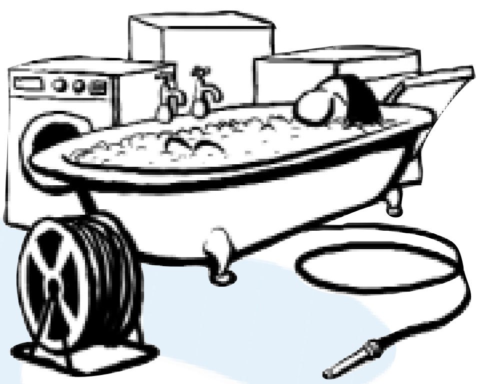
Based on the assumption that in 2020 London's water demand will be 918,000 Ml, the following revolutionary scenarios can be applied:

· The collection and use of rainwater could save London 18% (78,000 Ml) of its household water consumption by 2020 (based on BedZED, 2002), and

· Using grey water recycling systems could save London 30% (129,000Ml) of its household consumption (based on BSRIA, 2002 and UNED, 2001)

Figure 17: The ecological footprints of Londoners future household water demand, based on business as usual, evolutionary and revolutionary assumptions





Household water consumption

The average London household consumes 150 litres (l) of water per person per day, or 54,800 l per annum.

BedZED, an environmentally-sound, energy-efficient mix of housing and work space in Sutton, London, has developed schemes to reduce household water consumption. Through its water saving schemes, such as the installation of rain water collection tanks, water efficient washing machines and duel-flush toilets, water consumption can be reduced to 33,200 l per person per annum. The developers believe that 18% of all household water consumption can be met by rain water, and the installation of duel flush toilets could save an estimated 55,000 l of water per household per year.

Source: BedZED, 2002

Methodology

Project Aims

Data collection efforts were focussed on:

- **Resource flow and consumption data for the study year 2000.** Consumption data, a sub-section of the resource flow, was required for the ecological footprint analysis, and
- **Data for the calculation of trends, scenarios and proxy measures.**

Data Collection

Methodology

To facilitate systematic data collection and to feed into the final analyses, data was collected for the following components:

- **Direct energy**
- **Materials**
- **Waste**
- **Transport**
- **Water**
- **Land Use**
- **Tourism**
- **Demographics**
- **Economics**

Data was collected from:

- **Best Foot Forward's (BFF) databases and published sources,** a total of 4,500 documents and 57,500 electronic data-points, and
- **Organisations and individuals** identified for this project.

A matrix was developed to identify and organise potential data providers and sources according to the data they could supply (London, South East Region and/or national (UK) data). Those identified as possible providers of London-based data were targeted as a priority.

Over 240 organisations were contacted during the data collection and analysis phases (see Appendix 1). Additional data providers were identified as leads from data providers and the project Steering Group.

Meetings were arranged with key data providers, such as the GLA, Association of London Government (ALG), Environment Agency, London Tourist Board, ONS and Transport for London (TfL). Organisations not visited, but identified in the matrix, were notified of the *City Limits* project by e-mail or letter. Information sent to these organisations consisted of: a project leaflet, data specification, guide on how data could be gathered and how it would be used. Organisations that showed an interest in the project were contacted to discuss their possible input, and if necessary meetings were arranged. A project website was established and promoted to attract further potential data providers.

Data provided by organisations was assessed for suitability. In some instances organisations were contacted to validate data and cross-reference it with other sources. Data was also collated regularly to assess collection progress and data gaps. The Steering Group was particularly useful in providing guidance on filling gaps.

Data was not only gathered for the resource flow and ecological footprint analyses, but also for scenarios. Criteria used for gathering scenario data was based on whether it provided trend or prediction patterns. Data collected for scenarios was further sub-divided into whether it was appropriate for 'business as usual', 'evolutionary' or 'revolutionary' scenarios. Primary sources for scenarios included: GLA strategies (air quality, energy, municipal waste and transport), and information from various NGO's operating in London, such as BioRegional, Friends of the Earth and London REMADE.

Data Availability and Quality

Overall, data availability and quality was impressive, and exceeded initial expectations. However, it did vary from component to component (see Appendix 2). For example, there was a large quantity of waste data (which appears to have improved over the past few years), but relatively little London and South East region data on material consumption.

Commercial confidentiality and cost

Commercial confidentiality and market sensitivity was a hindrance to data availability. Data confidentiality was an issue for some data providers. However, it was assured that their data would not be made publicly available without permission. To ensure data was accurately reported in this publication, selected data providers were given the opportunity to check their data far correct representation.

Confidentiality was most problematic when accessing data on food consumption, ownership of household goods, material sales and production figures by businesses in London. Some business information, such as NOMIS data (labour market data produced from commercial sources) could be potentially useful, but was unavailable at a regional level for reasons of commercial security (NOMIS, 2002). Developments in corporate environmental reporting might, in time, resolve many data confidentiality issues.

Some commercial data, although not confidential, was unavailable for reasons of cost. In particular, market research conducted by or for trade associations. In these situations, government and other publicly available reports were used, such as the *National Food Survey* (ONS, 2001d). However, if a priced publication contained valuable data it was purchased, for example, CIPFA 1999-2000 returns (2001).

The key data providers for the resource flow analysis, ONS (Mills, 2002) and DTLR (Burrows, 2002 and Turner, 2002), were contacted to clarify any double counting possibilities in their datasets. In an attempt to avoid double counting in the resource flow analysis, certain DTLR material categories were not included in the total figure of materials consumed in London. For example, it was assumed that metals used in vehicles were also accounted for in the metals category (CSRGT, 2000).

Proxy Measures

In some instances London data was derived using some form of proxy calculation. A proxy was normally used to compensate for a lack of raw data. Proxies are estimates derived from an existing data set using a statistical modifier. A proxy can be derived using, for example, population, employee numbers, GDP or waste generation. For example, deriving local water consumption data by using average per capita consumption of a region of which the locality is part. However, each proxy method has advantages and disadvantages and carries with it certain assumptions. (Proxy measures are discussed further in the Resource Flow Analysis Methodology, which follows this section).

The Double Counting Demon

In a study of this kind, there are two potential areas for double counting:

• Double counting inherent in datasets, which affects both the resource flow and ecological footprint analyses, and

• Double counting of impacts between components, which primarily affects the ecological footprint analysis

Double Counting in the Resource Flow Analysis

Double counting in the resource flow analysis can be illustrated by using paper as an example. Paper will go through many stages of production until it becomes the final product we might read or use. Economic data can track these sequential processes and report the financial value of each stage. However, it is still the same paper and for resource accounting purposes this presents a risk of double counting. To ensure that data is not represented more than once in the resource flow, it is also important to note where data was taken from in a materials life cycle, such as the production or end-use phase.

Double Counting in the Ecological Footprint Analysis

In the component approach used here for ecological footprint analysis there is a danger of double counting impacts in more than one component. For example, the ecological footprint of materials included freight-transported goods to show the true 'cost' of consumption. However, freight transport was also analysed in the transport component. Therefore, when all the individual ecological footprint components were totalled, an adjustment was made to compensate for this. Similarly, the ecological footprint of water consumption includes the energy used to treat and supply water. This energy was also included in the energy component. In both these situations, the same impact was included in different components, and therefore when all the component ecological footprints were totalled an allowance was made for any possibility of double counting.

Filling the Data Gaps

There are a number of data issues, which need to be addressed if this type of study is to be easily replicated. Suggested key areas for improvement are:

· To make ONS ProdCom data available at a regional level,
· To eliminate or reduce double counting in ONS ProdCom and DTLR data,
· Further research work on the use of economic data and its compatibility with the ecological footprint should be undertaken,
· To improve corporate reporting responsibilities, especially on natural resource issues,
· To develop a common reporting format for waste (this is already underway, see IWM (EB)'s Data Flow project to develop a national municipal wastes database; also www.capitalwastefacts.com),
· To include renewable energy supply in GLA energy data,
· To regularly release Transco gas consumption data,
· To include all modes of transport, in London, in passenger kilometres in transport statistics, and
· To encourage utility companies to provide relevant consumption data (such as energy and water). This may be required under the Environmental Information Regulations (Statutory Instrument 1992 No. 3240) (DoE, 1992).

Resource Flow Analysis Methodology

Resource flows analysed for *City Limits* were calculated on an annual basis, using data for the year 2000. Data sets represented either the financial (April to March 2000-2001) or calendar (January to December 2000) year.

Attempts were made, wherever data allowed, to follow the resource flow model proposed by Forum for the Future, in their document *Mass Balance UK* (Linstead and Ekins, 2001). This document presents examples of a limited set of material and product flows. As *City Limits* covered a wider range of materials, products, waste and energy it went beyond the structure set out in the *Mass Balance UK* model.

DEFRA's analysis of the Total Material Requirement (TMR) of the UK was also referred to (Wuppertal Institute for Climate, Environment and Energy, 2001). Although at the time of writing *City Limits* the full methodology was not available. The TMR methodology accounts for the entire material flow through the UK. The boundaries of the TMR show that materials exported from the UK and a 'hidden flows' stream were included in calculations. Due to the inclusion of these two streams, the TMR methodology is not compatible with *City Limits.* However, Domestic Material Consumption (DMC) (production + imports - exports), a step within the TMR methodology, was compatible with *City Limits*' boundaries. DMC was used as the base for deriving UK average consumption, presented in Figure 3 and Tables 23-25.

Direct Energy Flows

Derivation of data sets

GLA provided data on London's energy consumption (by sector and fuel type) (GLA, 2002a). The data included commercial, industrial, domestic and transport sectors. Gas, electricity, solid and oil fuel types were also provided and analysed.

Data on renewable energy was sourced from AEA Technology's *Renewable Energy Assessment* and *Targets for London* (2001) and the DTI's *UK Energy Sector Indicators:* 2001 (Scullion, 2001). These documents provided data on current grid electricity supplied from renewable sources, and the current renewable energy situation in London.

Proxy measures used and limitations

Due to the generally high quality of energy data received from GLA, few proxy measures were necessary. However, as GLA did not provide data on the grid electricity supplied through renewables, proxy measures were used to derive this component. According to the DTI 3% of all electricity in the UK, in 2000, was generated from renewable sources (Scullion, 2001). This percentage was applied to GLA's total electricity figure to derive a renewable energy figure for London. In addition, AEA Technology's (2001) data on energy produced by smaller, private renewable schemes (excluding energy from waste, but including the incineration of biosolids) was added to GLA's energy consumption figure to give a total energy consumption for London.

Material and Waste Flows (including Food)

Derivation of material flows datasets

To carry out a comprehensive and accurate calculation of material flows, four main data points were sought for each material stream.

- Imports into London,
- Production within London,
- Exports from London, and
- Waste production within London.

It was not always possible to track the diverse range of material and product flows through London. This was mainly due to the difficulty in obtaining consistent data for all four data points. Efforts were concentrated on identifying 'big hitter' flows, such as construction materials, which were then further investigated. Materials and products referred to in the European Commission's (EC) priority waste streams were also investigated in detail (Environment Agency, 2000d).

For most materials, UK data from DTLR (CSRGT, 2000) and ONS ProdCom (ONS, 2000c-au) was used to derive some of the estimated flows through London. Comprehensive, but not detailed, data from DTLR's *Continuing Survey of Road Goods Transport* (CSRGT, 2000) was used to derive baseline material and product flow categories. This data included materials and products 'lifted' by origin and destination, for example, tonnes of materials entering and leaving London. DTLR figures used, represented imports to London from other parts of the UK. It was not possible to identify which of these materials had been imported from outside the UK. DTLR export data used represented materials leaving London, however, it was not possible to identify the materials' destination outside the UK.

ONS's ProdCom data (ONS, 2000c-au) was used to provide further detail on the composition of material and product categories reported by DTLR. ONS ProdCom data not only provided a detailed breakdown of components, but also import, export and production data for each material and product. ONS ProdCom data used for imports represented the portion of material imports to the UK consumed in London. It was not possible to identify whether imported materials went directly to London or via other parts of the UK. ONS ProdCom data used for exports represented the portion of materials leaving London for outside the UK. It was not possible to identify whether these materials were exported directly from London or via other parts of the UK.

Product (material) codes, such as NST and SIC, were used to expand on data provided by the DTLR and ONS ProdCom. These codes were also used to assess compatibility between the different datasets.

Product codes

By cross-referencing the different product codes used in the DTLR and ONS ProdCom datasets, it was possible to derive more detailed material and product consumption data. For example, DTLR provided high-level material category data (CSRGT, 2000). The NST codes used by DTLR enabled the identification of materials and products within these categories. To derive consumption figures for the individual NST code-identified materials and products they were cross-referenced with ONS ProdCom codes (ONS 2000c-au). As there was no direct conversion from NST to ONS ProdCom codes, an intermediate stage from NST to CN codes and CN to ONS ProdCom codes (Eurostat, 2002) was required. Table 21 illustrates an example of how codes were correlated to derive material and product consumption figures for London.

Table 21: An example of how NST codes were correlated with ONS ProdCom codes, using the DTLR's miscellaneous manufactures category

DTLR high-level category	NST codes and description	NST to CN code equivalents	CN to ONS ProdCom code equivalents
Miscellaneous manufactures	**96 Leather, textiles and clothing** of which...		
	961 Leather, manufactures of leather and raw hide and skins	41-43, 61	15, 17-19, 36
	962 Textile yarn, fabrics, made-up articles and related products	46, 48, 50-60, 63, 65, 70	17, 18, 20-22, 24, 26, 36
	963 Travel goods, clothing, knitted and crocheted goods, footwear	40, 42, 43, 59-65	18-19, 24-26, 36
	97 Other manufactured articles of which...		
	971 Semi-finished products and manufactured articles of rubber	40, 56	17, 25
	972 Paper and paperboard, unworked	44, 48	20-22
	973 Paper and paperboard manufactures	48	21, 22
	974 Paper matter	48, 49	21, 22
	975 Furniture, new	94	20, 25, 26, 31, 33, 36
	976 Wood and cork manufactures, excluding furniture	44, 45, 84, 94	20, 24, 25, 28-30
	979 Other manufactured articles, n.e.c	34, 36, 37, 39, 85, 90-97	22, 24, 25, 28, 29, 31-33, 36

Sources: Eurostat, 2002; ONS 2000c-au; Turner, 2002

Proxy measures used and their limitations

To derive materials consumption and waste data used in *City Limits* a variety of proxy measures were used.

When UK materials data was the only source available, it was proxied down to the London level using either a per capita, employment, gross domestic product (GDP) or waste generation adjustment.

Per Capita

The simplest method of adjusting UK data was to divide the original data by the UK population and multiply by the London population. This method assumes that every person in the UK consumes an equal amount of the material analysed.

Employment numbers

To proxy UK data more sensitively, the assumption that the percentage of employees working in a certain sector in the UK could be representative of a particular material or product consumed in London can be made. For example, 2.6% of people employed in the UK construction industry were employed in London (Construction Industry Board, 2000). It would therefore be assumed that 2.6% of the UK's total construction materials were consumed in London.

Gross Domestic Product (GDP)

As with the employment assumption above, UK data can also be proxied by GDP. The analysis of GDP figures allows for the identification of contributions made by certain sectors to the London economy. London's GDP figures are then compared to the UK's overall GDP. For example, the construction industry in the UK in 1998 contributed £38,945m, whilst in London it contributed £4,934m (12.7% of the total UK construction industry) (ONS, 2001e). This method assumes that consumption of resources occurs where products are manufactured or services are based.

Waste Generation

Detailed waste data provided a material breakdown of waste generated in London. In order to ascertain the quantities of a product or material consumed in London, London-specific waste data was used as the proxy against national waste data (London data was calculated as a percentage of national waste generated for each material). For example, London produced 15.9% of waste paper generated in the UK (Environment Agency, 2000b-k) . Total UK paper consumption is then proxied to estimate London paper consumption by multiplying it by 15.9%. This method assumes that material efficiency was the same throughout all regions of the UK. For example, the production of one tonne of paper creates the same amount of waste wherever it is made.

In most instances, the waste generation proxy was used as a default, unless another method was more appropriate, such as the per capita proxy, which was used to estimate total food consumption in London. Although, whichever proxy measure is used it will only produce an estimate, and will therefore always be less reliable than raw or primary data. For example, a London-based ProdCom data series could produce significantly different data from estimates proxied from UK ONS ProdCom data.

Derivation of waste data

Waste data was derived from sector specific sources. Commercial and industrial waste production and management data was predominantly sourced from the Environment Agency's *Strategic Waste Management Assessment 2000: London* (Environment Agency, 2000d). Construction and demolition waste data was sourced from London Waste Action and London REMADE (Enviros RIS, 2000a). Household data was gathered from a combination of GLA (2001a) and CIPFA's *Waste Collection and Disposal Statistics: 1999-2000* (2001).

As mentioned above, no single method or source was used to derive waste data for analysis. For example, construction and demolition waste was derived from three different sources:

1. London REMADE provided data on the amount of waste generated by the construction and demolition sector in London in 1999. To obtain a 2000 figure, the 1999 total was proxied using a projected 5.5% growth rate per annum. This assumption was adopted from London REMADE and was based on London's projected GDP growth rate per annum (Enviros RIS, 2000a).

2. Construction and demolition waste generated by London's commercial and industrial sector was obtained from the Enivornment Agency's *Strategic Waste Management Assessment: London* (2000d). This data was recorded for 1998 and was also proxied (by GDP as above) to derive a 2000 figure.

3. CIPFA provided data on construction and demolition waste recycled by London households. London REMADE recorded that 73% of construction and demolition waste was reused and recycled in 1999 (Enviros RIS, 2000a), which was assumed for 2000. Using this data, total construction and demolition waste, generated by households, was estimated.

By combining figures from the above three sources, it was possible to derive a total estimate of construction and demolition waste for London. Landfill and recycling rates were also derived from these sources.

Transport

Derivation of data sets

Fuel consumption and passenger-kilometres (pass-km) travelled were the two key datasets used to derive transport use in London. Materials associated with vehicle production were accounted for in the materials component.

Proxy measures used and limitations

No proxy measures were needed for GLA's fuel consumption data as it was already in a usable format. However, proxy measures were required to derive some of the pass-km calculations for London. ONS' *Regional Trends (36)* (McGinty and Williams, 2001) provided information on the average distance travelled per person per annum (in miles) in London by car, taxi, rail (including London Underground), bus, walking and cycling.

Data provided in *Regional Trends (36)* did not distinguish between rail and the London Underground. In order to distinguish between these two modes, London Transport's (Espiñeira and Haslam, 2001) pass-km data for the underground in 1998/ 99 was subtracted from the *Regional Trends (36)* total rail pass-km figure.

London air travel data was derived from UK-wide figures and proxied down using the per capita methodology (DTLR, 2002). It was assumed that Londoners travel the same distance by air as the average UK citizen.

Water

Derivation of data sets

Data on London's water consumption was provided by the Environment Agency (Rice, 2002). The data covered Thames Water's London resource zone, as well as parts of Three Valleys, Sutton and East Surrey. This ensured that water consumed within the Greater London boundary was accounted for.

Proxy measures used and limitations

The data provided was reported in Megalitres (Ml) consumed per annum and therefore required no proxying. The figures were sub-divided into household (metered and un-metered) and non-household (metered and un-metered) water consumed, as well as water leakages. Non-household water consumption was effectively regarded as industrial and commercial water consumption.

Tourism and Day Visitors

Tourists and day visitors to London also contributed towards the final consumption figures for London. Although there was good tourism data on numbers and length of stay (London Tourist Board, 2000), data on the amount consumed by tourists in London was much harder to estimate (and not possible to ascertain within this project's time frame). It was also difficult to estimate the amount consumed by the 1.1 million commuters who entered London daily (TfL, 2000b).

For the above reasons, tourists and commuters were only taken into account when the ecological footprint was calculated (see the Ecological Footprint Analysis Results section).

It was difficult to estimate the amount consumed by the 1.1 million commuters who entered london daily.

Ecological Footprint Analysis Methodology

What is an Ecological Footprint Analysis?

Although ecological footprint analysis only gained widespread publicity in 1995, it has rapidly taken hold and is used in many countries at national and local levels, such as Australia, Canada, Denmark, Holland, Italy, Mexico, Northern Ireland, Norway, Scotland, Spain, Sweden, the United States of America and Wales[6].

The ecological footprint of a region or community can be viewed as the bioproductive area (land and sea) that would be required to sustainably maintain a region or community's current consumption, using prevailing technology. Imagine a glass dome over London - what area would this dome have to cover to ensure that the population could maintain their current lifestyles using only the productive area enclosed within the dome?

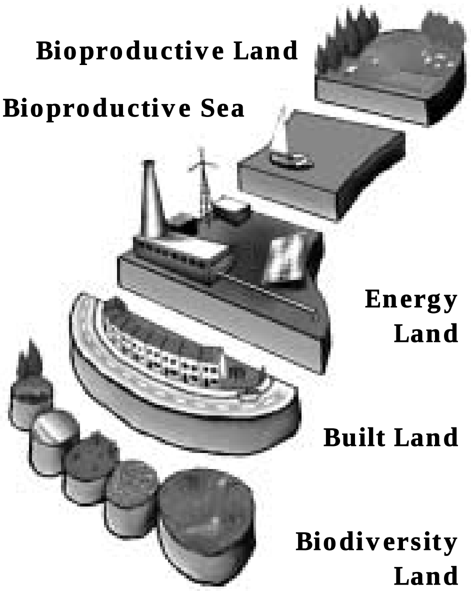
For the purposes of calculating the ecological footprint, the bioproductive area is divided into four basic types:

- **Bioproductive land**
- **Bioproductive sea**
- **Energy land** (forested land required for the absorption of carbon emissions[7]), and
- **Built land** (such as, buildings and roads)

A fifth land type, **biodiversity land**, refers to the area of land that would need to be set-aside to preserve biodiversity (see Figure 18).

The following examples illustrate how the four types of bioproductivity are interlinked when an ecological footprint is calculated.

Figure 18: The bioproductive categories used for ecological footprinting



Example 1:

A cooked meal of fish and rice would require bioproductive land for the rice, bioproductive sea for the fish, and forested 'energy' land to re-absorb the carbon emitted during processing and cooking.

Example 2:

Driving a car requires built land for roads, parking and so on, as well as a large amount of forested 'energy' land to re-absorb the carbon emissions generated from petrol use. In addition, energy and materials are used for construction and maintenance of the vehicle.

Once an ecological footprint has been calculated it can be apportioned (normalised) in different ways, or used to investigate future scenarios. For example, by comparing an average London resident's use of bioproductive area with the average 'earthshare', it is possible to estimate ecological sustainability.

The *Living Planet Report* and *Footprint of Nations* Accounts

The Footprint of Nations, published as part of WWF's *Living Planet Report* (Loh, 2000), is a series of ecological footprint calculations for countries, prepared by Wackernagel and his research team at Redefining Progress, California and the Centre for Sustainability Studies, Mexico.

To enable comparisons between countries with various bioproductive capabilities, the ecological footprint is presented in global hectares (gha). One global hectare is equivalent to one hectare of biologically productive space with world average productivity.

1 gha = 1 ha of biologically productive space with world average productivity

To convert different land and sea types (with their differing productivities) into standardised global hectares a set of equivalence factors are used. These factors are subject to change due to both improved data availability and variability in the bioproductivity of the planet over time. The values used in *City Limits* are the most recently available at the time of writing.

Care has been taken in *City Limits* to ensure compatibility with the *Living Planet Report* (Loh, 2000) calculation methodology, though different data sources have been used to determine consumption.

The Component Approach: The EcoIndex™ Methodology

To enable the broad categories of consumption, set out in both *Living Planet Reports* (Loh, 2000 and Wackernagel, 2002) and associated *Footprint of Nations* (Wackernagel *et al*, 2000) accounts, to be explored in more detail for London, it is necessary to adopt a component-based approach to analyse the ecological footprint. The EcoIndex™ Methodology (Chambers, Simmons and Wackernagel, 2000) is compatible with the *Living Planet Reports*' accounts, but takes its starting point with resource consumption data, rather than trade data, to allow the ecological footprint to be calculated for a range of smaller and more pedagogic components. For example, to calculate the ecological footprint conversion factor for car travel, data on fuel use, materials and energy for manufacture and maintenance and road space appropriated are analysed to determine the footprint per pass-km (see Table 22).

A similar approach was used to derive a range of ecological footprint conversion factors, representing the main categories of environmental impact, before calculating the total ecological footprint of London. The key components used in this study were:

- **Energy use**
- **Materials consumption** (including food consumption and waste generation)
- **Passenger transport**
- **Freight transport**
- **Water use,** and
- **Built** (degraded) **land**

Many of these components were broken down into smaller sub-categories. For example, passenger transport was further broken down into mode of travel and energy by fuel type and sector.

The Snap Shot Approach

It is important to note that ecological footprint analysis is a 'snapshot' methodology. Based on a year-specific data set, an ecological footprint tells us how much bioproductive area would be required to support London's current lifestyle (it does not attempt to predict future or past impacts). It is likely that, due to technological changes and variations in material flows through the economy, the ecological footprint will change over time.

The Geographical and Responsibility Accounting Principles

In this study, a fundamental decision was whether the aim of *City Limits* was to calculate the footprint of London (geographical principle) or Londoners' consumption (responsibility principle). These two approaches can give very different answers. As an example, how do we account for Heathrow Airport? Do we include the full impact of all the airport's activities as part of London's footprint (geographical principle) or estimate only the part of the impact that is attributable to the Londoners who use the airport (responsibility principle)? This study calculated Londoners' ecological footprint using the responsibility principle, as this is most compatible with other global, regional and city studies (see Lewan and Simmons (2001) for a discussion on 'responsibility' versus 'geographic' principle).

Table 22: An example analysis for the footprint of UK car travel, per pass-km

Component	Inputs	CO_2 emissions	Built-upon land	Footprint
Petrol	0.094 litres	0.22 kg		0.000031 **ii** gha
Maintenance & manufacture	0.0423 litres equivalent	0.10 kg		0.000014 **iii** gha
Road space	258,175 ha		**a** 817,043 gha*	
Car road share	**b** 86%			
Car km (millions)	**c** 362,400			
Average occupancy	**d** 1.6 persons			
Calculation			**(a x b)/c/d**	**i + ii + iii**
Footprint			0.0000012 **i** gha	**0.000046** gha/pass-km

Sources: (DETR, 1997; DETR, 1999 and Wackernagel and Rees, 1996)

* This figure is the 'global average' land equivalent to the actual UK area built on by roads

The ecological footprint of the Greater London geographical area

If all the materials and energy identified within the resource flow analysis were assessed, the footprint of Greater London would be 66,991,479 gha, which is equivalent to 9.08 gha per capita[8].

Although this is an accurate account of the consumption of the London geographical area, it does not reflect the consumption of Londoners (individuals). Consumption recorded in the geographical resource flow analysis includes resources consumed by commuters and visitors (for example food and travel), industrial processes and commercial services (whose products are consumed elsewhere), associated waste, transportation and energy impacts.

The geographical principle is incompatible with the ecological footprint. The ecological footprint aims to apportion consumption impacts to the individual so that consumption can be compared with the sustainable earthshare (the average available global supply of resources per person). Therefore, the responsibility principle has been adopted for the *City Limits* ecological footprint analysis.

The ecological footprint of Londoners

To convert the geographical resource flow analysis to the responsibility principle ecological footprint, two main adjustments were made. Firstly, double counting, which occurs within the ecological footprint conversion factors and some data sources, was subtracted. Finally, resources consumed within London, but not by Londoners, were also subtracted.

Adjusting for double counting

As referred to above (see the first part of the Methodology section), double counting was inherent in some of the data sources (notably ONS ProdCom (2000c-au) and DTLR (CSRGT, 2000)), as well as in some of the ecological footprint components.

Table 23: The excluded raw construction material sub-components

Construction material	Ecological footprint ('000s gha)
Gravel	13
Rock & stone	120
Sand	12
Clay	4
Minerals	1
Other crude materials	114
Total	**262**

Inherent double counting in the above two data sources was addressed by removing categories that were most likely to contain double counting. In ONS ProdCom (ONS, 2000c-g, j) double counting was assumed in the construction materials, which recorded 'raw' products, such as clay, as well as bricks and tiles made of clay. Therefore, the raw construction products were excluded (listed in Table 23).

To address the double counting within the footprint components, energy, water and transport were adjusted.

The energy component was adjusted in two ways. Firstly, industrial energy use was excluded to avoid double counting the energy embodied within consumed goods accounted elsewhere (see Table 24). Secondly, adjustments were made to the energy supply needed to treat water, by adding the proportion used for personal use, back into the water component.

Table 24: The excluded industrial energy sub-components

Energy	Ecological footprint ('000s gha)
Industrial gas	1,254
Industrial grid electricity	862
Industrial oil	298
Industrial coal	10
Total	**2,424**

The transport component was adjusted, to extract double counting, by removing the freight transport component (see Table 25). All freight transport impacts were assumed to be included within the conversion factors for consumed goods.

Table 25: The excluded freight transport component

Energy	Ecological footprint ('000s gha)
Road	961
Rail	23
Water	28
Pipeline	0
Total	**1,012**

Aligning the responsibility principle

To convert the geographical (London) resource flow analysis to a responsibility (Londoners) ecological footprint, the materials not consumed by Londoners were removed. The materials identified fell into four main categories:

- **Food consumed by non-Londoners**
- **Commercial institutions** which do not serve the local community, such as the global financial sector (see the City of London vignette)
- **The industrial sector,** whose products were assumed to be consumed by non-domestic end-users, and
- **The general resource use of London's tourists**

The food consumed by non-residents in London was easily identified, as the DEFRA's *National Food Survey* (ONS, 2001d) gave data on food consumed by Londoners in their homes, as well as food eaten, for example, in restaurants. Food eaten out was subtracted from the total food consumed in London to derive food consumed by non-residents. The amount of food consumed by non-Londoners, which was excluded from the ecological footprint analysis, was calculated to have an ecological footprint of 5,942,000 gha.

Regarding data on the resource use of commercial institutions that serve a wider community, this was very difficult to obtain or remained unrecorded. In addition, data on the use of built-upon and degraded land did not allow a break down of use, such as residential housing or industrial estates. Therefore, due to a lack of data these resources could not be subtracted from the ecological footprint analysis, which could have resulted in an over-estimate of the *City Limits* ecological footprint.

Table 27: London land types, by hectare and yield factors

Land use type	Hectares	Yield factor
Sea/estuary	1,000	1.00
Arable farmland	9,700	2.83
Managed grassland	42,000	7.07
Forestry & woodland	6,800	1.25
Semi-natural vegetation	3,700	7.07
Urban	110,000	2.83
Inland water	1,800	1.00
Total	**175,000**	

Source: Environment Agency, 2000d and Loh, 2000

The resource use of the industrial sector was estimated. The Environment Agency's *Strategic Waste Management Assessment: London* (2000d) gave the total industrial waste generated in London as 3,050,000 tonnes. This data was converted to estimate the amount of materials consumed in order to produce this waste, by identifying the amount of waste produced per tonne of material consumed throughout London. The industrial waste total was then divided by the general waste production rate in London to produce an estimated 5,961,000 tonnes of materials consumed by the industrial sector. The materials assumed to make-up the 5,961,000 tonnes were based on identifiable industrial waste data and a general mix of materials consumed in London. The results of this process are shown in Table 26.

The general impact of resource use by tourists was also considered. Tourists who visit London, whether staying a number of nights, or a number of hours, consume resources. Without any adjustments to the footprint accounts, these would be allocated entirely to the resident population.

Table 26: The excluded industrial materials and waste sub-components

Component	Consumption (1000s of tonnes)	Ecological footprint (1000s gha)
Construction & demolition materials	217	16
Metals	305	152
Chemicals	782	1,861
Paper	784	2,435
Other miscellaneous manufactures	369	1,336
Unidentified waste assumed as a general mix of materials	3,504	4,057
Total	**5,961**	**9,856**

The size of London tourists' impact on the city was also estimated. This was achieved by comparing the number of bed nights that tourists stayed in London, with the number of bed nights Londoners spent in the city[9]. In order to calculate the ecological footprint of London tourists, it was conservatively assumed that tourists and Londoners consumed equal amounts of resources. Using this method, it was possible to estimate that tourists contributed approximately 4.6% to London's total resource use.

Ecological Supply: The Biocapacity Analysis

To balance *City Limits*' ecological account, an analysis of ecological supply (local biocapacity) was presented alongside ecological demand (the ecological footprint). The biocapacity analysis estimated the bioproductivity of the local area (Greater London) in global hectares (the same unit as the ecological footprint).

To estimate the biocapacity of the London area, three steps were followed. Firstly, the various land and sea types within this area were defined (see Table 27). Secondly, a yield factor (calculated by Wackernagel *et al*, 2000) was applied to each land and sea type. These yield factors accounted for the differences in bioproductivity between local (in this case the UK) and global land types (see Table 27). A positive yield factor represented a bioproductivity greater than the global average. A global average bioproductivity was used for fishing grounds (sea/estuary and inland water).

Finally, the different land types were converted into global hectares using *Living Planet Report* (Loh, 2000) equivalence factors.

Comparison of Londoners Ecological Footprint to Other Studies

The ecological footprint is a very popular concept and has been applied widely using various methodologies (Lewan and Simmons, 2001). This variation in methods, further distorted by data quality and availability, produces a wide range of results, which are not always easily comparable.

The studies selected for their comparability with *City Limits* (Guernsey, Herefordshire, the Isle of Wight, Oxfordshire and Wales) all used the EcoIndex™ Methodology (Chambers, Simmons and Wackernagel, 2000), *Living Planet Report* (Loh, 2000) equivalence factors[10] and annually recorded, official statistics. However, the *City Limits* study is not strictly comparable, as it captured a larger amount of material and food flows data than the other studies (see Table 3). This was due to the quality and extent of data available. To gauge London's ecological performance on a comparable level, the ecological footprint needed to be adjusted.

Four adjustments were made. Firstly, by using a materials focus it was possible to derive estimates of stock build-up by subtracting waste from apparent consumption. However, this stock accumulation estimate might also mask double counting inherent within some data sources. Previous component studies have only managed to account for materials that became waste within the study year. Therefore, the first adjustment was to only account for the waste materials.

Secondly, food consumed by Londoners eating out was included in *City Limits*, but was not included in the other studies. Therefore, food eaten out was also excluded.

Thirdly, a new water conversion factor, which accounted for the treatment of wastewater as well as the supply of water, was used in *City Limits*. This conversion factor was not used in previous studies. Because of this, an assessment of London's water consumption was re-analysed using the water conversion factor applied to previous studies.

Finally, *City Limits* reports the biodiversity area as a proportion of consumption (in line with the *Living Planet Report* methodology (Loh, 2000), rather than as a proportion of biocapacity (as used in the comparable studies). Therefore, an adjustment was made to remove the biodiversity area from the *City Limits* analysis.

The adjusted ecological footprint of Londoners is comparable to the *Living Planet Report* (Loh, 2000) methodology, and the per capita ecological footprints of Guernsey (Barrett, 1998), Herefordshire (BFF, 2001), the Isle of Wight (BFF and Imperial College of Science & Technology, 2000), Oxfordshire (BFF, 1999) and Wales (WWF Cymru, 2002). A second set of comparisons was also made between the Londoners adjusted ecological footprint and five Scottish cities. (See the Ecological Sustainability Assessment in the Results section).

Need for a comparative methodology

As previously mentioned, ecological footprint analysis has become an increasingly popular methodology for measuring, monitoring and communicating environmental sustainability. Regional analyses have been completed by a wide and varied group of organisations. This has led to variations in methodology and therefore makes comparisons between regions difficult.

In recognition of the need to derive a common methodology, the European Common Indicators Programme (ECIP)[11] commissioned Lewan and Simmons (2001) to review, in consultation with several EU practitioners and Wackernagel, the methodologies used in seven European regional ecological footprint studies, and to recommend a way forward. Their final report set out a framework for a common European ecological footprint methodology. This 'common' methodology is currently in the process of being piloted in five European cities.

The *City Limits* footprint methodology is compatible with the emerging ECIP framework, which in turn is consistent with the *Footprint of Nations* report (Loh, 2000).

Also relevant to *City Limits* is a project, by DTLR's New Horizons Programme, to develop a UK ecological footprint model and tools. The model is intended for use by local authorities, and even though it will not produce results as detailed as those reported in *City Limits*, it is nonetheless important that the results are comparable. Stockholm Environment Institute, York and BFF are the collaborators on this project, and are committed to ensuring compatibility with both the ECIP and *City Limits* methodology.

Scenarios Methodology

The *City Limits* scenarios attempt to provide quantifiable answers to three questions:

1. If London continues to consume resources in line with trends of the last few decades, how far from sustainability will London be in 2020? ('business as usual' scenario)
2. How much closer to sustainability would current policy targets take London by 2020? ('evolutionary' scenario)
3. What would London and its residents need to do to achieve interim ecological sustainability targets, as defined by the ecological footprint, by 2020? ('revolutionary' scenario)

While some useful work has been carried out on developing scenarios for sustainability (for example, the *Foresight* project and *World Business Council for Sustainable Development (WBCSD) Global Scenarios 2000-2050*)[12], the majority of work has come from a social and economic rather than an ecological perspective, with a predominantly qualitative rather than quantitative focus.

The scenarios presented in *City Limits* have been developed specifically to draw on quantifiable data and targets on resource use, and do not address social and economic implications. Linking social, economic and ecological perspectives is an area, which would benefit from further research.

There may be a variety of ways to achieve ecological sustainability, such as through reduced consumption or more efficient production technology. Population changes obviously also have effects. The *City Limits* scenarios focus mainly on altering consumption patterns.

Consumption patterns could be changed in various ways to achieve sustainability. For example, an individual may chose to 'save' their consumption 'budget' by commuting by bicycle or public transport and 'spend' their budget on a holiday flight. A rural community, for example, may choose to 'save' their budget by decreasing materials consumption and implementing state of the art recycling, while 'spending' their budget on a car based transport system. These are political decisions, and as such *City Limits*' scenarios do not recommend any particular path towards sustainability. An attempt has been made to quantify the impact of various possibilities on sustainability.

The revolutionary scenarios were developed to explore what changes to consumption patterns would be required by 2020 to make London sustainable by 2050. Sustainability by 2050 was defined as the per capita ecological footprint of the average Londoner being equal to the available earthshare in 2050. The earthshare depends on both the available productive area and the size of the global population. Both can vary over time.

These calculations are presented below, and have been projected for Londoners along a linear trend, from 2000 to 2050 (Table 28). The predicted earthshare figure of 1.44 (down from 2.18 in 2000) was based on a global population projection of 8.9 billion in 2050 (UNEP, 2000) and the assumption that global productivity will remain unchanged.

Table 28: Per capita ecological footprints and percentage 2020 reduction targets required to achieve ecological sustainability for Londoners by 2050, with and without a 12% biodiversity allowance

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Excluding biodiversity (gha)	6.63	5.59	4.55	3.52	2.48	1.44
% reduction from 2000		16%	31%	47%	63%	78%
Including biodiversity (gha)	7.53	6.31	5.09	3.88	2.66	1.44
% reduction from 2000		16%	32%	49%	65%	81%

Business as usual scenarios were based on trend data gathered from years preceding 2000. Evolutionary scenarios were based, wherever possible, on published policy targets at local, national or international levels.

Wherever possible, an attempt was made to include actions, which were relevant to all sectors of London's society, such as individuals in the home, national and local policy makers, and businesses.

The website **www.citylimitslondon.com** provides an interactive scenario model where the effects of a variety of options to reduce London's ecological footprint can be selected and illustrated accordingly.

Endnotes

Resource Flow Analysis Results

1 Miscellaneous manufactures and miscellaneous articles are categories used by DTLR (CSRGT, 2000). Due to project time constraints, it was not possible to identify all materials and products in these two categories.

2 In order to compare consumption per capita between the three studies the components included in the total materials figure had to be similar. For this reason petrol and diesel, which was accounted for under the energy rather than materials section for London, was also omitted for the Isle of Wight and UK.

3 Priority Waste Streams are waste identified by the European Commission (EC) as posing a potential threat to the environment. Wastes identified are: construction and demolition waste, packaging waste and accredited reprocessor, batteries, solvents, oils, polychlorinated biphenyls (PCBs), tyres, end of life vehicles (ELV), fragmentiser waste, waste electrical and electronic equipment (WEEE) and fluorescent tubes.

Ecological Footprint Analysis Results

4 These figures are rounded. All other energy sources accounted for 0.29% of the energy ecological footprint.

Ecological Sustainability Assessment

5 The component boundaries for Guernsey differ from the other studies. The embodied energy and transport impacts usually associated with materials have been assigned to energy (438% larger than the lowest, Isle of Wight and 203% larger than the next highest, Oxfordshire). Hence, they are very high compared to the other studies, but the materials and waste component is low (77% lower than the next lowest, Herefordshire, and 86% lower than the highest, Oxfordshire).

Ecological Footprint Methodology

6 Those wishing to understand more about ecological footprinting (its benefits, strengths and weaknesses) are referred to two background papers, which can be downloaded at www.bestfootforward.com

7 Assimilation of CO_2 emissions by forests is used to indicate fossil fuel use for two main reasons. Firstly, the common use of planting forests as a method for abating anthropogenic CO_2 emissions. Secondly, the assimilation method produces conservative results when compared to other approaches; such as the amount of bioproductive area required to produce an equivalent amount of energy.

8 This figure has been adjusted to remove double counting by conservatively removing industrial energy use - which is included as part of the consumption of goods and services - and freight transport - which is similarly accounted as part of individual items of consumption.

9 Bed nights spent by Londoners in London was assumed as population multiplied by 365 nights, minus bed nights that Londoners spent elsewhere (only Londoner bed nights spent abroad were available). Bed night data sourced from the London Tourist Board (2000), for 1998 to 2000, also included day visitors to London. However, data regarding bed nights spent abroad by Londoners was last reported for 1998 (ONS, 2000b).

10 The Guernsey, Isle of Wight and Oxfordshire studies are not strictly comparable as they used the equivalence factors from the previous *Footprint of Nations* study (Wackernagel *et al*, 1999). The affect of this is that the ecological footprints will be slightly over-estimated. Even though the Isle of Wight's ecological footprint is slightly over-estimated, it remains the lowest of the regional comparisons.

11 European Common Indicators Programme (ECIP) is managed by Ambiente Italia on behalf of the European Commission.

Scenario Methodology

12 For further information on the Foresight Project visit www.foresight.gov.uk, and the WBCSD Global Scenarios visit www.cfsd.org.uk/events/tspd6/tspd6_scenarios.html

Appendix 1

Best Foot Forward would like to thank the following organisations for providing data and assistance

Association of London Government*
Biffaward
Biffa Waste Services
Bioregional Group
British Egg Industry Council
British Glass
British Potato Council
Building Research Establishment
British Retail Consortium*
Building Services Research & Information Services
Chartered Institute of Public Finance & Accountancy
Community Energy (Energy Savings Trust)
Corporation of London*
Department of Environment, Food & Rural Affairs*
Department of Trade & Industry
Department of Transport & Local Regions
Driver & Vehicle Licence Agency
Enviro-Logic Ltd
Environment Agency
Environment Agency (Thames Region)*
Forum for the Future
Greater London Authority*
Government Office London
Industry Council for Packaging & the Environment
IWM (EB)
London Borough of Kensington & Chelsea
London Borough of Richmond upon Thames*
London Cycling Campaign*
London Farmers' Markets*
London First*
London REMADE*
London Tourist Board*
London Waste Action*
Office of National Statistics*
Port of London Authority
Quarry Products Association
Smithfield's Market
Soil Association
Solar Century
Sustain: The alliance for better food & farming*
The Institution of Civil Engineers
Transport for London*
Viridis
WasteWatch*
Water UK
Women's Environment Network

*** Organisations visited for data**

Organisations referred to for data (i.e. not visited or contacted directly)

Aluminium Federation Ltd
Berrymans & Sons
Billingsgate Fish Market
Brick Development Association
Business Link
Centre for Independent Transport Research in London
Dairy Industry Federation
Ealing Community Group: Transport/Recycling/Engineering
East London Waste Authority
Edmonton Incinerator
Electricity Association
Environmental Services Association
Eurostat
Friends of the Earth (London)
HM Customs & Excise
Imperial College, Centre for Environment Technology
Industry Council for Electronic Equipment Recycling
Independent Transport Commission
Institute of Civil Engineers
Institute of Waste Management
Iron & Steel Statistics Bureau
London 21 Sustainability Network
London Borough of Brent
London Borough of Bromley
London Borough of Camden
London Borough of Croydon
London Borough of Enfield
London Borough of Hammersmith & Fulham
London Borough of Hillingdon
London Borough of Hounslow
London Borough of Lewisham
London Borough of Westminster City
London Development Agency
London Ecology Centre
London Electricity
London Research Centre
Newsquest (London)
North London Waste Authority
Railtrack Plc
Transco
Wastebusters
West London Waste Authority
Western Riverside Waste Authority
WRC plc

Note: Not all data obtained from these organisations was used in the final report

Other Contacted Organisations

These organisations did not or were unable to provide data:

Airfields Environment Trust
Asda Stores Ltd
Ashted Trust
Associate Parliamentary Sustainable Waste Group
Associated British Ports
Association for the Conservation of Energy
Association of Consulting Engineers
Association of Electricity Producers
Association of Franchised Distributors of Electronic Components
Association of Manufacturers of Household Appliances
Association of Plastics Manufacturers in Europe
Association of Suppliers to the Furniture Industry
Automobile Association
Aviation Environment Federation
AW Lawson & Company Ltd
Aluminium Packaging Recycling Association
Biogas Association
British Plastics Federation
British Association of Toy Retailers
British Biogen
British Cement Association
British Coatings Federation
British Compressed Gases Association
British Energy
British Lime Association
British Printing Industries Federation
British Recovered Paper Association
British Retail Consortium
British Rubber Manufacturers Association
British Telecom
British Water
Business in the Community
Bywaters (Leyton) Ltd
Cakebread Associates
Confederation of British Industry: London region
Central London Partnership
Centre for Sustainable Energy
Chemical Industries Association
Chingford Council
Construction Industry Council: Sustainability Committee
Construction Industry Research & Information Association: Construction Industry Environmental
Civic Trust
Civil Engineering Contractors Associations
Cleanaway
Central & Local (Government) Information Partnership
Co-operative Stores
Common Ground
Community Development Foundation
Composting Association
Confederation of Paper Industries
Construction Industry Confederation
Construction Industry Council
Cornwall County Council
Corrugated Packaging Association
Corus
Cory Environmental Ltd
Councils for Climate Protection Programme
Countryside Agency: South East & London Regional Office
Collaborative Research in the Economics of Environment & Development: North Europe: Environment Energy & Waste Research Centre
Davies Langdon & Everest
Department of Environment, Food & Rural Affairs: Environment Protection Statistics & Information Management
Department of Environment, Food & Rural Affairs: Sustainable Development Unit
Department of Environment, Transport & Regions: Sustainable Development Committee
Department of Health
Domestic Tourism Branch
Domestic Fowl Trust
Eastern Energy
EcoConstruct
Environment Exchange
Energy from Waste Association
Energy Conservation & Solar Centre
Energywatch
English Tourist Board
English, Welsh & Scottish Railways
Environment Council
Environmental Services Strategy
Ernst & Young
Essex County Council
Essex & Sussex Water
Exel Logistics
Fairtrade Foundation
Farmaround
Federation of the Electronics Industry
Federation of Small Businesses: Greater London
Fit Buildings Network
Food & Drink Federation
Food Commission
Food Service Intelligence
Forest Forever
Forestry Commission/Forest Enterprise
Freightliner
Freight Transport Association
Fresh Food Company
Global Action Plan
Greater London Enterprise
Green Alliance
Greener World Ltd
Greenpeace: London
Greenwich Millenium Village
Groundwork: Regional Office for London, South East & Eastern Regions
Glasspac
Government Office for London
Hackney Environment Forum
Hannay Recycling
Hanson Waste Management & Recycling
House Builders Confederation
Improvement & Development Agency
International Institute for Environment & Development
Institute of Packaging
Institute of Petroleum
International Hotels Environment Initiative
Islington Green Party

J Sainsbury plc
Johnson Controls
Kingston Sustainable Initiative
KPMG
Local Authority Recycling Advisory Committee
Local Government Management Board
London Biodiversity Partnership
London Borough of Barking & Dagenham
London Borough of Barnet
London Borough of Bexley
London Borough of Ealing
London Borough of Greenwich
London Borough of Hackney
London Borough of Haringey
London Borough of Harrow
London Borough of Havering
London Borough of Islington
London Borough of Kingston-upon-Thames
London Borough of Lambeth
London Borough of Merton
London Borough of Newham
London Borough of Redbridge
London Borough of Southwark
London Borough of Sutton
London Borough of Tower Hamlets
London Borough of Waltham Forest
London Borough of Wandsworth
London City Airport Consultative Committee
London City Business Library
London Community Recycling Network
London Chamber of Commerce & Industry
London Development Agency
London Docklands Development Corporation
London Energy & Environment Group
London Planning Advisory Committee
London Regional Transport
London Springs Ltd
London Sustainability Exchange
London Underground Ltd
London Vegans
London Waterway Partnership
London Planning Advisory Committee
LP Gas Association
Made in London Consortium
Manufacturing Systems Integration
Manweb (Scottish Power)
Marks & Spencer
McGovens
Metropolitan Water Company
Motor Manufacturers Association
National Consumer Council
National Farmers' Union
National Grid
National Materials Handling Centre

National Travel Wise Association: London
National Trust
New Covent Garden Market
New Economics Foundation
Newspaper Publishers Association
NHS Executive: London Region
North London Green Business Network
North Surrey Water
npower
Office of the Gas & Electricity Markets
Office of Water Services
Onyx Environmental Group
Office of The Passenger Rail Franchising
Organic Delivery Company
Packaging Federation
Paper Agents Association
Paper Federation of Great Britain
Petroleum Retailers Association
Pipes Group (part of British Plastics Federation)
Pro Carton
Pulp Faction Recycling
Rail Freight Group
Ready-Mix Concrete Bureau
Real Nappy Association
Royal Commission on Environmental Pollution
Royal Docklands Management Authority
Road Haulage Association
Royal Institute of British Architects
Safeway
South East London Combined Heat & Power
Scottish & Southern Electric Plc
SITA
Simply Organic
Small Business Service
Society of British Water Industries
Soil Association
Somerfield Stores
South East England Forest District
Spitalfields Fruit & Vegetable Market
Strategic Rail Authority
StarUK
Steel Can Recycling Information Bureau
Suffolk Water
Sustainable London Trust
Sutton & East Surrey Water
Tesco Stores Ltd
Textile Recycling Association
Thames 21
ThamesBank
Thames Water Utilities
Timber Research and Development Association
Timber Trade Federation
Transport Planning Society
Trees for London
Trust for Urban Ecology
Transport 2000
TXU-Europe
UK Agricultural Supply Trade Association
UK Steel Association
UK Petroleum Industry Association
Valuplast
Waitrose Ltd
Waste & Resources Action Programme
Waste Recycling Group
West London Friends of the Earth
Western International Market
Women's Environmental Network
World Travel & Tourism Council (WTTC)
Wren Conservation & Wildlife Group
Yorkshire Electricity Group

Appendix 2

Data Availability and Quality by Component

Direct Energy

Key data sources: AEA Technology (renewable energy) (London)(AEAT, 2001); DTI (UK) (Scullion, 2001) and GLA (London)(2002a & b). Thumin, of GLA, had done extensive modelling for projected energy usage. This data was used in the *City Limits* energy scenario.

Other data sources: *Digest of UK Energy Statistics (DUKES)* (Scullion, 2001) and Intergovernmental Panel on Climate Change (IPCC) (2000) for CO2 emissions data; DTI's *UK Sector Energy Indicators* (2001c); *London Energy Study* (Chell and Hutchinson, 1993) and TRANSCO (London) (2001).

Data gaps, problems and recommendations: No attempt was made to access energy consumption data from primary sources, as this type of data was limited and often unavailable for confidentiality reasons.

Materials

Key data sources: DTI (SE Region & UK) (2001b); DTLR's *Continuing Survey of Road Goods Transport* (CSRGT, 2000); Industry Council for Packaging & the Environment (UK) (INCPEN, 2001); ONS's *Family Expenditure Survey* (London) (2001a) and ONS's ProdCom data (UK) (2000c-au).

Other data sources: AEA Technology (AEAT, 2001); Industry Council for Electronic Equipment Recycling (UK) (ICER, 2000); London REMADE (Enviros RIS, 2000a & b); Quarry Products Association (London & SE Region) (Griffiths, 2001); Viridis' Tyre mass balance study (UK) (Hird *et al*, 2001).

Data gaps, problems and recommendations: Significant gaps were identified in the materials component. London data was almost non-existent, and had to be proxied down from regional and national level data. Some relevant data for bulk goods was available at the SE Region level, but it focussed on common construction materials, such as bricks, concrete, sand and gravel. There was little or no data on bulk usage of glass, plastics or timber. ONS ProdCom data has the potential to fill this data gap, although it is not currently available on a regional basis. Discussions with ONS suggest that it might be possible to provide this data at a regional level, but only if issues of cost and commercial confidentiality are resolved.

Where possible, data produced in legislative and performance monitoring reports, for example recycling, energy and CO_2 emissions, was used. However, this data often concentrated on one stage of a product or life cycle processes. More detailed life cycle data could improve the accuracy of future ecological footprint analyses.

Waste

Key data sources: CIPFA returns (London) (2001); DETR (2000c); Environment Agency's *Strategic Waste Management Assessment: London* (2000d) and (2001); GLA's *Draft Municipal Waste Management Strategy* (2001a); London REMADE and London Waste Action (Enviros RIS, 2000a & b).

Data gaps, problems and recommendations: During the initial data collection phase, no significant gaps were identified. The quality of data received from key sources was good and relevant for our requirements. Even though many sources provided waste data, most referred to similar primary sources, such as CIPFA returns and Environment Agency's *Strategic Waste Management Assessments.*

Data gaps were identified in the data analysis phase, and revealed a need to find more construction and demolition waste arisings data, as well as a detailed breakdown on electrical and electronic equipment waste (WEEE).

It was hoped that the *Packaging Recovery Notes* (PRN's) produced by companies, as an obligation to the Producer Responsibility Obligations (Packaging Waste) Regulation 1997 (Wastepack, 2001), would serve as a useful source of information. There is a central registry for accredited reprocessors recording annual tonnages of packaging waste recycled - The Environment Agency, National Waste Registration Unit - Producer Responsibility. Possibly for reasons of commercial confidentiality, data is not published at a regional level.

Food

Key data sources: DEFRA's *National Food Survey* (London) (ONS, 2001d); INCPEN (UK) (2001) and ONS ProdCom data (UK) (2000i, k-ab).

Other data sources: DEFRA (2001); ONS's *Family Expenditure Survey* (London) (2001a) and Sustain (London) (Garnett, 1999 and Jones, 2001).

Data gaps, problems and recommendations: Data for the domestic consumption of food was generally good, however ONS ProdCom data was proxied down to provide a more detailed estimate of the total tonnage of food consumed in London. This was cross-referenced with London-specific DEFRA's *National Food Survey* data (ONS, 2001d).

Food consumption in non-domestic sectors, such as schools and hospitals was not available. Data on London food flows and food products was also poor. However, some raw food flow data was available from waterborne and road freight datasets, although this suffered from potential double counting. Industry-based sources for food production and processing were often restricted by commercial confidentiality and in some instances cost. Food packaging data for London was non-existent, and had to be proxied down from national INCPEN data (2001).

Transport

Passenger transport

Key data sources: DTLR's *National Travel Survey* (London) (2001); London Transport; ONS's *Regional Trends (36*) (London) (McGinty and Williams, 2001) and Transport for London (TfL) (2000a & b and 2001).

Other data sources: Corporation of London (2000) and GLA's Transport Strategy (based on TfL data) and energy data (2001b).

Freight transport

Key data sources: DETR's *Regional Transport Statistics* (London) (2001a) and (CSRGT, 2000), DETR's *Transport of Goods by Road in Great Britain* (London) (2001c). Data tended to focus on total 'goods lifted' (tonnes) and 'goods moved' (tonne-km) in London by road (DTLR).

Other data sources: GLA's *Transport Strategy* (TfL based data) (2001b), DETR's *Focus on Ports* (London) (2000a) and Port of London Authority (Jeffrey, 2001). Good waterborne freight data was received from the Port of London Authority and the Quarry Products Association.

Data gaps, problems and recommendations: Most of the road freight data suffered from a high probability of double counting. Non-road freight data, such as rail, was proxied from UK data.

Water

Key data sources: Environment Agency (Thames Region) (Rice, 2002) and *State of the Environment Report for the Thames Region* (2000a) and Water UK's *Waterfacts 2000* (Thames Region) (2000).

Other data sources: ONS's *Estimated Household Water Consumption* (2000a).

Data gaps, problems and recommendations: While water data was publicly available for the Thames Region, Thames Water Utilities did not provide data for the London region. By law, this data should be accesible. It was also difficult to obtain water consumption data for the different sectors in London.

Land Use

Key sources: Environment Agency (2000d) and London Ecology Centre (Dawson and Worrell, 1992). Detailed data was available on land types in Greater London.

Other data sources: DETR's *Local Housing Statistics* (London) (2001a) and ONS's *Focus on London* (2000b).

Tourism

Key data sources: London Tourist Board (2000); ONS's *Focus on London* (2000b) and *International Passenger Survey* (2001b). Excellent data was available on overseas and domestic visitors.

Other data sources: DTLR's *National Travel Survey* (London) (2001).

Data gaps, problems and recommendations: Data on materials and food consumed, and waste produced by tourists, was not available. Although, time permitting, data could be estimated or proxied.

Economic

Key data sources: Corporation of London (2000 and 2001), ONS's *Focus on London* (2000b) and DTI's business clusters report (London) (2001a). Excellent local, regional and national economic data was available.

Appendix 3

Conversion Tables

The following prefixes are commonly used:

Kilo (k)	= 1000	or 10^3
Mega (M)	= 1,000,000	or 10^6
Giga (G)	= 1,000,000,000	or 10^9

Energy	Data	Unit
1 GigaWatt hour (**GWh**) is equal to:	85.98	Tonnes of oil equivalents
	3600	gigajoules
	1,000,000	KiloWatt hours
	34,120	Therms (European)
	3,412,000,000	British thermal units (Btu)
	8,598,452,278,590	Calories
1 tonne of oil equivalent is equal to:	10,000,000	Kilocalories
	396.8	Therms (European)
	41.87	Gigajoules
	11,630	KWh
	39,680,000	British thermal units (Btu)

Length	Data	Unit
1 kilometre (**km**) is equal to:	0.621	Miles
	1094	Yards
	1000	Metres
1 metre (**m**) is equal to:	100	Centimetres
	39.4	Inches
1 mile is equal to:	1.609	Kilometres
	1760	Yards
	1609	Metres
1 passenger-km	1 person travelling 1 km	
1 tonne-km	1 tonne travelling 1 km	

Weight	Data	Unit
1 tonne (**t**) is equal to:	1000	Kilogrammes
	1,000,000	Grammes
	0.984	Long ton
	1.102	Short ton

Volume	Data	Unit
1 litre (**l**) is equal to:	0.22	Imperial gallon (UK gal)
	0.26	US gallons

Area	Data	Unit
1 hectare (**ha**) is equal to:	10,000	Square metres
	2.47	Acres
	107,639	Square feet

Source: DUKES 1999

Abbreviations

ALG	Association of London Government
BFF	Best Foot Forward Ltd
CIPFA	Chartered Institute of Public Finance & Accountancy
CIWM	Chartered Institution of Wastes Management
CoL	Corporation of London
CN	Combined Nomenclature
CSRGT	Continuing Survey of Road Goods Transport
DEFRA	Department of Environment, Food & Rural Affairs
DETR	Department of Environment, Transport & Regions
DoE	Department of the Environment
DTLR	Department of Transport, Local Government & Regions
DTI	Department of Trade & Industry
DUKES	Digest of United Kingdom Energy Statistics
DVLA	Driver & Vehicle Licensing Agency
EA	Environment Agency
EC	European Commission
ECIP	European Common Indicators Project
EU	European Union
GDP	Gross Domestic Product
gha	global hectare
GLA	Greater London Authority
GW	GigaWatt
ICE	The Institution of Civil Engineers
ICER	Industry Council for Electronic Equipment Recycling
INCPEN	Industry Council for Packaging & the Environment
IPCC	Intergovernmental Panel on Climate Change
IWM (EB)	Chartered Institution of Wastes Management Environmental Body
LTB	London Tourist Board
MSW	Municipal Solid Waste
MWh	Megawatt Hours
NGO	Non-Governmental Organisation
NST	Nomenclature Statistique de Transport
ONS	Office for National Statistics
pass-km	passenger-kilometres
ProdCom	Products of the European Community
PRN	Packaging Recovery Note
SIC	Standard Industrial Classification
SE	South East
SWMA	Strategic Waste Management Assessment
TfL	Transport for London
TMR	Total Material Requirements
UK	United Kingdom
WEEE	Waste Electrical and Electronic Equipment

Glossary

Arisings are materials considered as waste, and commonly referred to as waste generation.

Biological capacity refers to the total of the biologically productive areas. See also 'biologically productive areas'.

Biologically productive areas are those areas of a country with quantitatively significant plant and animal productivity. Biologically productive areas of a country comprise its biological capacity. Arable land is potentially the most productive area.

Brown grid electricity is electricity that is not sourced from renewables ('green electricity').

Carbon Dioxide (CO_2) is a gas, which is naturally emitted by living organisms as well as during the combustion of fossil fuels. The latter is problematic since it leads to increased concentrations in the atmosphere.

City Limits is the popular name used to refer to this study - a resource flow and ecological footprint analysis of Greater London.

City of London or **Square Mile** is London's financial and commercial district. It is one of the oldest London boroughs, originally contained within medieval walls, and is governed by the Corporation of London.

Ecological footprint is the land and water area that is required to support indefinitely the material standard of living of a given human population, using prevailing technology. (Measured in global hectares).

Embodied energy of a commodity is the energy used during its entire life cycle for manufacturing, transporting, using and disposing.

Fossil fuels. Coal, natural gas and fuels derived from crude oil (for example, petrol and diesel).

Global hectares (gha). One global hectare is equivalent to one hectare of biologically productive space with world average productivity.

Gross Domestic Product. A measure of the total flow of goods and services produced over a specified time period. It is obtained by valuing outputs of goods and services at market prices.

Hectare one hectare (ha) is 10,000 square metres (100 x 100 metres). One hectare is equivalent to 2.47 acres.

Inert waste is chemically inert, non-combustible, non-biodegradable and non-polluting waste.

Miscellaneous articles. A category used by the DTLR (CSRGT, 2000) to report road-freighted goods. Miscellaneous articles include arms and ammunition; commodities not elsewhere specified and unknown commodities.

Miscellaneous manufactures. A category used by the DTLR (CSRGT, 2000) to report road-freighted goods. Miscellaneous manufactures include paper and paperboard, plastics, leather, textiles and clothing not elsewhere specified and other manufactured articles not elsewhere specified.

National rail. The mainline rail infrastructure and services (previously the responsibility of British Rail), notably including London's suburban and commuter rail network.

Natural Capital refers to the stock of natural assets that yield goods and services continuously. Main functions include resource production (such as fish, timber or cereals), waste assimilation (such as CO_2 absorption, sewage decomposition) and life support services (UV protection, biodiversity, water cleansing, climate stability).

Per Capita is a measure per person within a specific population.

Priority Waste Streams are waste identified by the European Commission (EC) as posing a potential threat to the environment. Wastes identified are: construction and demolition waste, packaging waste and accredited reprocessor, batteries, solvents, oils, polychlorinated biphenyls (PCBs), tyres, end of life vehicles (ELV), fragmentiser waste, waste electrical and electronic equipment (WEEE) and fluorescent tubes.

Private Hire Vehicles. A term covering minicabs, chauffeur driven services and executive car services.

Productivity is measured in biological production per year and hectare. A typical indicator of biological productivity is the biomass accumulation of an ecosystem.

Proxy is normally used to compensate for a lack of raw data. It is an estimation derived from an existing data set using a statistical modifier. For example, deriving local water consumption data by using average per capita consumption of a region in which the locality is part.

Recycling is the process of collecting, sorting, cleansing, treating and reconstituting materials that would otherwise become waste, and returning them to the economic stream as raw materials for new, reused or reconstituted products.

Reuse is the recovery or reapplication of a product for uses similar or identical to its original application, without manufacturing or preparation processes that significantly alter the original product.

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Can London be sustainable by 2050?

City Limits found that in 2000, the average Londoner's lifestyle consumed:

- 13 MWh of gas and electricity
- almost 5 tonnes of materials
- over 8,400 km of travel
- more than 680kg of food

City Limits shows that this level of consumption results in an ecological footprint of 6.63 global hectares, which exceeds the global earthshare of 2.18 global hectares and is therefore not ecologically sustainable.

To attain a sustainable lifestyle by 2050, each Londoner's ecological footprint would need to be 35% lower by 2020. Continuing this reduction trend until 2050 would enable Londoners to reach ecological sustainability.

One way to reduce the ecological fooprint by 35% would be if every Londoner:

- reduced gas consumption from 9.5MWh to 6.2MWh *AND*
- installed 11m² of solar panels *AND*
- travelled 3,000 km less each year OR switched 3,500 km of car travel to bicycle *AND*
- consumed 70% less meat, reducing food waste by over 100 kg *AND*
- ate more than 40% local seasonal unprocessed food *AND*
- produced over a tonne less waste.

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But this reduction can be achieved in a myriad of other ways. You can choose how by visiting the interactive model at:

www.citylimitslondon.com

City Limits

In the year 2000, London consumed 49 million tonnes of materials. The environmental impact of this was measured as an ecological footprint - the land and sea area required to sustain current lifestyles.

City Limits quantified and catalogued the resources consumed in Greater London for the year 2000. The ecological footprint of Londoners was also measured.

On an equitable basis, each global citizen would receive an 'earthshare' of 2.18 global hectares (gha). Londoners' ecological footprints were estimated at 6.63 gha per person. If everyone lived like the average Londoner, we would require at least 3 planet Earths.

Using a range of 'what if' scenarios, City Limits clearly demonstrates that interim sustainability targets for 2020, aiming for sustainability by 2050, could be met.

'I hope this report stimulates real debate and change.'

Oswald A. Dodds MBE
Chairman of IWM (EB)

'We cannot continue to use global resources at current levels without putting future generations and global ecosystems at risk.'

Ken Livingstone Mayor of London

Best Foot Forward

Bringing sustainability down to earth

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