Environment Agency

Evidence

Material comparators for end-of-waste decisions

Fuels: biomass

Report – SC130040/R7

Version 2

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Executive summary

This report details the work undertaken to characterise biomass, a key comparator. This information will inform end-of-waste assessments for waste-derived materials intended to replace biomass as a fuel.

The Waste Framework Directive (Article 6) provides criteria for identifying when a waste material has become a product and no longer needs to be regulated as a waste. Through Article 6 the case law requires the Environment Agency to consider the environmental and human health impacts from materials in comparison with their non-waste material alternatives.

> ‘It should be enough that the holder has converted the waste material into a distinct, marketable product, which can be used in exactly the same way as a [non-waste material], and with no worse environmental effects.’

Market research was used to define biomass as an ordinary comparator and a literature review was used to identify any existing published data.

A limited number of suitable pre-existing datasets were found during the literature review.

Forty-two samples of biomass (including wood and straw) were collected from various suppliers across England. Analytical data from these samples are presented in this report.

We recommend comparing the concentrations of analytes in the comparators dataset to the concentrations in the waste-derived material, paying attention to the higher values. This comparison does not constitute a pass/fail test or an end of waste view. It will provide an indication of whether the waste material contains similar levels of analytes to non-waste materials and whether an end-of-waste application may be appropriate or that further analysis or improved treatment processes may be warranted.

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Contents

1 Introduction

To define end-of-waste criteria, the Environment Agency requires a set of ordinary material comparator data for use as a benchmark against which other materials and wastes can be assessed.

The Waste Framework Directive (Article 6) provides criteria for identifying when a waste material has become a product and no longer needs to be regulated as a waste. Through Article 6 the case law requires the Environment Agency to consider the environmental and human health impacts from materials in comparison with their non-waste material alternatives.

> ‘It should be enough that the holder has converted the waste material into a distinct, marketable product, which can be used in exactly the same way as a [non-waste material], and with no worse environmental effects.’

The purpose of this report is to provide an evidence base of the composition and characteristics of biomass which is defined as an ordinary material comparator that is currently permitted for land application.

This report provides the results from the primary analysis of 42 biomass samples.

Three other reports cover ordinary material comparators for fuel:

- charcoal
- coal
- natural gas

2 Definition

2.1 Material properties relevant to use

The term biomass covers a range of materials of biological origin, some of which may also be regarded as wastes (James and Howes 2006). Biomass means non-fossilised and biodegradable organic material originating from plants, animals and microorganisms. This definition can also include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilised and biodegradable organic fractions of industrial and municipal wastes. Biomass also includes gases and liquids recovered from the decomposition of non-fossilised and biodegradable organic material. When burnt for energy purposes, biomass is referred to as biomass fuel or biofuel (European Union 2003).

For the purpose of this project, biomass is a non-waste and defined as a material grown specifically for biomass fuel. The category also includes straw and wood. Forestry residues such as sawdust are by-products and are not considered as a waste. Materials that are grown for consumption but are not suitable for consumption and are used as a fuel are waste materials. Biomass can be split into a number of sub-types as described below.

The use of biomass as a fuel is generally regarded as carbon neutral, because the carbon dioxide (CO_2) released during the generation of energy from biomass should be approximately balanced by the CO_2 absorbed during the fuel's production (that is, the growth period of the biomass).

Solid biofuels are specified by origin, source, major traded forms and properties (BSI 2010).

2.2 Short rotation coppice (SRC)

Short rotation coppice (usually willow or poplar) is typically harvested every three years following an initial cutback in the first winter to encourage multiple stem formation. New growth emerges from the coppiced stools and harvests can be taken from the same stools for 20 years or more before productivity starts to fall. The chips produced from the willow stems can be used in heat and power generation projects.

2.3 Short rotation forestry (SRF) and by-products and residues from the wood processing industry

Short rotation forestry involves growing high yielding tree species over short rotations (between 10 and 20 years) using single stem management and conventional forest establishment and harvesting techniques. Trees grown under SRF are primarily managed for biomass, but offer flexibility to be grown on to maturity in response to changing management objectives and market conditions. They therefore offer greater flexibility over alternative woody biomass crops such as SRC (Forest Research 2009).

Broadleaf and coniferous wood fuel is marketed in a number of forms as described below.

2.4 Logs

A log is a part of the trunk or a large branch of a tree that has fallen or been cut off. Logs can be derived from wood specifically grown as an energy crop or from by-products and residues from the wood processing industry.

2.4.1 Bark

Bark can be removed from logs and be available as a residue from wood processing.

Bark typically contains high levels of minerals and consequently is prone to give high levels of ash and slagging in combustion systems. However, it may be a suitable fuel for generating process heat close to where it is produced, such as for firing drying kilns at a sawmill. Minerals will be retained in the ash and which can thus be used as a soil fertiliser (Biomass Energy Centre 2011).

2.4.2 Kindling

Kindling comprises small dry sticks of wood used to start a fire. Kindling can be derived from wood specifically grown as an energy crop or from by-products and residues from the wood processing industry. Kindling is often used in a domestic setting.

2.4.3 Wood chips

Depending on the equipment used, wood chips typically have a longest dimension of 20–50 mm, though larger chips (known as hog fuel), and chunks can be 100 mm or more. Wood chips can be derived from wood specifically grown as an energy crop or from by-products and residues from the wood processing industry (Biomass Energy Centre 2011).

2.4.4 Wood pellets

Wood pellets are made from dry sawdust compressed under high pressure and extruded through a die. They may include a low level of added binder, such as starch, but many use nothing other than steam. Wood pellets come in a range of sizes. For domestic and relatively small scale systems 6 or 8 mm is typical, while for larger systems 10 or 12 mm is common (Biomass Energy Centre 2011).

2.4.5 Wood briquettes

Briquettes are similar to wood pellets, but physically larger and can vary in diameter from around 50 mm to 100+ mm. Briquettes are usually between 60 and 150 mm long (Biomass Energy Centre 2011).

2.5 Herbaceous biomass

Herbaceous biomass is derived from plants that have a non-woody stem and which die back at the end of the growing season. It includes grains and their by-products such as cereals. This sub-type also includes grasses, non-woody energy crops and straw.

2.5.1 Cereal crops

Cereal crops can be further sub-divided into whole plant, straw parts, grains or seeds, husks or shells, blends and mixtures (BSI 2010). Straw is an agricultural residue and can be used in a loose form, shredded, as a baled product or compressed into straw logs or briquettes. Different types of straw include wheat straw and oil seed rape straw.

2.5.2 Grasses

Grasses can be further sub-divided in to whole plant, straw parts, seeds, blends and mixtures (BSI 2010).

Miscanthus species are tall (up to 3.5 m high) woody, perennial, rhizomatous grasses. The calorific value of Miscanthus is slightly lower than that of most wood and the ash content quite high, similar to straw. Crops are baled using a conventional baler to produce rectangular or round bales, depending upon the requirements of the application (Biomass Energy Centre 2011).

Grasses other than Miscanthus have also been considered as potential energy crops in the UK and have shown high yields in trials. These include (Biomass Energy Centre 2011):

- switchgrass (*Panicum virgatum*)

- reed canary grass (*Phalaris arundinacea*)
- rye (*Secale cereale*)
- giant reed (*Arundo donax*)

2.5.3 Fruit biomass

Fruit biomass is derived from the seeds or part of a plant that hold seeds including berries, stones and kernels, and nuts and acorns (BSI 2010).

2.5.4 Aquatic biomass

Microalgae, macroalgae (seaweeds and kelps) and pond and lake weed are aquatic forms of biomass (BSI 2010).

2.6 Peat

Peat is a significant fuel source in countries such as Ireland and Finland where it is harvested on an industrial scale. Historically cut or cast by hand, modern machinery is now used to extract the peat from the bog land. It is then left to air dry naturally on the surface in the summer for 6–8 weeks. The dried peat is harvested, stored and bagged ready for distribution (Northern Peat & Moss Company 2013).

Peat is marketed as briquettes made from compressed peat and burning turves which are traditional peat sods.

3 Comparator sub-types

Forty-two biomass samples were obtained from a variety of suppliers across England to provide a cross-section of the main types of biomass. Figures 3.1 to 3.6 show breakdowns of the samples by sub-type, origin and form.

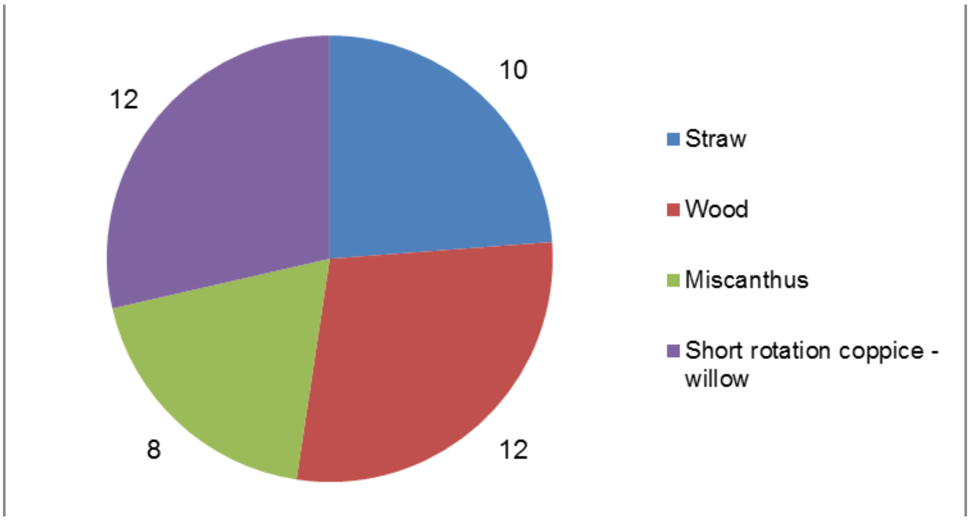

Figure 3.1 Number of biomass samples by sub-type

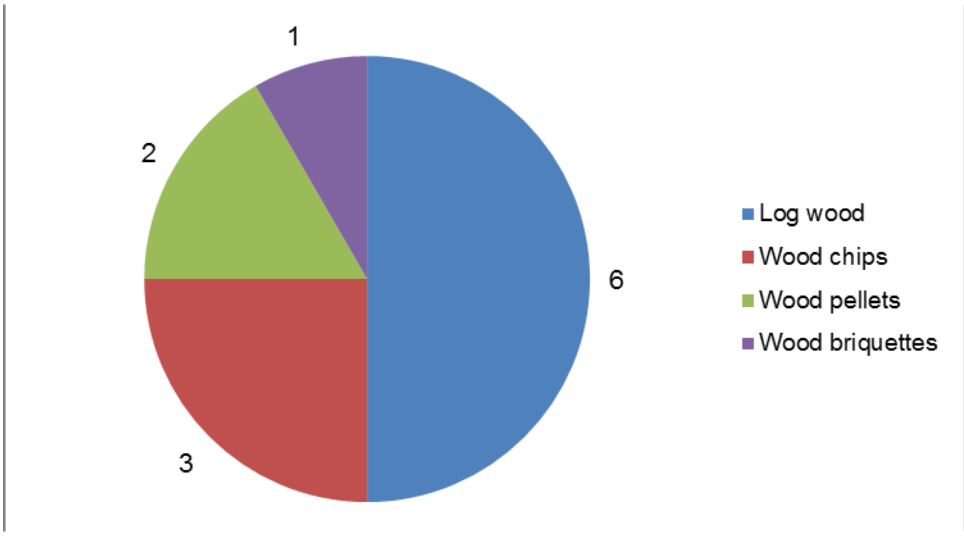

Figure 3.2 Number of wood samples by form

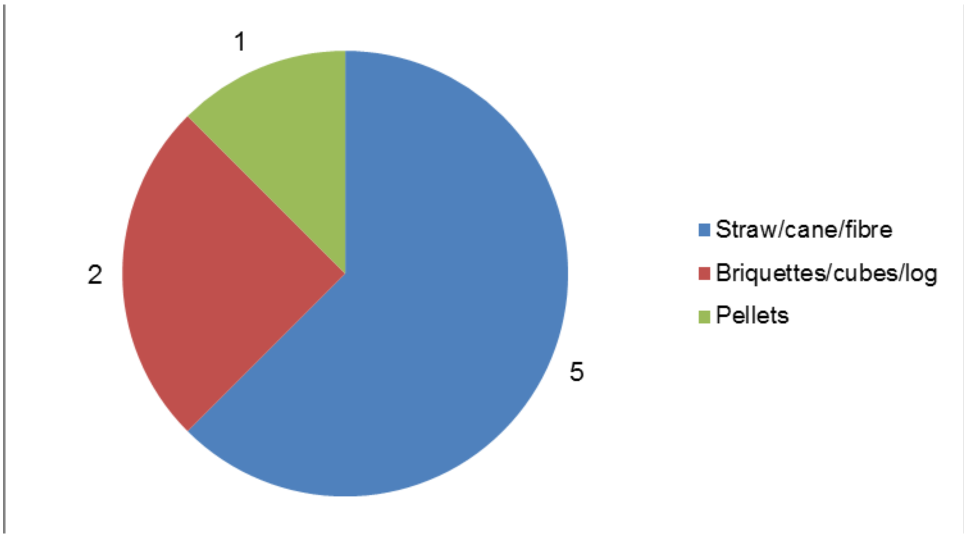

Figure 3.3 Number of Miscanthus samples by form

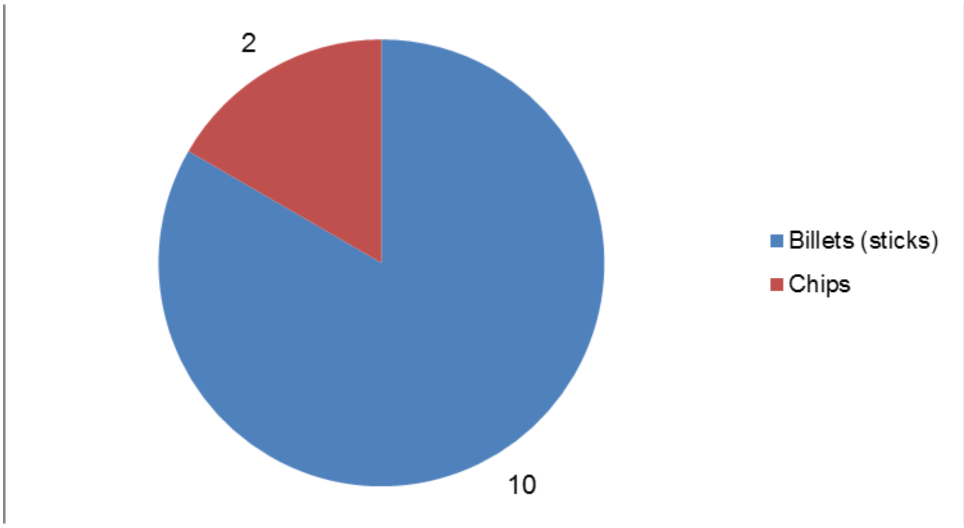

Figure 3.4 Number of SRC samples by form

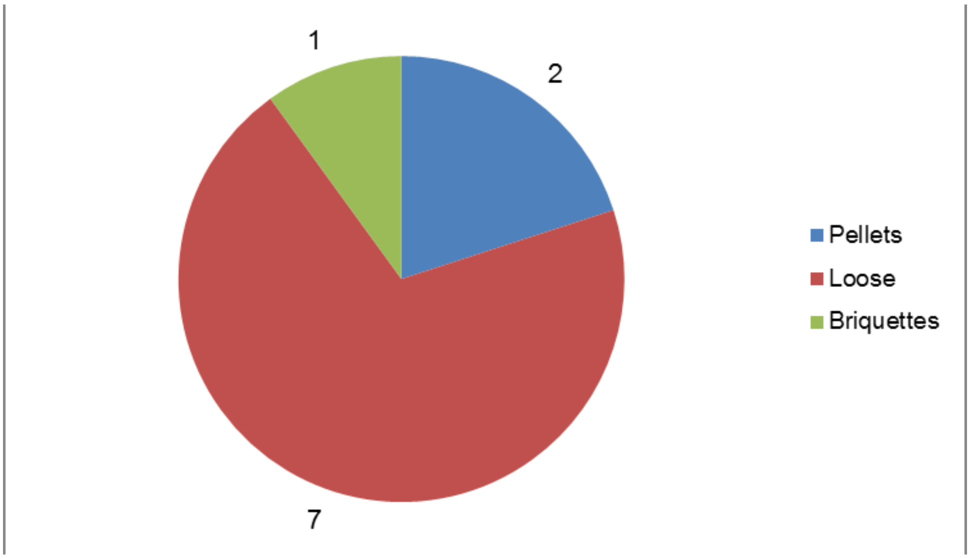

Figure 3.5 Number of straw samples by form

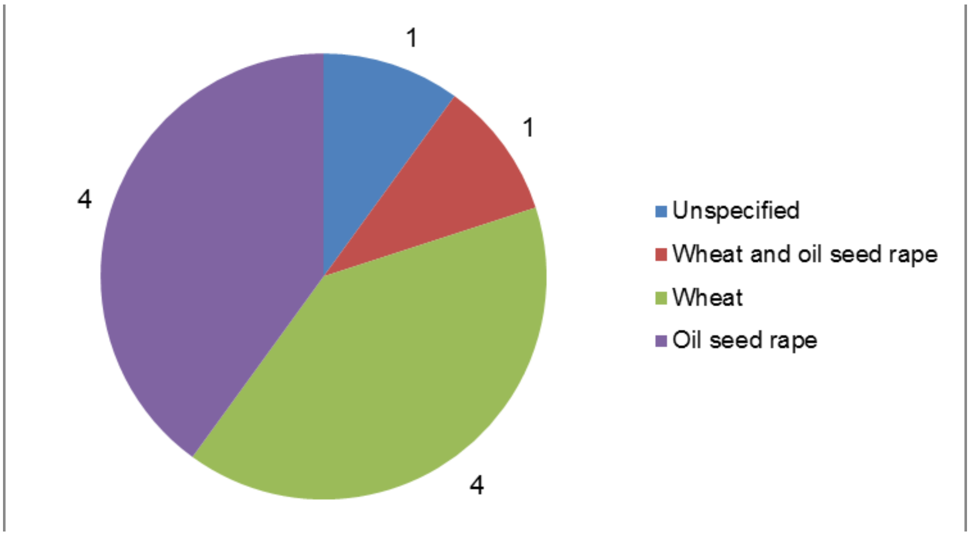

Figure 3.6 Number of straw samples by source

4 Material sources and sampling procedure

An internet search and the National Biofuel Supply Database (Carbon Trust and Biomass Energy Centre 2011) were used to produce a list of biomass suppliers. Biomass samples were requested from all these suppliers to ensure a cross-section of biomass types were sampled. Samples were collected from those willing to participate.

Biomass samples were taken in accordance with BS EN 14778:2011 (BSI 2011).

5 Analytical parameters

The main parameters determined, together with units of measurement, are summarised in Tables 5.1 to 5.5.

Testing was carried out in accordance with in-house methods documented by the Environment Agency's National Laboratory Service (NLS) which meet the requirements of the performance standards of the Environment Agency's monitoring certification scheme (MCERTS). Specific tests used are outlined in the tables. Other test methods are available.

In the tables, 'LE' refers to the NLS Leeds laboratory, 'SAL' refers to Scientific Laboratories Ltd and 'ESG' refers to Environmental Scientifics Group Limited.

Table 5.1 Physical properties

Parameter/ determinand	Test method used	Unit
Particle size distribution (PSD)	SAL determination of percentage particles. The particle size distribution calculates the percentage of a sample which is distributed via sieving between 2 and 20 mm, between 20 and 50 mm, and over 50 mm. The determination is performed on the >2 mm fraction of the sample (that is, the fraction of the sample that does not pass through the 2 mm sieve).	%
Bulk density	The test portion is filled into a standard container of a given size and shape, and is weighed afterwards. The density is calculated from the net weight per standard volume and reported.	kg/m^3

Table 5.2 Proximate (composition) analysis and calorific value

Parameter/ determinand	Test method used	Unit
Moisture content	ESG documented in-house method SP 20 based on EN 14774-1:2009	%
Ash content	ESG documented in-house method CA 3 based on EN 14775:2009	%
Volatile matter	ESG documented in-house method CA 6 based on EN 15148:2009	%
Fixed carbon	Parameter by calculation	%
Net calorific value (LHV)	ESG documented in-house method CA 11 based on EN 14918:2009	kJ/kg
Gross calorific value (HHV)	ESG documented in-house method CA 11 based on EN 14918:2009	kJ/kg

Table 5.3 Ultimate (elemental) analysis

Parameter/ determinand	Test method used	Unit
Total carbon	ESG documented in-house method CA 9 based on EN 15104:2011	%
Hydrogen	ESG documented in-house method CA 9 based on EN 15104:2011	%
Nitrogen	ESG documented in-house method CA 9 based on EN 15104:2011	%
Oxygen	Parameter by calculation	%
Sulphur	ESG documented in-house method CA 31 based on EN 15289:2011	%
Chlorine	ESG documented in-house method based on method described in Vol. 115 of the *Analyst* (November 1990) using wavelength dispersive X-ray fluorescence (XRF)	%
Fluorine	Following calorific value test (see Table 5.2) – the washings from the bomb calorimeter are submitted for analysis.	%
Bromine	Following calorific value test (see Table 5.2) – the washings from the bomb calorimeter are submitted for analysis by ion-selective electrode.	%

Table 5.4 Metals

Parameter/ determinand	Test method used	Unit
Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, vanadium, zinc	LE I metals (ICP-OES) 01– digestion block aqua regia extracted under reflux; determined by inductively coupled plasma optical emission spectrometry (ICP-OES)	mg/kg
Chromium VI	Hexavalent chromium by spectrophotometry	mg/kg

Table 5.5 Organic contaminants

Parameter/ determinand	Test method used	Unit
Polycyclic aromatic hydrocarbons (PAHs) (USEPA16)[1]	Organics dichloromethane (DCM) extracted; hexane exchange determined by gas chromatography–mass spectrometry (GCMS) (scan mode)	µg/kg
Benzene, toluene, ethylbenzene and xylenes (BTEX)	Organics DCM extracted; hexane exchange determined by GCMS (scan mode)	µg/kg
Polychlorinated biphenyls (PCBs)	LE O HRMS3 – dioxins; furans – toluene accelerated solvent extraction (ASE); three-stage clean-up; determined by high resolution GCMS	µg/kg
Halogenated organics (including lindane, pentachlorophenol)	Organics DCM extracted; hexane exchange determined by GCMS (scan mode) and LE O Phenols (HPLC) 01 – methanol extracted; determined by high performance liquid chromatography (HPLC) with diode array detection (DAD) from 'as received' sample	µg/kg

Notes: [1] List of 16 PAHs classified by the US Environmental Protection Agency (USEPA) as priority pollutants.

6 Existing data

Published existing data are reproduced in this section as they appear in the relevant reports. No further calculations (for example, mean) were made.

The values with ranges in brackets are reproduced from BS EN 14961-1:2010. Within this standard data have been obtained from a combination of Swedish, Finnish, Danish, Dutch and German research.

Some data in Tables 6.1 to 6.20 are results from a single sample while other results may represent averaged data. Within some reports the distinction between a single sample and an averaged value is not clear.

Table 6.1 Calorific value, bulk density, proximate and ultimate analysis of wood logs

	Net CV	Bulk density	Moisture content	Ash content	Volatile matter	Fixed carbon	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	kg/m^3	%	% (DW)							
Coniferous wood[1]	19.1 (18.5–19.8)			0.3 (0.1–1.0)			51 (47–54)	6.3 (5.6–7.0)	0.1 (<0.1–0.5)	<0.02 (<0.01–0.02)	42 (40–44)
Broadleaf wood[1]	18.9 (18.4–19.2)			0.3 (0.2–1.0)			49 (48–52)	6.2 (5.9–6.5)	0.1 (<0.1–0.5)	0.02 (<0.01– 0.05)	44 (41–45)
Wood (solid oven dried)[2]	18.6	400–600									
Wood[3]					84	16	48.6	6.1	0.2	0	45.1
Wood[4]									<0.5		
Logs[4]	7–11	335	>25	1–2							
Log wood[2]	14.6	350–500									

Notes: [1] BSI (2010)
[2] Carbon Trust (2009)
[3] RENEW (2004)
[4] Joint Research Centre (2013)
DW = dry weight

Table 6.2 Calorific value, bulk density, proximate and ultimate analysis of wood chips

	Net CV	Bulk density	Moisture content	Ash content	Volatile matter	Hydrogen	Nitrogen	Sulphur
	MJ/kg (DW)	kg/m^3	%	% (DW)				
Wood chips[1]			40–55	0.5–3				<0.1
Wood chips[2]	19	200	40	0.4	80–90		0.5	0.05
Logging residue chips[3]	18.5–20	150–300	50–60	1–3		6–6.2	0.3–0.5	<0.05
Whole tree chips[1]	18.5–20	250–350	45–55	1–2		5.4–6	0.3–0.5	<0.05
Log chips[1]	18.5–20	250–350	40–55	0.5–2		5.4–6	0.3–0.5	<0.05
Stump chips[1]	18.5–20	200–300	30–50	1–3		5.4–6	0.3–0.5	<0.05
Wood residue chips[1]	18.5–20	150–300	10–50	0.4–1		5.4–6.4	0.1–0.5	<0.05
Saw residue chips[1]	18.5–20	250–350	45–60	0.5–2		5.4–6.4	0.1–0.5	<0.05
Cutter chips[1]	19–19.2	80–120	5–15	0.4–0.5		6.2–6.4	0.1–0.5	<0.05
Wood chips[4]	12.5	200–250						
Wood chips[5]	13.4	200	>25	1				

Notes: [1] Data supplied by the Environment Agency
[2] Finnish Environment Institute (2001)
[3] Alakangas (1998)
[4] Carbon Trust (2009)
[5] Suttie (2011)

Table 6.3 Calorific value, bulk density, proximate and ultimate analysis of bark, logging residues and wood pellets

	Net CV	Bulk density	Moisture content	Ash content	Volatile matter	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	**kg/m³**	**%**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**
Softwood bark[1]	18.5–20	250–350	50–65	1–3			5.7–5.9	0.3–0.5	<0.05	
Birch bark[1]	21–23	300–400	45–55	1–3			6.2–6.8	0.5–0.8	<0.05	
Bark[2]	19	350	55	2–3	70–80			0.5	<0.2	
Coniferous wood bark	19.2 (17.5–20.5)			1.5 (<1–5)		52 (48–55)	5.9 (5.5–6.4)	0.5 (0.3–0.9)	0.03 (<0.02–0.05)	38 (34–42)
Broadleaf wood bark[3]	19 (17.1– 21.3)			1.5 (0.8–3.0)		52 (47–55)	5.8 (5.3–6.4)	0.3 (0.1–0.8)	0.03 (<0.02–0.20)	38 (32–42)
Sawdust[1]	19–19.2	250–350	45–60	0.4–0.5			6.2–6.4	0.1–0.5	<0.05	
Grinding dust[1]	19–19.2	100–150	5–15	0.4–0.8			6.2–6.4	0.1–0.5	<0.05	
Logging residues: coniferous wood[3]	19.2 (18.5–20.5)			3 (<1–10)		51 (48–52)	6 (5.7–6.2)	0.5 (0.3–0.8)	<0.02 (<0.02–0.06)	40 (38–44)
Logging residues: broadleaf wood[3]	18.7 (18.3–18.5)			5 (2–10)		51 (50–51)	6 (5.8–6.1)	0.5 (0.3–0.8)	0.04 (0.01–0.08)	40 (40–43)
Wood pellets[4]	16.8									
Wood pellets[5]	17	600–700								
Wood pellets[6]	17	650	8	0.5						
Wood pellets[1]	19.2	500–750	10	6.2–6.4			6.2–6.4	0.1–0.5	<0.05	

Notes:
[1] Alakangas (1998)
[2] Finnish Environment Institute (2001)
[3] BSI (2010)
[4] DECC (2012)
[5] Carbon Trust (2009)
[6] Suttie (2011)

Table 6.4 Calorific value, bulk density, proximate and ultimate analysis of short rotation coppice

	Net CV	Moisture content	Ash content	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	**%**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**
Short rotation coppice - Willow (Salix)[1]	18.4 (17.7–19.0)		2 (1.1–4.0)	48 (46–49)	6.1 (5.7–6.4)	0.5 (0.2–0.8)	0.05 (0.02–0.10)	43 (40–44)
Short rotation coppice – Poplar [1]	18.4 (18.1–18.8)		2 (1.5–3.4)	48 (46–50)	6.2 (5.7–6.5)	0.4 (0.2–0.6)	0.03 (0.02–0.10)	43 (39–45)
Short rotation coppice (40% MC)[2]	9.3							
Short rotation coppice[3]		40–60	1.1–4.5				<0.1	

Notes: [1] BSI (2010)
[2] DECC (2012)
[3] Data supplied by the Environment Agency

Table 6.5 Calorific value, bulk density, proximate and ultimate analysis of straw

	Net CV	Moisture content	Ash content	Volatile matter	Fixed carbon	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	%	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)
Straw from wheat, rye, barley[1]	17.6 (15.8–19.1)		5 (2–10)			47 (41–50)	6 (5.4–6.5)	0.5 (0.2–1.5)	0.1 (<0.05–0.2)	41 (36–45)
Straw from oilseed rape[1]	17.6 (15.8–19.1)		5 (2–10)			48 (42–52)	6 (5.4–6.5)	0.8 (0.3–1.6)	0.3 (<0.05–0.7)	41 (36–45)
Straw mouldings[2]	15.51	10.45	6.89							
Cereal mouldings[3]	15.05	10.7	4.34							
Pasture from landscape cultivation mouldings[3]	15.44	7.0	6.79							
Straw[4]		7–20	3–12				5.2–5.5	<1	<0.24	
Wheat straw pellets[5]	16	10	10						0.09	
Straw pellets (as received)[6]	15.97	9.3	6.7	67.8	16.2	41	4.76	0.64	0.14	37.4
Straw[3]	13.4									
Wheat straw[7]				75	26	47.8	6	0.5	0.3	45.3

Notes:
[1] BSI (2010)
[2] European Commission (2006)
[3] DECC (2012)
[4] Data supplied by the Environment Agency
[5] Agripellets (2004)
[6] Agripellets (2007)
[7] RENEW (2004)

Table 2.6 Calorific value, bulk density, proximate and ultimate analysis of non-woody biomass – grains, fruit and husks

	Net CV	Bulk density	Moisture content	Ash	Volatile matter	Fixed carbon	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	kg/m^3	%	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)
Olive cake[1]	17.1		8.76	8.9	64.4	18.0		6.4		0.1	
Olive cake pellets[1]	16.8		9.6	5.2	66.6	18.7	45.5	6.0	1.1	0.1	32.3
Olive pellets[1]	16.4		10.1	9.0	60.3	20.5	44.4	5.3	1.2	0.1	29.5
Olive pellets[1]	17.0		6.9	5.9	67.3	19.9	46.1	6.4	1.2	0.1	33.2
Olive pellets[1]	16.6		8.3	9.1	64.4	18.2	44.8	6.4	1.3	0.1	29.7
Olive pellets[1]	17.1	740	8.0	8.8	65.3	17.9	45.1	6.3	1.3	0.1	30.1
Olive pulp[1]	17.1		4.9	5.7	66.7	22.6	46.0	6.2	1.1	0.1	36.0
Olive pulp[1]	16.8		8.2	6.6	65.8	19.5		6.4		0.2	
Olive pulp[1]	16.1		11.4	7.9	63.7	17.0		5.5		0.2	
Olive pulp[1]	16.8	740–755	8.8	7.7	62.9	20.7	45.5	6.2	1.1	0.1	30.4
Olive pulp[1]	16.1	686–715	10.7	7.9	61.2	20.2	43.9	6.1	1.2	0.2	29.5
Olive pulp pellets[1]	16.2		12.8	5.4	64.6	17.3				0.2	
Olive residue[1]	16.0		15.3	4.3	59.7	20.7	43.6	5.5	1.0	0.1	30.2
Olive stones[1]	17.2		7.6	0.9	72.5	19.0	46.5	6.4	0.2	0.0	38.4
Olive cake pellets[1]	16.6		10.5	5.7	66.0	17.8		5.3		0.2	
Olive cake pellets[1]	16.8		10.9	6.6	66.0	16.5		5.1		0.1	
Olive cake pellets[1]	16.8		10.7	5.9	65.5	17.9		5.2		0.2	
Olive residues[1]			12	6						0.2	
Crude olive cake[2]	18.1–20.7			10 (3.4–11.3)			50 (4–52)	6.9	1.5	0.2	30
Olive kernels[2]	13.9–19.2							4.6–6.3	1.4–2.7	0.0–0.5	33
Shea meal [1]	15.7		12.47	6.11	56.29	25.14	43.08	4.77		0.21	
Grain from wheat, rye, barley[2]	16.5 (15.0–18.1)			2 (1.2–4)			45 (42–50)	6.5 (5.5–6.5)	2	0.16 (0.05–0.1)	44 (43–50)
Grain from rape [2]	26.6			4.3 (3.75–5.5)			60	7.1	3.8	0.1	23
Wheat bran[2]					76	24	48.1	6.4	2.8	0.3	42.3
Rice straw[3]					75	24	48.4	5.9	0.5	0.3	44.9
Rice husks[3]					79	21	49.9	7	1	0.7	41.3
Rice husk[1]	14.5–16.2			13–23			38–43	4.3–5.1	0.1–0.8	0.02–0.10	35–47
Crude grape cake[2]	17.3–19.3			1.2–4.4			45.7–52.3	6.1–6.8	0.8–1.6	0.0–0.5	38.5–42.1

	Net CV	Bulk density	Moisture content	Ash	Volatile matter	Fixed carbon	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	**kg/m^3**	**%**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**	**% (DW)**
Exhausted grape cake[2]	16.7			4.5–11.2			54	6.8	1.5	0.2	
Exhausted grape cake[2]	19			6–13			46.0–54.4	5.8–7.5	1.9–2.4	0.03–0.18	
Apricot, peach, cherry fruit stone[3]	19.5–22.9			0.2–1.0			51–55	5–7	0.2–0.3	0.05–0.50	43
Almond, hazelnut, pinenut shells[3]	17.5–19.0			0.95–3.00			44–50	5–6	0.1–1.2	0.04–0.22	40–45
Cotton stalks[3]				6.0–6.7			39.5–47	5.1–5.8	0.65–1.25	0.02–0.21	
Cotton Stalks[3]					75	25	48.7	5.9	0.8	0	44.7
Cotton gin trash[3]				1.6–9.4			39.6–43.7	5.3–6.1	0.2–2.9		
Sunflower husk[3]	17–22			1.9–7.6			51.5–52.9	5.0–6.6	0.6–1.4	0	36–43
Pennsylvanian malva[3]				2.8			17.7				5.9
Cocoa meal (brown meal)[1]			13.1	5.5	67.3		45.6	6.1	3.1	0.3	

Notes: [1] Data supplied by the Environment Agency
[2] BSI (2010)
[3] RENEW (2004)

Table 6.7 Calorific value, bulk density, proximate and ultimate analysis of non-woody biomass – grasses

	Net CV	Bulk density	Moisture content	Ash content	Volatile matter	Fixed carbon	Total carbon	Hydrogen	Nitrogen	Sulphur	Oxygen
	MJ/kg (DW)	kg/m³	%	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)	% (DW)
Canary grass[1]			7.6	5.8						0.04	
Canary grass – summer harvest (July to Oct)[2]	16.6			6.5 (2.5–10)			46	5.7	1.3	0.1 (0.1–0.2)	40
Canary grass – delayed harvest (March to May)[2]	16.5 (16.5–17.0)			6.9 (1.0–8.0)			46 (45–50)	5.8 (5.7–6.2)	0.9 (0.4–2.0)	0.13 (0.04–0.17)	42 (40–43)
Grass[3]	17.1 (16–19)			7 (4–10)			46 (45–50)	5.9 (5–7)	1.3 (1–2)	0.2 (0–90.5)	40 (38–48)
Miscanthus[3]	17.7 (16–19)			4 (1–6)			47 (46–52)	6.1 (5–6.5)	0.7 (0.1–1.5)	0.2 (0.02–0.6)	42 (40–45)
Miscanthus (bale at 25% MC)[1]	12.1	140–180									
Miscanthus[1]			50–65	6.2–7.5						<0.15	
Hay[4]					76	24	49	6.3	2.4	0.3	41.9

Notes: [1] Carbon Trust (2009)
[2] BSI (2010)
[3] RENEW (2004)
[4] Data supplied by the Environment Agency

Table 6.8 Calorific value, bulk density, proximate and ultimate analysis of peat

	Net CV	Bulk density	Moisture content	Ash content	Nitrogen	Sulphur
	MJ/kg (DW)	kg/m³	%	% (DW)	% (DW)	% (DW)
Milled peat[1]	20	350	50	3–6	1.7	0.5
Peat[2]					1.5–2.5	

Notes: [1] Finnish Environment Institute (2001)
[2] Joint Research Centre (2013)

Table 6.9 Chlorine and fluorine analysis of log wood (% DW)

	Cl	F
Coniferous wood[1]	0.01 (<0.01–0.03)	<0.0005
Broadleaf wood[1]	0.01 (<0.01–0.03)	<0.0005

Notes: [1] BSI (2010)

Table 6.10 Chlorine and fluorine analysis of wood chip, bark and logging residues (% DW)

	Cl	F
Wood chip[1]	<0.35	
Coniferous wood bark[2]	0.02 (<0.01–0.05)	0.001 (<0.0005–0.002)
Broadleaf wood bark[2]	0.02 (<0.01–0.05)	
Logging residues – coniferous wood[2]	0.01 (<0.01–0.04)	0.001
Logging residues – broadleaf wood[2]	0.01 (<0.01–0.02)	0.002 (0.0–0.001)

Notes: [1] Data supplied by the Environment Agency
[2] BSI (2010)

Table 6.11 Chlorine and fluorine analysis of short rotation coppice (% DW)

	Cl	F
Short rotation coppice – willow (Salix)[1]	0.03 (0.01 –0.05)	0.003 (0–0.01)
Short rotation coppice – poplar[1]	<0.01 (<0.01 –0.05)	
Short rotation coppice[2]	<0.05	

Notes: [1] BSI (2010)
[2] Data supplied by the Environment Agency

Table 6.12 Chlorine and fluorine analysis of straw (% DW)

	Cl	F
Straw from wheat, rye, barley[1]	0.4 (<0.1–1.2)	0.0005
Straw from oilseed rape[1]	0.5 (<0.1– 1.1)	
Straw[2]	<0.35	
Wheat straw pellets[3]	0.14	
Straw pellets (as received)[4]	0.11	

Notes: [1] BSI (2010)
[2] Data supplied by the Environment Agency
[3] Agripellets (2004)
[4] Agripellets (2007)

Table 6.13 Chlorine and fluorine analysis of non woody biomass – grains, fruit and husks (% DW)

	Cl
Olive cake[1]	0.2
Olive cake[1]	0.2
Olive pellets[1]	0.3
Olive pellets[1]	0.2
Olive pellets[1]	0.3
Olive pellets[1]	0.3
Olive[1]	0.3
Olive[1]	0.1
Olive pulp[1]	0.2
Olive pulp[1]	0.5
Olive pulp pellets[1]	0.2
Olive residue[1]	0.2
Olive cake pellets [1]	0.2
Olive cake[1]	0.2
Olive cake[1]	0.2
Olive residues[1]	0.3
Crude olive cake [1]	0.2
Olive kernels[2]	0.1–0.4
Shea meal (as received)[1]	0.07
Grain from wheat, rye, barley [2]	0.11 (0.05–0.5)
Grain from rape[2]	0.07 (0.01–0.15)
Rice husk[2]	0.03–0.3
Crude grape cake[2]	0.1–0.4
Exhausted grape cake[2]	<0.05
Apricot, peach, cherry fruit stone[2]	0.04
Almond, hazelnut, pinenut[2]	0.004–0.09
Cotton stalks[2]	0.08
Sunflower husk[2]	0–0.1
Pennsylvanian malva[2]	0.05

Notes: [1] Data supplied by the Environment Agency
[2] BSI (2010)

Table 6.14 Chlorine and fluorine analysis of non woody biomass – grasses (% DW)

	Cl	F
Canary grass[1]	0.03	
Reed canary grass – summer harvest (July to Oct)[2]	0.5 (0.2–0.6)	
Reed canary grass – delayed harvest (March to May)[2]	0.025 (0.01–0.09)	
Grass[2]	0.7 (0.02–1.3)	0.001 (0.001–0.003)
Miscanthus[2]	0.2 (0.02–0.6)	0.002 (0.001–0.003)
Miscanthus[1]	<0.35	

Notes: [1] Data supplied by the Environment Agency
[2] BSI (2010)

Table 6.15 Metal analysis of log wood (mg/kg DW)

(a)

	Al	**As**	**B**	**Ba**	**Ca**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**K**
Coniferous wood[1]	100 (30–400)	<0.1 (<0.1–1.0)			900 (500–1,000)	0.1 (<0.05–0.50)	1 (0.2–10.0)	2 (0.5–10.0)	25 (10–100)	0.02 (<0.02–0.05)	400 (200–500)
Broadleaf wood[1]	20 (<10–50)	<0.1 (<0.1–1.0)			1200 (800–20,000)	0.1 (<0.05–0.50)	1 (0.2–10.0)	2 (0.5–10.0)	25 (10–100)	0.02 (<0.02–0.05)	800 (500–1500)
Spruce Scotland 2[*2]		0.01				0.07	0.05	0.72			
Spruce Wales[*2]		0.03				0.09	0.08	0.78			
Spruce N. Ireland[*2]		0				0.04	0.03	1.36			
Spruce Finland 1[* 2]		0				0.03	0.03	0.59			
Spruce Finland 2[*2]		0				0.02	0.03	0.33			
Spruce Finland 3[2]		0				0.02	0.01	0.4			
Spruce Sweden 1[*2]		0				0.02	1.96	0.66			
Spruce Latvia[*2]		0				0.07	0.06	0.54			
Spruce Scotland 1[+2]	170	<0.1	62	453	10799	<0.1	<0.1	1.44	381		
Spruce Scotland 2[+2]	123	<0.1	65	275	11585	<0.1	<0.1	0.87	246		
Spruce Wales[2]	101	<0.1	67	184	6366	<0.1	<0.1	0.8	176		
Spruce N. Ireland[2]	67	<0.1	67	329	11964	<0.1	<0.1	1.2	90		
Spruce Finland 1[+2]	5	<0.1	2	11	788	<0.1	<0.1	0.83	2		
Finland 2[+2]	3	<0.1	3	16	1002	<0.1	<0.1	1.11	3		
Finland 3[+2]	2	<0.1	2	20	687	<0.1	<0.1	0.61	2		
Sweden 1[+2]	3	<0.1	3	11	736	<0.1	<0.1	1.01	4		
Sweden 2[+2]	3	<0.1	3	13	923	<0.1	<0.1	0.89	2		
Spruce Latvia[+2]	4	<0.1	3	11	762	<0.1	<0.1	1.33	4		
Spruce Russia 1[+2]	3	<0.1	3	18	918	<0.1	<0.1	1.22	3		
Spruce Russia 2[+2]	3	<0.1	2	17	600	<0.1	<0.1	0.95	3		
Pine Scotland 2[*2]		0.04				0.05	0.13	0.76			
Pine England[*2]		0				0.08	0.5	0.56			
Pine Finland 1[*2]		0				0.1	0.03	0.38			
Pine Finland 2[*2]		0				0.04	0.01	0.15			
Pine Finland 3[*2]		0				0.07	0.02	0.21			
Pine Finland 4[*2]		0				0.04	0.04	0.36			

	Al	As	B	Ba	Ca	Cd	Cr	Cu	Fe	Hg	K
Pine Finland 5[*2]		0				0.09	0.02	0.4			
Pine Sweden[*2]		0				0.12	0.02	0.34			
Pine Latvia[*2]		0				0.08	0.04	0.51			
Pine Russia[*2]		0				0.05	0.03	0.36			
Pine Scotland 1[2]	87	<0.1	52	121	13,305	<0.1	<0.1	1.85	179		
Pine Scotland 2[2]	203	<0.1	68	85	16,056	<0.1	<0.1	0.68	127		
Pine England [+2]	189	<0.1	74	32	16,813	<0.1	<0.1	1.26	84		
Pine Finland 1[+2]	4	<0.1	3	3	642	<0.1	<0.1	0.71	6		
Pine Finland 2[+2]	4	<0.1	2	2	547	<0.1	<0.1	0.52	4		
Pine Finland 3[+2]	2	<0.1	2	1	458	<0.1	<0.1	0.44	2		
Pine Finland 4[+2]	10	<0.1	2	5	537	<0.1	<0.1	0.52	7		
Pine Finland 5[+2]	3	<0.1	2	4	663	<0.1	<0.1	0.74	2		
Pine Sweden[+2]	6	<0.1	2	6	540	<0.1	<0.1	0.63	3		
Pine Latvia[+2]	5	<0.1	3	6	575	<0.1	<0.1	1.01	3		
Pine Russia[+2]	7	<0.1	4	4	1021	<0.1	<0.1	1.09	6		
Douglas Fir Scotland 1[+2]	81	<0.1	51	233	5938	<0.1	<0.1	0.68	89		
Douglas Fir Scotland 2[+2]	122	<0.1	58	108	3025	<0.1	<0.1	2.88	115		
Douglas Fir England[+2]	637	<0.1	212	467	25,470	<0.1	<0.1	5.94	1040		
Douglas Fir Scotland 2[*2]		0.06				0.33	0.2	16.98			
Douglas Fir England[*2]		0.08				0.19	0.2	4.1			
Larch Scotland 2[*2]		0.08				0.2	0.37	4.79			
Larch England[*2]		0				0.1	0.03	0.87			
Larch Scotland 1[+2]	127	<0.1	67	290	5505	<0.1	<0.1	0.83	79		
Larch Scotland 2[+2]	133	<0.1	61	212	3455	<0.1	<0.1	2.42	158		
Larch England[+2]	64	<0.1	93	140	6408	<0.1	<0.1	1.4	93		

(b)

	Mg	Mn	Na	Ni	P	Pb	Si	Sr	V	Zn
Coniferous wood[1]	150 (100–200)	100 (40–2000)	20 (10–50)	0.5 (<0.1–10.0)	60 (50–100)	2 (<0.5–10.0)	150 (100–200)		<2	10 (5–50)
Broadleaf wood[1]	200 (100–400)	83	50 (10–200)	0.5 (<0.1–10.0)	100 (50–200)	2 (<0.5–10.0)	150 (100–200)		<2	10 (5–100)
Spruce Scotland 2*[2]				0.03		0.22				3.03
Spruce Wales*[2]				0.02		0.1				1.98
Spruce N. Ireland*[2]				0.03		1.21				1.7
Spruce Finland 1*[2]				0.04		0.09				3.23
Spruce Finland 2*[2]				0.03		0.04				2.51
Spruce Finland 3[2]				0.02		0.22				2.68
Spruce Sweden 1*[2]				0.05		0.04				4.7
Spruce Latvia*[2]				0.03		0.09				2.64
Spruce Scotland 1+[2]	1954	1646	668	<0.1	221	<0.1	283	159		7.61
Spruce Scotland 2+[2]	1955	2607	869	<0.1	94	<0.1	340	94		11.3
Spruce Wales[2]	1340	1005	813	<0.1	92	<0.1	276	59		8.43
Spruce N. Ireland[2]	1570	1495	748	<0.1	332	<0.1	232	127		35.89
Spruce Finland 1+[2]	87	62	25	<0.1	16	<0.1	11	6		9.95
Finland 2+[2]	95	53	43	<0.1	18	<0.1	16	7		13.35
Finland 3+[2]	83	65	22	<0.1	4	0.2	6	5		10.71
Sweden 1+[2]	91	114	68	<0.1	4	<0.1	5	3		12.43
Sweden 2+[2]	104	122	26	<0.1	4	<0.1	7	4		20.54
Spruce Latvia+[2]	83	119	32	<0.1	7	<0.1	12	3		12.26
Spruce Russia 1+[2]	73	129	26	<0.1	5	<0.1	6	3		21.12
Spruce Russia 2+[2]	47	79	22	<0.1	4	<0.1	6	2		9.78
Pine Scotland 2*[2]				0.03		0.15				2.8
Pine England*[2]				0.24		0.11				1.72
Pine Finland 1*[2]				0.02		0.06				2.8
Pine Finland 2*[2]				0.01		0.2				1.23
Pine Finland 3*[2]				0.01		0.16				2.16
Pine Finland 4*[2]				0.04		0.05				3.72
Pine Finland 5*[2]				0.03		0.04				1.49
Pine Sweden*[2]				0.02		0.05				3.87
Pine Latvia*[2]				0.02		0.04				1.55
Pine Russia*[2]				0.05		0.02				3.66
Pine Scotland 1[2]	4628	2487	810	<0.1	283	3.24	139	69		8.56

	Mg	Mn	Na	Ni	P	Pb	Si	Sr	V	Zn
Pine Scotland 2[2]	3718	930	651	<0.1	735	<0.1	161	85		13.86
Pine England [+2]	3468	1366	1471	<0.1	2312	<0.1	179	21		12.19
Pine Finland 1[+2]	132	61	61	<0.1	7	<0.1	7	4		13.2
Pine Finland 2[+2]	109	52	29	<0.1	2	0.52	5	2		12.25
Pine Finland 3[+2]	107	59	24	<0.1	1	<0.1	4	2		11.55
Pine Finland 4[+2]	106	78	19	<0.1	2	<0.1	3	3		9.71
Pine Finland 5[+2]	162	71	20	<0.1	3	<0.1	3	4		9.33
Pine Sweden[+2]	127	111	27	<0.1	6	<0.1	4	2		12.06
Pine Latvia[+2]	139	68	41	<0.1	2	<0.1	8	1		6.43
Pine Russia[+2]	204	77	30	<0.1	18	<0.1	8	4		13.49
Douglas Fir Scotland 1[+2]	1230	721	1230	<0.1	848	<0.1	174	42		3.73
Douglas Fir Scotland 2[+2]	382	108	1584	<0.1	202	<0.1	144	58		16.71
Douglas Fir England[+2]	3396	5306	4033	<0.1	2335	0.85	1358	106		20.38
Douglas Fir Scotland 2[*2]				0.13		0.71				21.09
Douglas Fir England[*2]				0.09		1.04				3.97
Larch Scotland 2[*2]				0.28		1.36				17.6
Larch England[*2]				0.02		4.67				1.18
Larch Scotland 1[+2]	1754	599	1694	<0.1	260	<0.1	236	79		2.66
Larch Scotland 2[+2]	1091	297	970	<0.1	97	<0.1	176	67		26.67
Larch England[+2]	874	4602	757	<0.1	157	7.92	175	35		5.13

Notes: [1] BSI (2010)
[2] WRAP (2005)
* ICP Lab 1
[+] ICP Lab 2

Table 6.16 Metal analysis of bark and logging residues (mg/kg DW)

(a)

	Al	**As**	**B**	**Ba**	**Ca**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**K**
Coniferous wood bark[1]	800	1			5000	0.5	5	5	500	0.05	2000
	(400–1200)	(0.1–4.0)			(1000–15000)	(0.2–1.0)	(1–10)	(3–30)	(100–800)	(0.01–0.1)	(1000–3000)
Broadleaf wood bark[1]	50	0.4			15000	0.5	5	5	100	<0.05	2000
	(30–00)	(0.1–4)			(10000–20000)	(0.2–1.2)	(1–30)	(2–20)	(50–2000)		(1000–3200)
Pine, bark (Scotland 1*)[2]		0.06				0.06	0.18	3.07			
Pine, bark (Scotland 2*)[2]		0.07				0.05	0.99	3.61			
Pine, bark (Spain+)[2]	335		8	3	1116				223		
Spruce, bark Belgium*[2]		0.4				0.66	1.92	6.57			
Spruce, bark Scotland+[2]	686		25	77	3017				1508		
Spruce, bark Belgium+[2]	623		28	88	7934				935		
Logging residues –		0.6			5000	0.2	1	10	500–2000		
coniferous wood[1]		(0.2–1)			(2000–8000)	(0.1–0.8)	(0.7–1.2)	(10–200)			
Logging residues –	250	1			4000	0.5	8	10	150		
broadleaf wood[1]	(1–3000)	(0–2)			(3000–5000)	(0–3)	(1–40)	(1–100)	(10–1500)		

(b)

	Mg	Mn	Na	Ni	P	Pb	Si	Sr	Ti	V	Zn
Coniferous wood bark[1]	1000 (400–1500)	500 (9–840)	300 (70–2000)	10 (2–20)	400 (20–600)	4 (1–30)	2000 (500–5000)			1 (0.7–2.0)	100 (70–200)
Broadleaf wood bark[1]	500 (400–1000)	190	100 (20–1000)	10 (2–10)	400 (300–700)	15 (2–30)	2500 (2000–20,000)			2 (1–4)	50 (7–200)
Pine, bark (Scotland 1*)[2]				0.21		0.33					4.52
Pine, bark (Scotland 2*)[2]				0.27		0.34					4.35
Pine, bark (Spain+)[2]	290	45	190		107		167	4	4		
Spruce, bark Belgium*[2]				2		5.31					36.16
Spruce, bark Scotland+[2]	741	411	439		686		686	22	36		
Spruce, bark Belgium+[2]	793	992	680		510		680	23	11		
Logging residues – coniferous wood[1]	800 (400–2000)	130 (80–170)	200 (75–300)	1.6 (0.4–3)	500	1.3 (0.4–4)	3000 (200–10,000)			0.6 (0.1–1)	20 (8–30)
Logging residues – broadleaf wood[1]	250 (10–400)	120 (10–800)	100 (20–200)	10 (1–80)	300 (30–1000)	1.5 (0.5–5)	150 (75–250)		7(1–40)	0.5 (0.1–3)	50 (2–100)

Notes:
[1] BSI (2010)
[2] WRAP (2005)
* ICP Lab 1
+ ICP Lab 2

Table 6.17 Metal analysis of short rotation coppice (mg/kg DW)

(a)

	Al	As	Ca	Cd	Cr	Cu	Fe	Hg	K
Short rotation coppice – willow (Salix)[1]	50 (3–100)	<0.1	5000 (2000–9000)	2 (0.2–5)	1 (0.3–5)	3 (2–4)	100 (30–600)	<0.03	2500 (1700–4000)
Short rotation coppice – poplar[1]	10	<0.1 (<0.1–0.2)	5000 (4000–6000)	0.5 (0.2–1)	1 (0.3–2)	3 (2–4)	30	<0.03	2500 (2000–4000)

(b)

	Mg	Mn	Na	Ni	P	Pb	Si	Ti	V	Zn
Short rotation coppice – willow (Salix)[1]	500 (200–800)	97 (79–160)	10–450	0.5 (0.2–2)	800 (500–1300)	0.1 (0.1–0.2)	500 (2–2000)	10 (<10–50)	0.3 (0.2–0.6)	70 (40–100)
Short rotation coppice – poplar[1]	500 (200–800)	20	25 (10–60)	0.5 (0.2–1.0)	1000 (800–1100)	0.1 (0.1–0.3)				50 (30–100)

Notes: [1] BSI (2010)
[2] WRAP (2005)

Table 6.18 Metal analysis of straw (mg/kg DW)

(a)

	Al	**As**	**Ca**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**K**
Straw from wheat, rye, barley[1]	50 (up to 700)	<0.01 (<0.1–2.0)	4000 (2000–,000)	0.1 (<0.05–0.30)	10 (1–60)	2 (1–10)	100 (up to 500)	0.02 (<0.02–0.05)	10,000 (2000–26,000)
Straw from oilseed rape[1]	50 (up to 700)	<0.01 (<0.1–0.5)	15,000 (8000–20,000)	0.1 (<0.05–0.30)	10 (1–60)	2 (1–10)	100 (up to 500)	0.02 (<0.02–0.05)	10,000 (2000–26,000)
Wheat straw pellets[2]		<0.06		<0.06	0.65	2.3		<0.06	
Straw pellets (as received)[3]		<0.1		<0.05	1.65	2.63		0.04	

(b)

	Mg	**Mn**	**Na**	**Ni**	**P**	**Pb**	**Si**	**Ti**	**V**	**Zn**
Straw from wheat, rye, barley[1]	700 (400–1300)	40 (20–100)	500 (up to 3000)	1 (0.2–4.0)	1000 (300–2900)	0.5 (0.1–3.0)	10,000 (1000–20,000)	70 (5–200)	3 (1–6)	10 (3–60)
Straw from oilseed rape[1]	700 (300–2200)		500 (up to 3000)	1 (0.2–4.0)	1000 (300–2700)	2 (1.0–13.0)	1000 (100–3000)			10 (5–20)
Wheat straw pellets[2]				0.1		<0.06			0.21	7.14
Straw pellets (as received)[3]				0.76		1.56			<0.05	38.63

Notes: [1] BSI (2010)
[2] Agripellets (2004)
[3] Agripellets (2007)

Table 6.19 Metal analysis of non woody biomass - grains, fruit and husks (mg/kg DW)

(a)

	Ag	Al	As	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
Olive cake[1]			0.11		0.01		5	18.21		0.02	
Olive cake pellets[1]			0.5		0.05		1.56	10.66		0.02	
Olive pellets[1]			0.1		0.1		10.7	17.6		0.01	
Olive pellets[1]			0.2		0.05		4.22	10.68		0.04	
Olive pellets[1]			0.2		0.05		10.14	17.88		0.04	
Olive pellets[1]			0.1		0.1		9.3	16.1		0.01	
Olive pulp[1]			0.1		0.02		4.5	12.3		0.01	
Olive pulp[1]			0.26		0.01		6.3	22.31		0.02	
Olive pulp[1]			0.091		0.01		31	11.21		0.02	
Olive pulp[1]			0.5		0.05		2.98	14.69		0.02	
Olive pulp[1]			0.5		0.05		6.96	19.8		0.02	
Olive pulp pellets[1]			0.034		0.01		5	16.57		0.02	
Olive residue[1]			0.5		0.05		5.81	13.11		0.02	
Olive stones[1]											
Olive cake pellets[1]			0.122		0.01		5	15.29		0.02	
Olive cake pellets[1]			0.045		0.01		5	14.51		0.02	
Olive cake pellets[1]			0.056		0.01		5	14.43		0.02	
Olive residues[1]			0.4		0.1		10	16		0.1	
Crude olive cake[2]		1250	0.4	6900	<0.1		3	14	1000		
Olive kernels[2]	4	2700	4	17200	<0.5	1	3–13	10–20	1900		6000–16,000
Shea meal[1] (as received)										0.1	17,500
Grain from wheat, rye, barley[2]		<20	<0.5 (0.0–0.7)	600 (100–1200)	0.01 (0.0–0.7)		0.5 (<0.5–1.0)	5 (1.5–12)	75 (15–200)		
Grain from rape[2]				5000 (3200–6400)				2.6	93	<0.02	5000 (3700–6500)
Wheat bran[3]											8400
Rice straw[3]											
Rice husks[3]											
Rice husk[1]											
Crude grape cake[1]		559	0.8	968	0.2		3	9	391		2800–4300
Exhausted grape cake[2]											6950

	Ag	Al	As	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
Exhausted grape cake[2]					0.05–0.18		0.73–1.54	48–190			
Apricot, peach, cherry fruit Stone[2]											12,500–35,700
Almond, hazelnut, pinenut shells[2]		65		300–1,200					58–66		
Cotton stalks[2]											1500–1750

(b)

	Mg	Mn	Na	Ni	P	Pb	Si	Sn	Ti	V	Zn
Olive cake[1]				4.8		0.35				4.5	14.4
Olive cake pellets[1]				1.56		0.3				0.58	8.97
Olive pellets[1]				8.5		15.3				2.7	14
Olive pellets[1]				3.06		0.68				0.75	8.98
Olive pellets[1]				6.98		5.23				2.18	13.73
Olive pellets[1]				7.4		6.7				1.9	11.7
Olive pulp[1]				5.4		0.6				1.5	7.5
Olive pulp[1]				4.6		12.24					
Olive pulp[1]				15.9		0.8				4	10.6
Olive pulp[1]				3.16		0.37				1.3	10.42
Olive pulp[1]				5.78		1.86				2.55	20.38
Olive pulp pellets[1]				3		0.56				1.7	17.5
Olive residue[1]				6.9		1.6				1.88	14.59
Olive stones[1]											
Olive cake pellets[1]				3		0.69				1.7	14.8
Olive cake pellets[1]				3		0.31				1.8	14.1
Olive cake pellets[1]				3		0.1				2.5	16.5
Olive residues[1]				4		3				10	20
Crude olive cake[2]	3400	<26	44–1000	2	2450	2	14–6600		53		19
Olive kernels[2]	4000	17–44	250–450	2–17	30–1,750	15	20–11,850	4	145	5	19
Grain from wheat, rye, barley[2]	1400 (1000–2100)	30 (9–60)	100 (50–120)	1 (0.2–2.0)	3400 (2100–4300)	0.9 (<0.1–1)	50 (10–200)		<50–100		22 (17–34)
Grain from rape[2]	2600	39	100 (50–120)		7300						
Rice husk[2]			33–38								

	Mg	Mn	Na	Ni	P	Pb	Si	Sn	Ti	V	Zn
Crude grape cake[2]	316	12	120	0.05	590	2.1	9–3500		39		7
Exhausted grape cake[2]											
Exhausted grape cake[2]		14–36	34–180	0.66–1.64		0.35–2.70					
Almond, hazelnut, pinenut shells[2]	175–300	3–12	62–73		79–82		580–4200		1–6		2.3–5.3

Notes: [1] Data supplied by the Environment Agency
[2] BSI (2010)
[3] RENEW (2004)

Table 6.20 Metal analysis of non woody biomass – grasses (mg/kg DW)

(a)

	Al	**As**	**Ca**	**Cd**	**Cr**	**Cu**	**Fe**	**Hg**	**K**
Canary grass[1]		<0.5		0.2	6.2	25.4		<0.1	
Reed canary grass – summer harvest (July to Oct)[2]		0.1 (<0.04–0.10)	3500 (1300–5700)	0	0.04			0.03 (<0.02–0.05)	12,000 (3100–22,000)
Reed canary grass – delayed harvest (March to May)[2]	20	0.06 (<0.04–0.20)	2000 (800–3200)				140 (60–220)	0.03 (<0.02–0.05)	2700 (<800–6000)
Grass[2]	200 (20–300)	0.1 (<0.1–1.4)	3500 (2500–5500)	0.2 (0.03–0.60)	1 (0.2–3.0)	5 (2–10)	600 (100–1200)	<0.02 (<0.02–0.03)	15,000 (4900–24,000)
Miscanthus[2]	100 (50–200)	1 (0.5–4)	2000 (900–3000)	1 (0.4–8)	2 (1–10)	2 (1–6)	100 (40–400)	2 (0.5 –5)	7000 (1000–11,000)

(b)

	Mg	**Mn**	**Na**	**Ni**	**P**	**Pb**	**Si**	**Ti**	**V**	**Zn**
Canary grass[1]				4.5		19.8			<2.0	63.5
Reed canary grass – summer harvest (July to Oct)[2]	1300 (300–2300)		200 (<100–400)		1700 (500–3000)	1 (<0.5–4.0)	12,000 (<1000 to 25,000)	<0.1–0.2		
Reed canary grass – delayed harvest (March to May)[2]	500 (100–900)	160	200 (<20–400)		1100 (300–2000)	2 (<0.5–5.0)	18,000 (2300–30,000)	0.2 (<0.1–0.5)		
Grass[2]	1700 (800–2300)	1000 (200–2600)	3000 (1400–6300)	2 (0.5–5.0)	15,000 (3000–25,000)	1 (<0.5–2.0)			3	25 (10–60)
Miscanthus[2]	600 (300–900)	20 (10–100)	700 (20–100)	2 (0.5 –5)	500 (200–800)	2 (1–20)	8000 (2000–10,000)	5 (3–10)	<2	5 (3–30)

Notes: [1] Data supplied by the Environment Agency
[2] BSI (2010)

7 Primary data

7.1 Statistical analysis of data

All ‘less than’ values were taken as the measured value. The mean, median, minimum, maximum and 90th percentile were calculated for each analyte.

Box plots can be used to graphically represent groups of quantitative data. The sample minimum, lower quartile (Q1), median (Q2), upper quartile (Q3) and sample maximum are used. The median is indicated by the horizontal line that runs across the box. The top of the box is 75th percentile (upper quartile or Q3). The bottom of the box is the 25th percentile (lower quartile or Q1). The interquartile range is represented by the height of the box (Q3 – Q1). A smaller interquartile range indicates less variability in the dataset while a larger interquartile range indicates a variable dataset. Whiskers extend out of the box to represent the sample minimum and maximum. Outliers are plotted as asterisks and are defined as data points that are 1.5 times the interquartile range.

Outliers can adversely affect the statistical analysis by:

- giving serious bias or influence to estimates that may be of less interest
- increasing the error variance and reducing the power of statistical tests
- decreasing normality (if non-random) and altering the odds of type I and II errors

A box and whisker plot of potassium concentration in biomass is shown in Figure 7.1. This diagram demonstrates the issue of outliers in the dataset.

It is important to provide a reasonable sized dataset for comparison purposes. Where there is sufficient sample size (≥10) to calculate a 90th percentile of the data, the 90th percentile has been calculated.

7.1.1 Organics analytical data

Due to difficulties encountered during sample preparation, the limit of detection (LOD) for some analytes was elevated above the target limit of detection. This was particularly the case for many of the organics analyses where all the analytical results were less than a LOD. Due to the difficult nature of the matrices the LODs achieved varied across different samples.

The Environment Agency considers that these natural, non-waste materials do not contain the substances analysed for. A decision has been taken that in these cases the 90th percentile has been replaced by a target concentration corresponding to the lowest LOD actually achieved for any of the comparators for that substance. Those results are highlighted in red in the tables 7.1 to 7.27.

We consider this a reasonable and proportionate position.

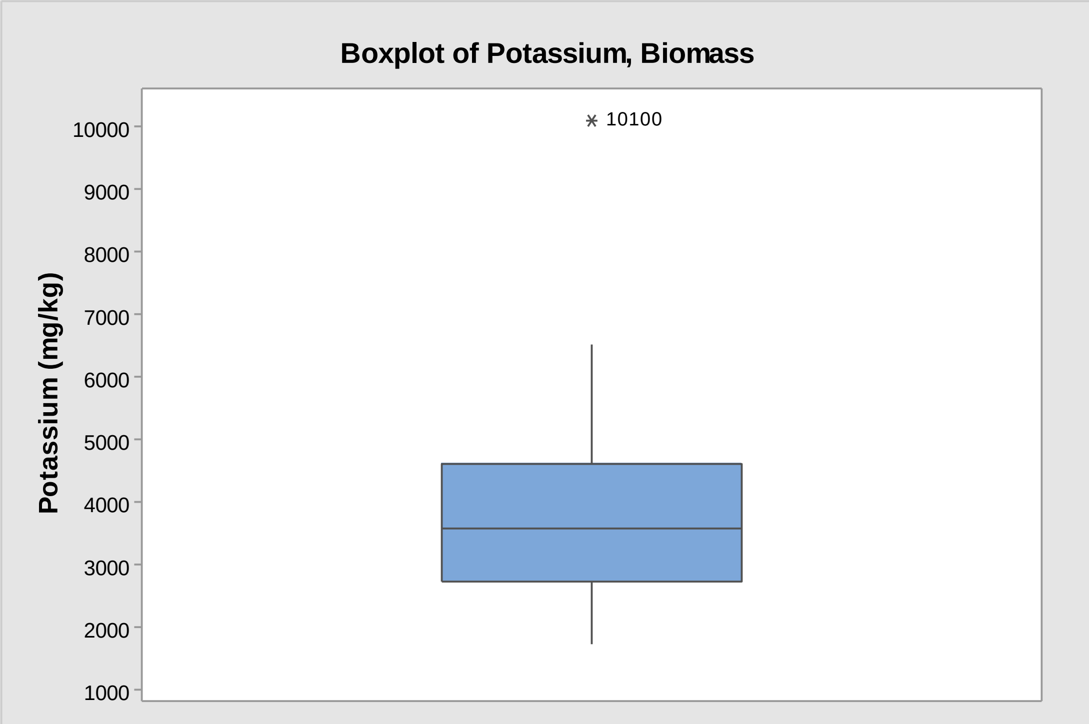

Figure 7.1 Boxplot of potassium, biomass

7.2 Using the data tables

Data are presented in tables summarising:

- physical properties
- calorific value, proximate and ultimate analysis
- metals
- organic contaminants

We recommend comparing the concentrations of analytes in the comparators dataset to the concentrations in the waste-derived material, paying attention to the higher values. This comparison does not constitute a pass/fail test or an end of waste view. It will provide an indication of whether the waste material contains similar levels of analytes to non-waste materials and whether an end-of-waste application may be appropriate or that further analysis or improved treatment processes may be warranted.

Due to difficulties encountered during sample preparation, the limit of detection (LOD) for some analytes was elevated above the target limit of detection.

7.3 Primary data tables

Primary data are shown as follows:

- wood – Tables 7.1 to 7.9
- other biomass (Miscanthus and willow) – Tables 7.10 to 7.18
- straw – Tables 7.19 to 7.27.

Table 3.1 Primary data for biomass: physical properties – wood

Sample ID	Dry solids @ 30°C	PSD 2–20 mm	PSD 20–50 mm	PSD >50 mm	Loose bulk density
	%	%	%	%	kg/m^3
Biomass 01	82.3	<0.10	100.0	<0.1	–
Biomass 02	98.1	<0.10	100.0	<0.1	–
Biomass 03	99.1	<0.10	100.0	<0.1	694
Biomass 04	78.1	24.70	24.7	<0.1	206
Biomass 05	98.9	75.30	<0.1	<0.1	612
Biomass 06	86.6	<0.10	100.0	<0.1	–
Biomass 07	94.9	69.90	<0.1	<0.1	–
Biomass 08	92.6	<0.10	100.0	<0.1	–
Biomass 09	81.8	<0.10	100.0	<0.1	–
Biomass 10	89.1	<0.10	100.0	<0.1	–
Biomass 11	73.2	<0.01	100.0	<0.1	208
Biomass 12	55.5	93.00	<0.1	<0.1	269
Mean	85.9	21.97	68.8	0.1	445
Median	87.9	0.10	100.0	0.1	441
Minimum	55.5	0.01	0.1	0.1	206
Maximum	99.1	93.00	100.0	0.1	694
No. of samples	12	12	12	12	4
90^{th} percentile	98.8	74.76	100.0	0.1	n/a
LOD	0.5	0.1	0.1	0.1	n/a

Notes: – Particle size reduced, loose bulk density test not conducted.

Table 7.2 Primary data for biomass: metals – wood (mg/kg DW)

(a)

Sample ID	Al	Sb	As	Ba	Be	Bo	Cd	Ca	Cr	Cr VI	Co	Cu	Fe	Pb	Li
Biomass 01	168.0	<1.00	<0.500	1.10	<0.1	7.14	<0.200	1020	<0.500	<0.6	<0.100	1.83	<200	<1.00	<1.00
Biomass 02	<50.0	<5.00	<0.500	9.48	<0.1	11.90	<0.200	49000	<0.500	<0.6	<0.100	1.04	<200	<1.00	<1.00
Biomass 03	<50.0	21.30	0.825	11.40	<0.1	2.30	<0.200	522	0.698	<0.6	0.985	12.70	<200	<1.00	<1.00
Biomass 04	<50.0	<1.00	0.668	1.03	<0.1	3.31	<0.200	1000	<0.500	<0.6	0.101	1.12	<200	<1.00	<1.00
Biomass 05	<50.0	<1.00	0.648	6.03	<0.1	2.83	<0.200	899	<0.500	<0.6	<0.100	<1.00	<200	<1.00	<1.00
Biomass 06	69.9	<1.00	0.636	7.92	<0.1	7.67	<0.200	6020	0.934	<0.6	0.102	31.60	565	<1.00	<1.00
Biomass 07	<50.0	<1.00	0.722	9.15	<0.1	7.86	<0.200	1150	0.879	<0.6	0.161	4.03	290	2.09	<1.00
Biomass 08	<50.0	<1.00	<0.500	5.78	<0.1	2.84	<0.200	634	<0.500	<0.6	<0.100	<1.00	<200	<1.00	<1.00
Biomass 09	123.0	<5.00	<0.500	21.20	<0.1	15.90	<0.200	104000	0.697	<0.6	<0.100	2.91	<200	2.22	1.06
Biomass 10	184.0	<1.00	<0.500	7.08	<0.1	2.34	0.211	1320	1.150	<0.6	0.146	4.06	517	1.15	<1.00
Biomass 11	<50.0	<1.00	0.664	5.90	<0.1	1.62	<0.200	357	<0.500	<0.6	<0.100	<1.00	<200	<1.00	<1.00
Biomass 12	1040.0	3.05	4.470	69.70	<0.1	22.00	0.403	18900	5.730	<1.2	1.080	23.50	1420	175.00	1.37
Mean	161.2	3.53	0.928	12.98	0.1	7.31	0.218	15402	1.091	0.7	0.265	7.15	366	15.71	1.04
Median	50.0	1.00	0.642	7.50	0.1	5.23	0.200	1085	0.599	0.6	0.101	2.37	200	1.00	1.00
Minimum	50.0	1.00	0.500	1.03	0.1	1.62	0.200	357	0.500	0.6	0.100	1.00	200	1.00	1.00
Maximum	1040.0	21.30	4.470	69.70	0.1	22.00	0.403	104000	5.730	1.2	1.080	31.60	1420	175.00	1.37
No. of samples	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
90^{th} percentile	182.4	5.00	0.815	20.22	0.1	15.50	0.210	45990	1.128	0.6	0.903	22.42	560	2.21	1.05
LOD	50	1	0.50	0.50	0.10	1.00	0.2	60	0.5	0.6	0.1	1	200	1	1

(b)

Sample ID	Mg	Mn	Hg	Mo	Ni	P	K	Se	Ag	Na	Sr	Tl	Sn	Ti	V	Zn
Biomass 01	298	51.7	<0.2	<1	<0.60	218.0	1470	<1.00	<1	114.0	<1.00	<1	<1.0	<3.0	<0.100	10.70
Biomass 02	643	53.0	<0.2	<1	<0.60	622.0	3800	<1.00	<1	26.0	82.90	<1	<1.0	<3.0	<0.100	34.70
Biomass 03	94	71.7	<0.2	<1	<0.60	63.7	404	<1.00	<1	22.2	4.63	<1	361.0	<3.0	<0.100	7.01
Biomass 04	192	50.4	<0.2	<1	<0.60	80.5	554	<1.00	<1	30.2	1.54	<1	<1.0	<3.0	0.118	7.55
Biomass 05	198	66.3	<0.2	<1	<0.60	70.8	483	<1.00	<1	48.6	3.12	<1	<1.0	<3.0	<0.100	7.10
Biomass 06	351	13.4	<0.2	<1	66.9	107.0	982	<1.00	<1	901.0	9.66	<1	<1.0	<3.0	<0.100	9.17
Biomass 07	175	98.7	<0.2	<1	<0.60	81.0	629	1.03	<1	29.3	5.33	<1	<1.0	<3.0	0.188	12.60
Biomass 08	138	49.2	<0.2	<1	<0.60	53.5	379	<1.00	<1	<10.0	1.61	<1	<1.0	<3.0	<0.100	17.90
Biomass 09	1280	144.0	<0.2	<1	4.32	303.0	2520	<1.00	<1	4850.0	184.00	<1	<1.0	<3.0	0.279	36.50
Biomass 10	138	172.0	<0.2	<1	7.72	99.2	1130	<1.00	<1	55.3	1.39	<1	<1.0	<3.0	<0.100	17.90
Biomass 11	64	77.3	<0.2	<1	<0.60	14.2	190	<1.00	<1	24.9	2.62	<1	<1.0	<3.0	<0.100	4.75
Biomass 12	1050	109.0	<0.2	<1	6.10	1450.0	3920	<1.00	<1	297.0	58.70	<1	1.5	46.9	3.330	119.00
Mean	385	79.7	0.2	1	7.49	263.6	1372	1.00	1	534.0	29.71	1	31.0	6.7	0.393	23.74
Median	195	69.0	0.2	1	0.60	90.1	806	1.00	1	39.4	3.88	1	1.0	3.0	0.100	11.65
Minimum	64	13.4	0.2	1	0.60	14.2	190	1.00	1	10.0	1.00	1	1.0	3.0	0.100	4.75
Maximum	1280	172.0	0.2	1	66.90	1450.0	3920	1.03	1	4850.0	184.00	1	361.0	46.9	3.330	119.00
No. of samples	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
90th percentile	1009	140.5	0.2	1	7.56	590.1	3672	1.00	1	840.6	80.48	1	1.5	3.0	0.270	36.32
LOD	20	2	0.2	1	0.6	10	50	1	1	10	1	1	1	3	0.1	2

Table 7.3 Primary data for biomass: PAHs – wood (µg/kg DW)

(a)

Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(ghi)perylene	Benzo(k)fluoranthene
Biomass 01	2.66	<10	<200	<200	<200	<200	<70	<200
Biomass 02	5.93	<20	<300	<300	<300	<300	<100	<300
Biomass 03	<1.00	<10	<200	<200	<200	<200	<70	<200
Biomass 04	7.13	<1	<20	<20	<20	<20	<6	<20
Biomass 05	<1.00	<2	<20	<20	<20	<20	<6	<20
Biomass 06	1.65	<6	<100	<100	<100	<100	<40	<100
Biomass 07	1.91	<2	<40	<40	<40	<40	<10	<40
Biomass 08	<0.80	<8	<200	<200	<200	<200	<50	<200
Biomass 09	<1.00	<10	<200	<200	<200	<200	<60	<200
Biomass 10	<1.00	<10	<200	<200	<200	<200	<70	<200
Biomass 11	3.31	<8	<200	<200	<200	<200	<50	<200
Biomass 12	74.90	<7	<100	<100	<100	<100	<40	<100
Mean	8.52	8	148	148	148	148	48	148
Median	1.78	8	200	200	200	200	50	200
Minimum	0.80	1	20	20	20	20	6	20
Maximum	74.90	20	300	300	300	300	100	300
No. of samples	12	12	12	12	12	12	12	12
90th percentile	7.01	1	20	20	20	20	6	20
LOD	0.1	1	20	20	20	20	6	20

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	Chrysene	Dibenzo(ah)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
Biomass 01	<400	<40	<200	<100	<400	<100	<200	<200
Biomass 02	<500	<50	<300	<200	<500	<200	<300	<300
Biomass 03	<300	<30	<200	<100	<300	<100	<200	<200
Biomass 04	<30	<3	<20	<10	<30	<10	<20	<50
Biomass 05	<30	<3	<20	<10	<30	<10	<20	<20
Biomass 06	<200	<20	<100	<60	<200	<60	<100	<100
Biomass 07	<60	<6	<40	<20	<60	<20	<40	<40
Biomass 08	<300	<30	<200	<80	<300	<80	<200	<200
Biomass 09	<300	<30	<200	<100	<300	<100	<200	<200
Biomass 10	<300	<30	<200	<100	<300	<100	<200	<200
Biomass 11	<200	<20	<200	<80	<200	<80	<200	<200
Biomass 12	<200	<20	101	<70	<200	<70	140	<100
Mean	235	24	148	78	235	78	152	151
Median	250	25	200	80	250	80	200	200
Minimum	30	3	20	10	30	10	20	20
Maximum	500	50	300	200	500	200	300	300
No. of samples	12	12	12	12	12	12	12	12
90th percentile	30	3	200	10	30	10	20	20
LOD	30	3	20	10	30	10	20	20

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.4 Primary data for biomass: organochlorine pesticides (OCPs) – wood (μg/kg DW)

(a)

Sample ID	**1,2,3-Trichlorobenzene**	**1,2,4-Trichlorobenzene**	**1,3,5-Trichlorobenzene**	**2,3,5,6-Tetrachloroaniline**	**2,3,5,6-Tetrachlorothioanisole**	**Aldrin**	**Chlordane -cis [Chlordane – alpha]**	**Chlordane -trans [Chlordane - gamma]**
Biomass 01	<10.0	<10.0	<10	<20	<10	<20	<20	<20
Biomass 02	<10.0	<10.0	<20	<30	<20	<30	<30	<30
Biomass 03	<9.0	<9.0	<10	<20	<10	<20	<20	<20
Biomass 04	<0.8	<0.8	<1	<2	<1	<2	<2	<2
Biomass 05	<0.8	<0.8	<1	<2	<1	<2	<2	<2
Biomass 06	<5.0	<5.0	<6	<10	<6	<10	<10	<10
Biomass 07	<2.0	<2.0	<2	<4	<2	<4	<4	<4
Biomass 08	<7.0	<7.0	<8	<20	<8	<20	<20	<20
Biomass 09	<8.0	<8.0	<10	<20	<10	<20	<20	<20
Biomass 10	<9.0	<9.0	<10	<20	<10	<20	<20	<20
Biomass 11	<7.0	<7.0	<9	<20	<9	<20	<20	<20
Biomass 12	<6.0	<6.0	<7	<10	<7	<10	<10	<10
Mean	6.2	6.2	8	15	8	15	15	15
Median	7.0	7.0	9	20	9	20	20	20
Minimum	0.8	0.8	1	2	1	2	2	2
Maximum	10.0	10.0	20	30	20	30	30	30
No. of samples	12	12	12	12	12	12	12	12
90^{th} percentile	0.8	0.8	1	2	1	2	2	2
LOD	0.8	0.8	1.0	2.0	1.0	2	2.0	2.0

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	Chlorpropham	DDD -op	DDE -op	DDE -pp	DDT -op + DDD pp	DDT -pp	Dichlobenil	Dieldrin
Biomass 01	<20	<20	<20	<20	<2	<20	<10	<20
Biomass 02	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 03	<20	<20	<20	<20	<2	<20	<10	<20
Biomass 04	<2	<2	<2	<2	<4	<2	<0.9	<2
Biomass 05	<2	<2	<2	<2	<4	<2	<0.9	<2
Biomass 06	<10	<10	<10	<10	<2	<10	<6	<10
Biomass 07	<4	<4	<4	<4	<2	<4	<2	<4
Biomass 08	<20	<20	<20	<20	<2	<20	<8	<20
Biomass 09	<20	<20	<20	<20	<2	<20	<9	<20
Biomass 10	<20	<20	<20	<20	<2	<20	<10	<20
Biomass 11	<20	<20	<20	<20	<2	<20	<8	<20
Biomass 12	<10	<10	<10	<10	<2	<10	<7	<10
Mean	15	15	15	15	2	15	7	15
Median	20	20	20	20	2	20	8	20
Minimum	2	2	2	2	2	2	1	2
Maximum	30	30	30	30	4	30	10	30
No. of samples	12	12	12	12	12	12	12	12
90th percentile	2	2	2	2	2	2	0.9	2
LOD	2.0	2.0	2.0	2.0	2.0	2.0	0.9	2.0

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(c)

Sample ID	Endosulfan A	Endosulfan B	Endrin	HCH -alpha	HCH -beta	HCH -delta	HCH -epsilon	HCH -gamma [lindane]
Biomass 01	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 02	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 03	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 04	<2	<2	<2	<2	<2	<2	<2	<2
Biomass 05	<2	<2	<2	<2	<2	<2	<2	<2
Biomass 06	<10	<10	<10	<10	<10	<10	<10	<10
Biomass 07	<4	<4	<4	<4	<4	<4	<4	<4
Biomass 08	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 09	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 10	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 11	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 12	<10	<10	<10	<10	<10	30.4	<10	<10
Mean	15	15	15	15	15	17	15	15
Median	20	20	20	20	20	20	20	20
Minimum	2	2	2	2	2	2	2	2
Maximum	30	30	30	30	30	30	30	30
No. of samples	12	12	12	12	12	12	12	12
90^{th} percentile	2	2	2	2	2	29	2	2
LOD	2	2	2	2	2	2	2	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(d)

Sample ID	Heptachlor	Heptachlor epoxide -cis	Heptachlor epoxide -trans	Hexachlorobenzene	Hexachlorobutadiene	Isodrin	Metazachlor	Methoxychlor
Biomass 01	<20	<20	<20	<10.0	<10.0	<20	<20	<20
Biomass 02	<30	<30	<30	<10.0	<10.0	<30	<30	<30
Biomass 03	<20	<20	<20	<10	<10.0	<20	<20	<20
Biomass 04	<2	<2	<2	<0.9	<0.9	<2	<2	<2
Biomass 05	<2	<2	<2	<0.9	<0.9	<2	<2	<2
Biomass 06	<10	<10	<10	<6.0	<6.0	<10	<10	<10
Biomass 07	<4	<4	<4	<2.0	<2.0	<4	<4	<4
Biomass 08	<20	<20	<20	<8.0	<8.0	<20	<20	<20
Biomass 09	<20	<20	<20	<9.0	<9.0	<20	<20	<20
Biomass 10	<20	<20	<20	<10.0	<10.0	<20	<20	<20
Biomass 11	<20	<20	<20	<8.0	<8.0	<20	<20	<20
Biomass 12	<10	<10	<10	<7.0	<7.0	<10	<10	<10
Mean	15	15	15	6.8	6.8	15	15	15
Median	20	20	20	8.0	8.0	20	20	20
Minimum	2	2	2	0.9	0.9	2	2	2
Maximum	30	30	30	10.0	10.0	30	30	30
No. of samples	12	12	12	12.0	12.0	12	12	12
90^{th} percentile	2	2	2	0.9	0.9	2	2	2
LOD	2	2	2	0.9	0.9	2	2	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(e)

Sample ID	Pendimethalin	Permethrin -cis	Permethrin -trans	Propachlor	Tecnazene	Trifluralin	Vinclozolin
Biomass 01	<20	<20	<20	<20	<20	<10	<20
Biomass 02	<30	<30	<30	<30	<30	<10	<30
Biomass 03	<20	<20	<20	<20	<20	<10	<20
Biomass 04	<2	<2	<2	<2	<2	<0.9	<2
Biomass 05	<2	<2	<2	<2	<2	<0.9	<2
Biomass 06	<10	<10	<10	<10	<10	<6	<10
Biomass 07	<4	<4	<4	<4	<4	<2	<4
Biomass 08	<20	<20	<20	<20	<20	<8	<20
Biomass 09	<20	<20	<20	<20	<20	<9	<20
Biomass 10	<20	<20	<20	<20	<20	<10	<20
Biomass 11	<20	<20	<20	<20	<20	<8	<20
Biomass 12	<10	<10	<10	<10	<10	<7	<10
Mean	15	15	15	15	15	7	15
Median	20	20	20	20	20	8	20
Minimum	2	2	2	2	2	1	2
Maximum	30	30	30	30	30	10	30
No. of samples	12	12	12	12	12	12	12
90^{th} percentile	2	2	2	2	2	0.9	2
LOD	2	2	2	2	2	0.9	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.5 Primary data for biomass: PCBs – wood (μg/kg DW)

(a)

Sample ID	PCB-008	PCB-020	PCB-028	PCB-035	PCB-052	PCB-077	PCB-101	PCB-105	PCB-118
Biomass 01	<20	<20	<2	<20	<10	<20	<20	<10	<10
Biomass 02	<30	<30	<2	<30	<20	<30	<30	<20	<20
Biomass 03	<20	<20	<20	<20	<10	<20	<20	<10	<10
Biomass 04	<2	<2	<2	<2	<1	<2	<2	<1	<1
Biomass 05	<2	<2	<2	<2	<1	<2	<2	<1	<1
Biomass 06	<10	<10	<2	<10	<6	<10	<10	<6	<6
Biomass 07	<4	<4	<2	<70	<2	<4	<4	<2	<2
Biomass 08	<20	<20	<2	<20	<8	<20	<20	<8	<8
Biomass 09	<20	<20	<2	<20	<10	<20	<20	<10	<10
Biomass 10	<20	<20	<2	<20	<10	<20	<20	<10	<10
Biomass 11	<20	<20	<2	<20	<8	<20	<20	<8	<8
Biomass 12	<10	<10	<10	<10	<7	<10	<10	<7	<7
Mean	15	15	4	20	8	15	15	8	8
Median	20	20	2	20	8	20	20	8	8
Minimum	2	2	2	2	1	2	2	1	1
Maximum	30	30	20	70	20	30	30	20	20
No. of samples	12	12	12	12	12	12	12	12	12
90th percentile	2	2	2	2	1	2	2	1	1
LOD	2	2	2	2	1	2	2	1	1

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	PCB-126	PCB-128	PCB-138	PCB-149	PCB-153	PCB-156	PCB-169	PCB-170	PCB-180
Biomass 01	<10	<10	<10	<10	<10	<10.0	<10.0	<2	<10
Biomass 02	<20	<20	<20	<20	<20	<10.0	<10.0	<2	<20
Biomass 03	<10	<10	<10	<10	<10	<10.0	<10.0	<20	<10
Biomass 04	<1	<1	<1	<1	<1	<0.9	<0.9	<2	<1
Biomass 05	<1	<1	<1	<1	<1	<0.9	<0.9	<2	<1
Biomass 06	<6	<6	<6	<6	<6	<6.0	<6.0	<2	<6
Biomass 07	<7	<2	<2	<2	2.02	<2.0	<2.0	<2	<2
Biomass 08	<8	<8	<8	<8	<8	<8.0	<8.0	<2	<8
Biomass 09	<10	<10	<10	<10	<10	<9.0	<9.0	<2	<10
Biomass 10	<10	<10	<10	<10	<10	<10.0	<10.0	<2	<10
Biomass 11	<8	<8	<8	<8	<8	<7.0	<7.0	<2	<8
Biomass 12	<7	<7	<7	<7	<7	<7.0	<7.0	<10	<7
Mean	8	8	8	8	8	6.7	6.7	4	8
Median	8	8	8	8	8	7.5	7.5	2	8
Minimum	1	1	1	1	1	0.9	0.9	2	1
Maximum	20	20	20	20	20	10.0	10.0	20	20
No. of samples	12	12	12	12	12	12	12	12	12
90^{th} percentile	1	1	1	1	10	0.9	0.9	2	1
LOD	1	1	1	1	1	0.9	0.9	2	1

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.6 Primary data for biomass: phenols – wood (μg/kg DW)

(a)

Sample ID	2,3,4,6-Tetrachlorophenol	2,4,5-Trichlorophenol	2,4-Dichlorophenol	2,4-Dinitrophenol	2-Nitrophenol	3,4-Dimethylphenol [3,4-Xylenol]	3,5-Dimethylphenol [3,5-Xylenol]
Biomass 01	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Biomass 02	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 03	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 04	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 05	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 06	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 07	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 08	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 09	<9000	<9000	<9000	<9000	<9000	<9000	<9000
Biomass 10	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 11	<7000	<7000	<7000	<7000	<7000	<7000	<7000
Biomass 12	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Mean	7667	7667	7667	7667	7667	7667	7667
Median	9500	9500	9500	9500	9500	9500	9500
Minimum	2000	2000	2000	2000	2000	2000	2000
Maximum	10000	10000	10000	10000	10000	10000	10000
No. of samples	12	12	12	12	12	12	12
90th percentile	2000	2000	2000	2000	2000	2000	2000
LOD	1000	1000	1000	1000	1000	1000	1000

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	4-Chloro-3-methylphenol [*p*-chloro-*m*-cresol]	4-Methylphenol [*p*-Cresol]	DNOC	Dinoseb [2-Methyl-n-propyl-4,6-dinitrophenol]	Pentachlorophenol	Phenol	Resorcinol [1,3-Dihydroxybenzene]
Biomass 01	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Biomass 02	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 03	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 04	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 05	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 06	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 07	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 08	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 09	<9000	<9000	<9000	<9000	<9000	<9000	<9000
Biomass 10	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 11	<7000	<7000	<7000	<200000	<7000	<7000	<7000
Biomass 12	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Mean	7667	7667	7667	23750	7667	7667	7667
Median	9500	9500	9500	10000	9500	9500	9500
Minimum	2000	2000	2000	2000	2000	2000	2000
Maximum	10000	10000	10000	200000	10000	10000	10000
No. of samples	12	12	12	12	12	12	12
90th percentile	2000	2000	2000	2000	2000	2000	2000
LOD	1000	1000	1000	1000	1000	1000	1000

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.7 Primary data for biomass: BTEX – wood

Sample ID	1,2-Dimethylbenzene [o-Xylene]	Benzene	Dimethylbenzene	Ethylbenzene	Toluene [Methylbenzene]
	μg/kg (DW)	μg/kg (DW)	μg/kg (DW) sum of (1,3- 1,4-isomers)	μg/kg (DW)	μg/kg (DW)
Biomass 01	<2.0	<2.00	<4.00	<1.000	10.6
Biomass 02	<2.0	<2.00	8.76	1.800	15.7
Biomass 03	<3.0	<3.00	<6.00	<1.000	<8.0
Biomass 04	<4.0	<4.00	<7.00	<2.000	<10.0
Biomass 05	1.1	2.05	2.33	1.100	25.6
Biomass 06	<1.0	<1.00	<3.00	<0.700	<4.0
Biomass 07	<2.0	<2.00	<3.00	<0.800	15.8
Biomass 08	<1.0	<1.00	<3.00	0.857	<4.0
Biomass 09	<2.0	<2.00	<4.00	<1.000	<6.0
Biomass 10	<1.0	<1.00	<3.00	<0.700	30.1
Biomass 11	<6.0	<6.00	<10.00	<3.000	<20.0
Biomass 12	<5.0	<5.00	<9.00	<2.000	<10.0
Mean	2.5	2.59	5.26	1.330	13.3
Median	2.0	2.00	4.00	1.000	10.3
Minimum	1.0	1.00	2.33	0.700	4.0
Maximum	6.0	6.00	10.00	3.000	30.1
No. of samples	12	12	12	12	12
90^{th} percentile	4.9	4.90	8.98	2.	25.0
LOD	1	1	2	0.5	3

Table 7.8 Primary data for biomass: calorific value and proximate analysis – wood

Sample ID	Calorific value (gross)	Calorific value (net)	Total moisture	Ash	Volatile matter	Fixed carbon
	kJ/kg	kJ/kg	%	%	%	%
Biomass 01	14055	12379	32.2	0.3	55.5	12.0
Biomass 02	18339	16911	7.6	0.6	78.2	13.6
Biomass 03	18793	17366	7.1	0.2	79.0	13.7
Biomass 04	15207	13583	24.2	0.2	64.1	11.5
Biomass 05	18658	17193	6.9	0.5	79.5	13.1
Biomass 06	16617	15108	15.5	0.5	71.6	12.4
Biomass 07	17781	16305	11.6	0.7	74.2	13.5
Biomass 08	8494	6481	59.8	0.1	34.3	5.8
Biomass 09	14758	13120	25.8	0.4	62.7	11.1
Biomass 10	16115	14531	21.0	0.2	65.9	12.9
Biomass 11	13787	12078	32.5	0.1	57.5	9.9
Biomass 12	10664	9150	46.3	2.1	42.3	9.3
Mean	15272	13684	24.2	0.5	63.7	11.6
Median	15661	14057	22.6	0.4	65.0	12.2
Minimum	8494	6481	6.9	0.1	34.3	5.8
Maximum	18793	17366	59.8	2.1	79.5	13.7
No. of samples	12	12	12	12	12	12
90th percentile	18626	17165	44.9	0.7	78.9	13.6
LOD	100	100	0.1	0.1	1.1	Calculated

Table 7.9 Primary data for biomass: ultimate analysis – wood

Sample ID	Bromine	Carbon	Chlorine	Fluorine	Hydrogen	Nitrogen	Oxygen	Sulphur
	mg/kg	%	%	mg/kg	%	%	%	%
Biomass 01	<100	34.78	0.01	113.1	4.08	0.10	28.5	<0.02
Biomass 02	<100	45.79	0.01	<10.0	5.70	0.16	40.1	<0.02
Biomass 03	<100	47.37	0.01	21.4	5.76	0.33	39.2	<0.02
Biomass 04	<100	38.08	0.01	12.2	4.74	0.10	32.7	0.02
Biomass 05	<100	46.62	0.01	808.0	5.95	0.10	39.9	0.02
Biomass 06	<100	41.68	0.01	<10.0	5.19	0.18	36.9	<0.02
Biomass 07	<100	45.04	0.01	21.8	5.48	0.16	37.0	<0.02
Biomass 08	<100	20.15	<0.01	<10.0	2.54	<0.10	17.3	<0.02
Biomass 09	<100	36.31	0.01	<10.0	4.62	0.13	32.7	<0.02
Biomass 10	<100	40.07	0.01	<10.0	4.92	0.18	33.6	<0.02
Biomass 11	<100	34.16	0.01	10.4	4.21	<0.10	28.9	<0.02
Biomass 12	<100	26.95	0.01	18.2	1.72	0.38	22.5	0.03
Mean	100	38.08	0.01	87.9	4.58	0.17	32.4	0.02
Median	100	39.08	0.01	11.3	4.83	0.15	33.2	0.02
Minimum	100	20.15	0.01	10.0	1.72	0.10	17.3	0.02
Maximum	100	47.37	0.01	808.0	5.95	0.38	40.1	0.03
No. of samples	12	12	12	12	12	12	12	12
90th percentile	100	46.54	0.01	104.0	5.75	0.32	39.8	0.02
LOD	100	0.41	0.01	10	0.06	0.10	Calculated	0.02

Table 4.10 Primary data for biomass: physical properties – other biomass (Miscanthus and willow)

Sample ID	Dry solids @ 30°C	PSD 2–20 mm	PSD 20–50 mm	PSD >50 mm	Loose bulk density
	%	**%**	**%**	**%**	**kg/m^3**
Biomass 14	95.8	77.6	<0.1	<0.1	543
Biomass 15	97.9	65.7	<0.1	<0.1	–
Biomass 16	82.7	<0.1	100.0	<0.1	160
Biomass 17	83.7	<0.1	100.0	<0.1	151
Biomass 18	94.8	<0.1	100.0	<0.1	82
Biomass 19	68.8	100.0	<0.1	<0.1	–
Biomass 20	92.7	100.0	<0.1	<0.1	–
Biomass 21	92.8	100.0	<0.1	<0.1	109
Biomass 22	93.0	100.0	<0.1	<0.1	–
Biomass 23	93.9	100.0	<0.1	<0.1	–
Biomass 24	84.0	*	*	*	–
Biomass 25	91.4	*	*	*	–
Biomass 26	92.6	*	*	*	–
Biomass 27	91.7	*	*	*	–
Biomass 28	90.8	*	*	*	–
Biomass 29	83.6	*	*	*	–
Biomass 30	93.8	*	*	*	–
Biomass 31	86.5	*	*	*	–
Biomass 32	84.9	*	*	*	–
Biomass 33	93.1	*	*	*	–
Mean	89.4	64.4	30.07	0.1	209
Median	92.2	88.8	0.10	0.1	151
Minimum	68.8	0.1	0.10	0.1	82
Maximum	97.9	100.0	100.00	0.1	543
No. of samples	20	10	10	10	5
90^{th} percentile	94.9	100	100	0.1	n/a
LOD	0.5	n/a	n/a	n/a	n/a

Notes: – Particle size reduced, loose bulk density test not conducted
* Sample unsuitable

Table 7.11 Primary data for biomass: metals – other biomass (Miscanthus and willow) (mg/kg DW)

(a)

Sample ID	Al	Sb	As	Ba	Be	Bo	Cd	Ca	Cr	Cr VI	Co	Cu	Fe	Pb	Li
Biomass 14	206.0	<1	0.545	21.60	<0.1	6.92	<0.200	3320	1.200	<0.6	0.105	3.42	335	<1.00	1.75
Biomass 15	<50.0	<5	0.517	10.20	<0.1	4.53	<0.200	1200	0.709	<1.2	<0.100	3.03	<200	<1.00	<1.00
Biomass 16	<50.0	<1	0.735	4.25	<0.1	4.98	0.692	1990	<0.500	<0.6	<0.100	1.55	<200	<1.00	<1.00
Biomass 17	<50.0	<1	0.761	4.87	<0.1	6.48	0.395	2260	<0.500	<0.6	<0.100	1.69	<200	<1.00	<1.00
Biomass 18	<50.0	<1	0.869	3.10	<0.1	<1.00	<0.200	545	<0.500	<0.6	<0.100	1.45	<200	<1.00	<1.00
Biomass 19	<50.0	<1	0.661	3.77	<0.1	1.98	<0.200	1840	<0.500	<0.6	<0.100	1.29	<200	<1.00	<1.00
Biomass 20	<50.0	<1	0.637	8.04	<0.1	3.69	<0.200	4920	<0.500	<0.6	<0.100	2.36	<200	<1.00	<1.00
Biomass 21	<50.0	<1	0.607	2.07	<0.1	1.61	<0.200	1330	<0.500	<0.6	<0.100	1.30	<200	<1.00	<1.00
Biomass 22	111.0	<1	0.679	16.30	<0.1	4.11	<0.200	3220	<0.500	<0.6	<0.100	2.48	<200	1.02	<1.00
Biomass 23	92.6	<1	0.638	10.50	<0.1	2.48	<0.200	2160	<0.500	<0.6	<0.100	2.27	<200	<1.00	<1.00
Biomass 24	<50.0	<1	0.657	9.24	<0.1	12.80	0.751	9800	<0.500	<1.2	0.229	3.61	<200	<1.00	<1.00
Biomass 25	<50.0	<1	0.535	4.77	<0.1	14.60	0.901	6030	<0.500	<1.2	0.170	7.66	<200	<1.00	<1.00
Biomass 26	<50.0	<1	0.582	12.10	<0.1	12.90	2.270	9090	<0.500	<1.2	0.204	2.31	<200	<1.00	<1.00
Biomass 27	<50.0	<1	0.536	6.67	<0.1	13.40	2.320	6540	<0.500	<1.2	0.175	5.30	<200	<1.00	<1.00
Biomass 28	<50.0	<1	0.616	13.10	<0.1	12.40	2.970	7630	<0.500	<1.2	0.196	4.41	<200	<1.00	<1.00
Biomass 29	182.0	<1	0.654	7.15	<0.1	12.50	5.130	8630	<0.500	<1.2	0.395	10.30	215	<1.00	<1.00
Biomass 30	<50.0	<1	0.568	10.10	<0.1	14.20	2.530	7680	<0.500	<1.2	0.380	3.48	<200	<1.00	<1.00
Biomass 31	<50.0	<1	<0.500	10.80	<0.1	10.10	0.820	6310	<0.500	<1.2	0.195	3.66	<200	<1.00	<1.00
Biomass 32	<50.0	<1	0.605	9.62	<0.1	11.50	2.360	6740	<0.500	<1.2	0.362	6.52	<200	<1.00	<1.00
Biomass 33	<50.0	<1	0.623	5.32	<0.1	10.80	1.200	6350	<0.500	<1.2	0.105	4.22	<200	<1.00	<1.00
Mean	69.6	1	0.626	8.68	0.1	8.15	1.197	4879	0.545	0.9	0.171	3.62	208	1.00	1.04
Median	50.0	1	0.620	8.64	0.1	8.51	0.722	5475	0.500	1.2	0.105	3.23	200	1.00	1.00
Minimum	50.0	1	0.500	2.07	0.1	1.00	0.200	545	0.500	0.6	0.100	1.29	200	1.00	1.00
Maximum	206.0	5	0.869	21.60	0.1	14.60	5.130	9800	1.200	1.2	0.395	10.30	335	1.02	1.75
No. of samples	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
90th percentile	118.1	1	0.738	13.42	0.1	13.48	2.574	8676	0.521	1.2	0.364	6.63	202	1.00	1.00
LOD	50	1	0.5	0.5	0.1	1	0.2	60	0.5	0.6	0.1	1	200	1	1

(b)

Sample ID	Mg	Mn	Hg	Mo	Ni	P	K	Se	Ag	Na	Sr	Tl	Sn	Ti	V	Zn
Biomass 14	542	44.4	<0.2	<1	0.650	474	4920	<1	<1	116.0	10.20	<1	<1	3.99	0.586	20.50
Biomass 15	802	44.1	<0.2	<1	<0.600	941	6520	<1	<1	141.0	2.31	<1	<1	<3.00	0.135	22.90
Biomass 16	355	11.4	<0.2	<1	<0.600	727	2370	<1	<1	74.2	5.56	<1	<1	<3.00	<0.100	53.70
Biomass 17	437	7.0	<0.2	<1	<0.600	799	2650	<1	<1	61.0	6.13	<1	<1	<3.00	<0.100	48.90
Biomass 18	593	60.3	<0.2	<1	<0.600	470	3610	<1	<1	64.3	1.01	<1	<1	<3.00	<0.100	4.84
Biomass 19	255	23.1	<0.2	<1	<0.600	214	2250	<1	<1	71.5	3.27	<1	<1	<3.00	<0.100	4.06
Biomass 20	601	21.3	<0.2	<1	<0.600	592	10100	<1	<1	83.4	5.38	<1	<1	<3.00	0.106	10.90
Biomass 21	203	24.9	<0.2	<1	<0.600	1040	3240	<1	<1	125.0	3.20	<1	<1	<3.00	<0.100	8.97
Biomass 22	620	39.7	<0.2	<1	<0.600	577	1700	<1	<1	123.0	3.92	<1	<1	<3.00	0.361	27.70
Biomass 23	465	30.9	<0.2	<1	<0.600	747	4370	<1	<1	78.7	2.75	<1	<1	<3.00	0.286	15.10
Biomass 24	706	47.8	<0.2	<1	0.943	1170	3540	<1	<1	123.0	31.10	<1	<1	<3.00	<0.100	103.00
Biomass 25	937	57.5	<0.2	<1	2.580	2010	4820	<1	<1	102.0	24.20	<1	<1	<3.00	<0.100	125.00
Biomass 26	398	84.7	<0.2	<1	1.220	456	2600	<1	<1	157.0	29.20	<1	<1	<3.00	<0.100	141.00
Biomass 27	488	97.6	<0.2	<1	1.570	1840	4660	<1	<1	55.6	21.80	<1	<1	<3.00	<0.100	110.00
Biomass 28	956	53.4	<0.2	<1	1.350	1400	3880	<1	<1	120.0	16.10	<1	<1	<3.00	<0.100	129.00
Biomass 29	630	137.0	<0.2	<1	1.440	1020	3270	<1	<1	183.0	27.30	<1	<1	<3.00	0.594	150.00
Biomass 30	676	109.0	<0.2	<1	2.290	1300	4100	<1	<1	131.0	40.50	<1	<1	<3.00	<0.100	138.00
Biomass 31	409	89.5	<0.2	<1	<0.600	920	3070	<1	<1	31.2	14.80	<1	<1	<3.00	<0.100	99.10
Biomass 32	866	48.7	<0.2	<1	1.070	985	3800	<1	<1	338.0	22.30	<1	<1	<3.00	<0.100	127.00
Biomass 33	558	42.8	<0.2	<1	0.734	1010	2870	<1	<1	119.0	22.30	<1	<1	<3.00	<0.100	87.50
Mean	575	53.8	0.2	1	0.992	935	3917	1	1	114.9	14.67	1	1	3.05	0.173	71.36
Median	576	46.1	0.2	1	0.625	931	3575	1	1	117.5	12.50	1	1	3.00	0.100	70.60
Minimum	203	7.0	0.2	1	0.600	214	1700	1	1	31.2	1.01	1	1	3.00	0.100	4.06
Maximum	956	137.0	0.2	1	2.580	2010	10100	1	1	338.0	40.50	1	1	3.99	0.594	150.00
No. of samples	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
90^{th} percentile	873	98.7	0.2	1	1.642	1444	5080	1	1	159.6	29.39	1	1	3.00	0.384	138.30
LOD	20	2	0.2	1	0.6	10	50	1	1	10	1	1	1	3	0.1	2

Table 7.12 Primary data for biomass: PAHs – other biomass (Miscanthus and willow) (μg/kg DW)

(a)

Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(ghi)perylene	Benzo(k)fluoranthene
Biomass 14	<0.200	<2.00	<40	<40	<40	<40	<10	<40
Biomass 15	1.430	4.22	<40	<40	<40	<40	<10	<40
Biomass 16	0.938	<8.00	<200	<200	<200	<200	<50	<200
Biomass 17	16.500	<10.00	<300	<300	<300	<300	<80	<300
Biomass 18	<0.800	<8.00	<200	<200	<200	<200	<50	<200
Biomass 19	<2.000	<20.00	<400	<400	<400	<400	<100	<400
Biomass 20	<2.000	<20.00	<400	<400	<400	<400	<100	<400
Biomass 21	3.800	<10.00	<300	<300	<300	<300	<90	<300
Biomass 22	3.570	<20.00	<400	<400	<400	<400	<100	<400
Biomass 23	<2.000	<20.00	<300	<300	<300	<300	<100	<300
Biomass 24	<2.000	<20.00	<300	<300	<300	<300	<90	<300
Biomass 25	<2.000	<20.00	<300	<300	<300	<300	<100	<300
Biomass 26	3.860	<20.00	<400	<400	<400	<400	<100	<400
Biomass 27	5.670	<20.00	<300	<300	<300	<300	<100	<300
Biomass 28	2.370	<20.00	<400	<400	<400	<400	<100	<400
Biomass 29	3.020	<20.00	<300	<300	<300	<300	<100	<300
Biomass 30	7.900	<20.00	<400	<400	<400	<400	<100	<400
Biomass 31	3.930	<10.00	<300	<300	<300	<300	<80	<300
Biomass 32	3.030	<20.00	<300	<300	<300	<300	<100	<300
Biomass 33	5.800	<20.00	<400	<400	<400	<400	<100	<400
Mean	3.641	15.61	299	299	299	299	83	299
Median	2.695	20.00	300	300	300	300	100	300
Minimum	0.200	2.00	40	40	40	40	10	40
Maximum	16.500	20.00	400	400	400	400	100	400
No. of samples	20	20	20	20	20	20	20	20
90th percentile	6.010	20.00	40	40	40	40	10	40
LOD	0.1	1	20	20	20	20	6	20

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	Chrysene	Dibenzo(ah)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
Biomass 14	<60	<6	<40	<20	<60	<20	<40	<40
Biomass 15	<60	<6	<40	<20	<60	<20	<40	<40
Biomass 16	<200	<20	<200	<80	<200	<80	<200	<200
Biomass 17	<400	<40	<300	<100	<400	<100	<300	<300
Biomass 18	<200	<20	<200	<80	<200	<80	278	<200
Biomass 19	<600	<60	<400	<200	<600	<200	<400	<400
Biomass 20	<600	<60	<400	<200	<600	<200	<400	<400
Biomass 21	<400	<40	<300	<100	<400	<100	<300	<300
Biomass 22	<600	<60	<400	<200	<600	<200	<400	<400
Biomass 23	<500	<50	<300	<200	<500	<200	<300	<300
Biomass 24	<500	368	<300	<200	<500	<200	<300	<300
Biomass 25	<500	<2000	<300	<200	<500	<200	<300	<300
Biomass 26	<500	<300	<400	<200	<500	<200	<400	<400
Biomass 27	<500	<200	<300	<200	<500	<200	<300	<300
Biomass 28	<600	<500	<400	<200	<600	<200	<400	<400
Biomass 29	<500	<300	<300	<200	<500	<200	<300	<300
Biomass 30	<600	<700	<400	<200	<600	<200	<400	<400
Biomass 31	<400	<700	<300	<100	<400	<100	<300	<300
Biomass 32	<500	<700	<300	<200	<500	<200	<300	<300
Biomass 33	<600	<400	<400	<200	<600	<200	<400	<400
Mean	441	327	299	155	441	155	303	299
Median	500	130	300	200	500	200	300	300
Minimum	60	6	40	20	60	20	40	40
Maximum	600	2000	400	200	600	200	400	400
No. of samples	20	20	20	20	20	20	20	20
90th percentile	60	700	40	20	60	20	400	40
LOD	30	3	20	10	30	10	20	20

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.13 Primary data for biomass: organochlorine pesticides (OCPs) – other biomass (Miscanthus and willow) (μg/kg DW)

(a)

Sample ID	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,3,5-Trichlorobenzene	2,3,5,6-Tetrachloroaniline	2,3,5,6-Tetrachlorothioanisole	Aldrin	Chlordane -cis [Chlordane – alpha]	Chlordane -trans [Chlordane - gamma]
Biomass 14	<2	<2	<2	<4	<2	<4	<4	<4
Biomass 15	<2	<2	<2	<4	<2	<4	<4	<4
Biomass 16	<6	<6	<8	<20	<8	<20	<20	<20
Biomass 17	<7	<7	<8	<20	<8	<20	<20	<20
Biomass 18	<10	<10	<10	<30	<10	<30	<30	<30
Biomass 19	<20	<20	<20	<40	<20	<40	<40	<40
Biomass 20	<20	<20	<20	<40	<20	<40	<40	<40
Biomass 21	<10	<10	<10	<30	<10	<30	<30	<30
Biomass 22	<20	<20	<20	<40	<20	<40	<40	<40
Biomass 23	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 24	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 25	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 26	<10	<10	<20	<40	<20	<40	<40	<40
Biomass 27	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 28	<20	<20	<20	<40	<20	<40	<40	<40
Biomass 29	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 30	<20	<20	<20	<40	<20	<40	<40	<40
Biomass 31	<10	<10	<10	<30	<10	<30	<30	<30
Biomass 32	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 33	<20	<20	<20	<40	<20	<40	<40	<40
Mean	12	12	16	30	16	30	30	30
Median	10	10	20	30	20	30	30	30
Minimum	2	2	2	4	2	4	4	4
Maximum	20	20	20	40	20	40	40	40
No. of samples	20	20	20	20	20	20	20	20
90^{th} percentile	2	2	2	4	2	4	4	4
LOD	0.8	0.8	1	2	1	2	2	2

(b)

Sample ID	Chlorpropham	DDD -op	DDE -op	DDE -pp	DDT -op + DDD pp	DDT -pp	Dichlobenil	Dieldrin
Biomass 14	<4	<4	<4	<4	<2	<4	<2	<4
Biomass 15	<4	<4	<4	<4	<2	<4	<2	<4
Biomass 16	<20	<20	<20	<20	<2	<20	<7	<20
Biomass 17	<20	<20	<20	<20	<2	<20	<7	<20
Biomass 18	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 19	<40	<40	<40	<40	<2	<40	<20	<40
Biomass 20	<40	<40	<40	<40	<2	<40	<20	<40
Biomass 21	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 22	<40	<40	<40	<40	<2	<40	<20	<40
Biomass 23	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 24	<30	<30	<30	<30	<30	<30	<10	<30
Biomass 25	<30	<30	<30	<30	<30	<30	<10	<30
Biomass 26	<40	<40	<40	<40	<30	<40	<20	<40
Biomass 27	<30	<30	<30	<30	<30	<30	<20	<30
Biomass 28	<40	<40	<40	<40	<30	<40	<20	<40
Biomass 29	<30	<30	<30	<30	<30	<30	<10	<30
Biomass 30	<40	<40	<40	<40	<40	<40	<20	<40
Biomass 31	<30	<30	<30	<30	<30	<30	<10	<30
Biomass 32	<30	<30	<30	<30	<30	<30	<10	<30
Biomass 33	<40	<40	<40	<40	<30	<40	<20	<40
Mean	30	30	30	30	17	30	13	30
Median	30	30	30	30	16	30	10	30
Minimum	4	4	4	4	2	4	2	4
Maximum	40	40	40	40	40	40	20	40
No. of samples	20	20	20	20	20	20	20	20
90^{th} percentile	4	4	4	4	2	4	2	4
LOD	2	2	2	2	2	2	0.9	2

(c)

Sample ID	**Endosulfan A**	**Endosulfan B**	**Endrin**	**HCH -alpha**	**HCH -beta**	**HCH -delta**	**HCH -epsilon**	**HCH -gamma [lindane]**
Biomass 14	<4	<4	<4	<4	<4	<4	<4	<4
Biomass 15	<4	<4	<4	<4	<4	<4	<4	<4
Biomass 16	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 17	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 18	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 19	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 20	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 21	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 22	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 23	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 24	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 25	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 26	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 27	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 28	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 29	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 30	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 31	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 32	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 33	<40	<40	<40	<40	<40	<40	<40	<40
Mean	30	30	30	30	30	30	30	30
Median	30	30	30	30	30	30	30	30
Minimum	4	4	4	4	4	4	4	4
Maximum	40	40	40	40	40	40	40	40
No. of samples	20	20	20	20	20	20	20	20
90^{th} percentile	4	4	4	4	4	4	4	4
LOD	2	2	2	2	2	2	2	2

(d)

Sample ID	Heptachlor	Heptachlor epoxide -cis	Heptachlor epoxide -trans	Hexachlorobenzene	Hexachlorobutadiene	Isodrin	Metazachlor	Methoxychlor
Biomass 14	<4	<4	<4	<2	<2	<4	<4	<4
Biomass 15	<4	<4	<4	<2	<2	<4	<4	<4
Biomass 16	<20	<20	<20	<7	<7	<20	<20	<20
Biomass 17	<20	<20	<20	<7	<7	<20	<20	<20
Biomass 18	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 19	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 20	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 21	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 22	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 23	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 24	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 25	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 26	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 27	<30	<30	<30	<20	<20	<30	<30	<30
Biomass 28	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 29	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 30	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 31	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 32	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 33	<40	<40	<40	<20	<20	<40	<40	<40
Mean	30	30	30	13	13	30	30	30
Median	30	30	30	10	10	30	30	30
Minimum	4	4	4	2	2	4	4	4
Maximum	40	40	40	20	20	40	40	40
No. of samples	20	20	20	20	20	20	20	20
90th percentile	4	4	4	2	2	4	4	4
LOD	2	2	2	0.9	0.9	2	2	2

(e)

Sample ID	Pendimethalin	Permethrin -cis	Permethrin -trans	Propachlor	Tecnazene	Trifluralin	Vinclozolin
Biomass 14	<4	<4	<4	<4	<4	<2	<4
Biomass 15	<4	<4	<4	<4	<4	<2	<4
Biomass 16	<20	<20	<20	<20	<20	<7	<20
Biomass 17	<20	<20	<20	<20	<20	<7	<20
Biomass 18	<30	<30	<30	<30	<30	<10	<30
Biomass 19	<40	<40	<40	<40	<40	<20	<40
Biomass 20	<40	<40	<40	<40	<40	<20	<40
Biomass 21	<30	<30	<30	<30	<30	<10	<30
Biomass 22	<40	<40	<40	<40	<40	<20	<40
Biomass 23	<30	<30	<30	<30	<30	<10	<30
Biomass 24	<30	<30	<30	<30	<30	<10	<30
Biomass 25	<30	<30	<30	<30	<30	<10	<30
Biomass 26	<40	<40	<40	<40	<40	<20	<40
Biomass 27	<30	<30	<30	<30	<30	<20	<30
Biomass 28	<40	<40	<40	<40	<40	<20	<40
Biomass 29	<30	<30	<30	<30	<30	<10	<30
Biomass 30	<40	<40	<40	<40	<40	<20	<40
Biomass 31	<30	<30	<30	<30	<30	<10	<30
Biomass 32	<30	<30	<30	<30	<30	<10	<30
Biomass 33	<40	<40	<40	<40	<40	<20	<40
Mean	30	30	30	30	30	13	30
Median	30	30	30	30	30	10	30
Minimum	4	4	4	4	4	2	4
Maximum	40	40	40	40	40	20	40
No. of samples	20	20	20	20	20	20	20
90^{th} percentile	4	4	4	4	4	2	4
LOD	2	2	2	2	2	0.9	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.14 Primary data for biomass: PCBs – other biomass (Miscanthus and willow) (μg/kg DW)

(a)

Sample ID	PCB-008	PCB-020	PCB-028	PCB-035	PCB-052	PCB-077	PCB-101	PCB-105	PCB-118
Biomass 14	<4	<4	<2	<4	<2	<4	<4	<2	<2
Biomass 15	<4	<4	<2	<4	<2	<4	<4	<2	<2
Biomass 16	<20	<20	<2	<20	<8	<20	<20	<8	<8
Biomass 17	<30	<30	<2	<30	<10	<30	<30	<10	<10
Biomass 18	<20	<20	<20	<20	<8	<20	<20	<8	<8
Biomass 19	<40	<40	<2	<40	<20	<40	<40	<20	<20
Biomass 20	<40	<40	<2	<40	<20	<40	<40	<20	<20
Biomass 21	<30	<30	<2	<30	<10	<30	<30	<10	<10
Biomass 22	<40	<40	<2	<40	<20	<40	<40	<20	<20
Biomass 23	<30	<30	<2	<30	<20	<30	<30	<20	<20
Biomass 24	<30	<30	<20	<30	<20	<30	<30	<20	<20
Biomass 25	<30	<30	<20	<30	<20	<30	<30	<20	<20
Biomass 26	<40	<40	<20	<40	<20	<40	<40	<20	<20
Biomass 27	<30	<30	<20	<30	<20	<30	<30	<20	<20
Biomass 28	<40	<40	<20	<40	<20	<40	<40	<20	<20
Biomass 29	<30	<30	<20	<30	<20	<30	<30	<20	<20
Biomass 30	<40	<40	<20	<40	<20	<40	<40	<20	<20
Biomass 31	<30	<30	<20	<30	<10	<30	<30	<10	<10
Biomass 32	<30	<30	<20	<30	<20	<30	<30	<20	<20
Biomass 33	<40	<40	<20	<40	<20	<40	<40	<20	<20
Mean	30	30	12	30	16	30	30	16	16
Median	30	30	20	30	20	30	30	20	20
Minimum	4	4	2	4	2	4	4	2	2
Maximum	40	40	20	40	20	40	40	20	20
No. of samples	20	20	20	20	20	20	20	20	20
90th percentile	4	4	2	4	2	4	4	2	2
LOD	2	2	2	2	1	2	2	1	1

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	PCB-126	PCB-128	PCB-138	PCB-149	PCB-153	PCB-156	PCB-169	PCB-170	PCB-180
Biomass 14	<2	<2	<2	<2	<2	<2	<2	<2	<2
Biomass 15	<2	<2	<2	<2	<2	<2	<2	<2	<2
Biomass 16	<8	<8	<8	<8	<8	<7	<7	<2	<8
Biomass 17	<10	<10	<10	<10	<10	<10	<10	<2	<10
Biomass 18	<8	<8	<8	<8	<8	<7	<7	<20	<8
Biomass 19	<20	<20	<20	<20	<20	<20	<20	<2	<20
Biomass 20	<20	<20	<20	<20	<20	<20	<20	<2	<20
Biomass 21	<10	<10	<10	<10	<10	<10	<10	<2	<10
Biomass 22	<20	<20	<20	<20	<20	<20	<20	<2	<20
Biomass 23	<20	<20	<20	<20	<20	<10	<10	<2	<20
Biomass 24	<20	<20	<20	<20	<20	<10	<10	<20	<20
Biomass 25	<20	<20	<20	<20	<20	<10	<10	<20	<20
Biomass 26	<20	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 27	<20	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 28	<20	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 29	<20	<20	<20	<20	<20	<10	<10	<20	<20
Biomass 30	<20	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 31	<10	<10	<10	<10	<10	<10	<10	<20	<10
Biomass 32	<20	<20	<20	<20	<20	<10	<10	<20	<20
Biomass 33	<20	<20	<20	<20	<20	<20	<20	<20	<20
Mean	16	16	16	16	16	13	13	12	16
Median	20	20	20	20	20	10	10	20	20
Minimum	2	2	2	2	2	2	2	2	2
Maximum	20	20	20	20	20	20	20	20	20
No. of samples	20	20	20	20	20	20	20	20	20
90th percentile	2	2	2	2	2	2	2	2	2
LOD	1	1	1	1	1	0.9	0.9	2	1

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.15 Primary data for biomass: phenols – other biomass (Miscanthus and willow) (μg/kg DW)

(a)

Sample ID	**2,3,4,6-Tetrachlorophenol**	**2,4,5-Trichlorophenol**	**2,4-Dichlorophenol**	**2,4-Dinitrophenol**	**2-Nitrophenol**	**3,4-Dimethylphenol [3,4-Xylenol]**	**3,5-Dimethylphenol [3,5-Xylenol]**
Biomass 14	<2000	<2000	<2000	<2000	7810	<2000	<2000
Biomass 15	<2000	<2000	<2000	<2000	23100	<2000	<2000
Biomass 16	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Biomass 17	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Biomass 18	<40000	<40000	<40000	<40000	<40000	<40000	<40000
Biomass 19	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 20	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 21	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 22	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 23	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 24	<8000	<8000	<8000	<8000	<8000	<8000	<8000
Biomass 25	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 26	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 27	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 28	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 29	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 30	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 31	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 32	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 33	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Mean	17200	17200	17200	17200	18546	17200	17200
Median	10000	10000	10000	10000	10000	10000	10000
Minimum	2000	2000	2000	2000	6000	2000	2000
Maximum	50000	50000	50000	50000	50000	50000	50000
No. of samples	20	20	20	20	20	20	20
90th percentile	2000	2000	2000	2000	50000	2000	2000
LOD	1000	1000	1000	1000	1000	1000	1000

(b)

Sample ID	4-Chloro-3-methylphenol [*p*-chloro-*m*-cresol]	4-Methylphenol [*p*-Cresol]	DNOC	Dinoseb [2-Methyl-n-propyl-4,6-dinitrophenol]	Pentachlorophenol	Phenol	Resorcinol [1,3-Dihydroxybenzene]
Biomass 14	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 15	<2000	<2000	<2000	<2000	<2000	47400	<2000
Biomass 16	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Biomass 17	<6000	<6000	<6000	<6000	<6000	<6000	<6000
Biomass 18	<40000	<40000	<40000	<40000	<40000	<40000	<40000
Biomass 19	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 20	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 21	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 22	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 23	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 24	<8000	<8000	<8000	<8000	<8000	<8000	<70000
Biomass 25	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 26	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 27	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 28	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 29	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 30	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 31	<10000	<10000	<10000	<10000	<10000	<10000	<50000
Biomass 32	<10000	<10000	<10000	<10000	<10000	<10000	<10000
Biomass 33	<10000	<10000	<10000	<10000	<10000	<10000	<50000
Mean	17200	17200	17200	17200	17200	19470	24300
Median	10000	10000	10000	10000	10000	10000	10000
Minimum	2000	2000	2000	2000	2000	2000	2000
Maximum	50000	50000	50000	50000	50000	50000	70000
No. of samples	20	20	20	20	20	20	20
90^{th} percentile	2000	2000	2000	2000	2000	50000	2000
LOD	1000	1000	1000	1000	1000	1000	1000

Table 7.16 Primary data for biomass: BTEX – other biomass (Miscanthus and willow)

Sample ID	1,2-Dimethylbenzene [o-Xylene]	Benzene	Dimethylbenzene	Ethylbenzene	Toluene [Methylbenzene]
	µg/kg (DW)	µg/kg (DW)	µg/kg (DW) sum of (1,3- 1,4-isomers)	µg/kg (DW)	µg/kg (DW)
Biomass 14	<1.00	<1.00	<2.00	0.698	<3.0
Biomass 15	1.82	1.12	6.37	1.970	4.1
Biomass 16	<6.00	<6.00	<10.00	<3.000	<20.0
Biomass 17	<6.00	<6.00	<10.00	<3.000	<20.0
Biomass 18	<5.00	<5.00	<10.00	2.060	<10.0
Biomass 19	<5.00	<5.00	<10.00	<2000	<10.0
Biomass 20	8.82	<4.00	19.7	5.470	26.2
Biomass 21	<6.00	<6.00	<10.00	<3.000	<20.0
Biomass 22	<4.00	<4.00	<7.00	<2.000	<10.0
Biomass 23	<4.00	<4.00	<9.00	<2.000	<10.0
Biomass 24	<4.00	<4.00	<8.00	<2.000	<10.0
Biomass 25	<4.00	<4.00	<9.00	<2.000	<10.0
Biomass 26	<4.00	<4.00	<8.00	<2.000	<10.0
Biomass 27	<5.00	<5.00	<9.00	<2.000	<10.0
Biomass 28	<5.00	<5.00	<10.00	<2.000	<10.0
Biomass 29	<4.00	<4.00	<8.00	<2.000	<10.0
Biomass 30	<3.00	<3.00	<7.00	<2.000	<10.0
Biomass 31	<3.00	<3.00	<7.00	<2.000	<10.0
Biomass 32	<5.00	<5.00	<10.00	<2.000	<10.0
Biomass 33	<4.00	<4.00	<8.00	<2.000	<10.0
Mean	4.43	4.16	8.90	2.260	11.7
Median	4.00	4.00	9.00	2.000	10.0
Minimum	1.00	1.00	2.00	0.698	3.0
Maximum	8.82	6.00	19.70	5.470	26.2
No. of samples	20	20	20	20	20
90^{th} percentile	6.00	6.00	10.00	3.000	20.0
LOD	1	1	2	0.5	3

Table 7.17 Primary data for biomass: calorific value and proximate analysis – other biomass (Miscanthus and willow)

Sample ID	Calorific value (gross)	Calorific value (net)	Total moisture	Ash	Volatile matter	Fixed carbon
	kJ/kg	kJ/kg	%	%	%	%
Biomass 14	16630	15233	10.0	4.9	69.4	15.7
Biomass 15	17831	16450	7.1	3.6	73.4	15.9
Biomass 16	14945	13374	24.0	1.4	61.5	13.1
Biomass 17	15570	14036	21.7	1.5	63.2	13.6
Biomass 18	17269	15823	11.9	1.9	70.3	15.9
Biomass 19	10257	8410	46.5	1.2	43.1	9.2
Biomass 20	16613	15175	13.0	3.1	67.5	16.4
Biomass 21	16762	15331	12.3	2.0	71.3	14.4
Biomass 22	16878	15447	12.2	2.6	68.4	16.8
Biomass 23	17098	15633	11.3	2.7	69.3	16.7
Biomass 24	13829	12171	30.4	1.7	54.6	13.3
Biomass 25	13810	12143	30.3	1.5	55.8	12.4
Biomass 26	15146	13541	23.9	1.8	60.0	14.3
Biomass 27	15470	13882	21.9	1.7	62.7	13.7
Biomass 28	14747	13098	26.9	1.8	58.0	13.3
Biomass 29	13845	12176	31.0	2.0	53.8	13.2
Biomass 30	16046	14484	19.9	1.6	64.6	13.9
Biomass 31	22547	20862	30.8	1.4	55.2	12.6
Biomass 32	10747	9078	30.3	1.4	56.4	11.9
Biomass 33	15341	13765	22.5	1.7	62.1	13.7
Mean	15569	14006	21.9	2.1	62.0	14.0
Median	15520	13959	22.2	1.8	62.4	13.7
Minimum	10257	8410	7.1	1.2	43.1	9.2
Maximum	22547	20862	46.5	4.9	73.4	16.8
No. of samples	20	20	20	20	20	20
90^{th} percentile	17325	15886	30.8	3.2	70.4	16.4
LOD	100	100	0.1	0.1	1.1	Calculated

Table 7.18 Primary data for biomass: ultimate analysis – other biomass (Miscanthus and willow)

Sample ID	Bromine	Carbon	Chlorine	Fluorine	Hydrogen	Nitrogen	Oxygen	Sulphur
	mg/kg	%	%	mg/kg	%	%	%	%
Biomass 14	<100.0	42.01	0.10	11.9	5.29	0.45	37.2	0.07
Biomass 15	<100.0	44.73	0.11	<10.0	5.55	0.50	38.3	0.07
Biomass 16	<100.0	38.00	0.01	<10.0	4.52	0.75	31.3	0.03
Biomass 17	<100.0	39.10	0.01	<10.0	4.61	0.67	32.4	0.03
Biomass 18	<100.0	42.88	0.08	<10.0	5.30	0.77	37.1	0.08
Biomass 19	104.8	25.70	0.15	<10.0	3.26	0.29	22.9	0.03
Biomass 20	<100.0	41.25	0.15	<10.0	5.14	0.36	37.0	0.05
Biomass 21	<100.0	42.44	0.07	<10.0	5.18	0.33	37.6	0.04
Biomass 22	<100.0	42.42	0.05	<10.0	5.20	0.16	37.3	0.05
Biomass 23	<100.0	3.81	0.06	<10.0	5.31	0.72	76.0	0.06
Biomass 24	<100.0	34.95	0.01	<10.0	4.20	0.53	28.2	0.05
Biomass 25	<100.0	34.81	0.01	14.6	4.26	0.31	28.8	0.04
Biomass 26	<100.0	38.31	0.01	<10.0	4.70	0.46	30.8	0.04
Biomass 27	<100.0	39.11	0.01	<10.0	4.84	0.37	32.0	0.03
Biomass 28	<100.0	37.03	0.01	247.6	4.56	0.44	29.2	0.04
Biomass 29	<100.0	34.61	0.01	<10.0	4.20	0.40	27.7	0.04
Biomass 30	<100.0	40.21	0.01	<10.0	4.95	0.46	32.8	0.03
Biomass 31	<100.0	34.76	0.01	<10.0	4.28	0.43	28.3	0.03
Biomass 32	<100.0	35.04	0.01	<10.0	4.26	0.47	28.5	0.04
Biomass 33	<100.0	38.60	0.01	18.4	4.71	0.40	32.1	0.03
Mean	100.2	36.49	0.04	22.6	4.72	0.46	34.3	0.04
Median	100.0	38.46	0.01	10.0	4.71	0.45	32.1	0.04
Minimum	100.0	3.81	0.01	10.0	3.26	0.16	22.9	0.03
Maximum	104.8	44.73	0.15	247.6	5.55	0.77	76.0	0.08
No. of samples	20	20	20	20	20	20	20	20
90^{th} percentile	100.0	42.48	0.11	15.0	5.30	0.72	37.7	0.07
LOD	100.0	0.41	0.01	10	0.06	0.1	Calculated	0.02

Table 5.19 Primary data for biomass: physical properties – straw

Sample ID	Dry solids @ 30°C	PSD 2–20 mm	PSD 20–50 mm	PSD >50 mm	Loose bulk density
	%	%	%	%	kg/m^3
Biomass 33	96.8	83.5	<0.1	<0.1	609*
Biomass 34	97.7	<0.1	100.0	<0.1	625*
Biomass 35	93.6	100.0	<0.1	<0.1	22
Biomass 36	94.5	38.7	<0.1	<0.1	–
Biomass 37	90.3	100.0	<0.1	<0.1	30
Biomass 38	93.3	100.0	<0.1	<0.1	20
Biomass 39	94.6	100.0	<0.1	<0.1	23
Biomass 40	89.4	100.0	<0.1	<0.1	27
Biomass 41	92.1	100.0	<0.1	<0.1	27
Biomass 42	90.1	100.0	<0.1	<0.1	32
Mean	93.2	82.2	10.1	0.1	157
Median	93.5	100.0	0.1	0.1	27
Minimum	89.4	0.1	0.1	0.1	20
Maximum	97.7	100.0	100.0	0.1	625
No. of samples	10	10	10	10	9
90th percentile	96.9	100.0	10.1	0.1	n/a
LOD	0.5	n/a	n/a	n/a	n/a

Notes: – Particle size reduced, loose bulk density test not conducted
* Straw pellets

Table 7.20 Primary data for biomass: metals – straw (mg/kg DW)

(a)

Sample ID	Al	Sb	As	Ba	Be	Bo	Cd	Ca	Cr	Cr VI	Co	Cu	Fe	Pb	Li
Biomass 33	122.0	<5	0.542	11.50	<0.1	4.27	0.200	1510	0.823	<0.6	<0.100	2.78	256	<1	1.07
Biomass 34	347.0	<1	0.927	25.40	<0.1	7.85	<0.200	1880	2.990	<0.6	0.174	1.59	513	<1	<1.00
Biomass 35	<50.0	<1	0.538	42.70	<0.1	5.16	<0.200	4330	<0.500	<0.6	<0.100	1.71	<200	<1	<1.00
Biomass 36	93.2	<1	0.727	3.11	<0.1	19.40	0.365	4850	0.594	<0.6	<0.100	5.12	<4000	<1	<1.00
Biomass 37	<50.0	<1	0.681	8.15	<0.1	30.20	<0.200	19200	<0.500	<0.6	0.110	1.85	<200	<1	<1.00
Biomass 38	90.3	<1	0.557	33.30	<0.1	9.23	<0.200	5900	<0.500	<0.6	<0.100	2.38	<200	<1	<1.00
Biomass 39	<50.0	<1	0.583	20.50	<0.1	5.65	<0.200	4290	<0.500	<0.6	<0.100	1.78	<200	<1	<1.00
Biomass 40	<50.0	<1	0.540	25.20	<0.1	2.48	<0.200	3360	<0.500	<0.6	<0.100	1.85	<200	<1	<1.00
Biomass 41	<50.0	<1	0.553	6.15	<0.1	21.10	<0.200	14400	<0.500	<0.6	<0.100	1.39	<200	<1	<1.00
Biomass 42	<50.0	<1	0.625	5.29	<0.1	25.40	<0.200	15300	<0.500	<0.6	<0.100	1.56	<200	<1	<1.00
Mean	95.3	1	0.627	18.13	0.1	13.07	0.217	7502	0.791	0.6	0.108	2.20	617	1	1.01
Median	50.0	1	0.570	16.00	0.1	8.54	0.200	4590	0.500	0.6	0.100	1.82	200	1	1.00
Minimum	50.0	1	0.538	3.11	0.1	2.48	0.200	1510	0.500	0.6	0.100	1.39	200	1	1.00
Maximum	347.0	5	0.927	42.70	0.1	30.20	0.365	19200	2.990	0.6	0.174	5.12	4000	1	1.07
No. of samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
90^{th} percentile	144.5	1	0.747	34.24	0.1	25.88	0.217	15690	1.040	0.6	0.116	3.01	862	1	1.01
LOD	50	1	0.5	0.5	0.1	1	0.2	60	0.5	0.6	0.1	1	200	1	1

(b)

Sample ID	Mg	Mn	Hg	Mo	Ni	P	K	Se	Ag	Na	Sr	Tl	Sn	Ti	V	Zn
Biomass 33	630	214.0	<0.2	<1.00	<0.6	775	8520	<1	<1	160.0	4.14	<1	<1	<3.00	0.363	24.40
Biomass 34	787	14.9	<0.2	<1.00	<0.6	702	10600	<1	<1	54.0	7.35	<1	<1	13.90	0.769	5.89
Biomass 35	647	14.6	<0.2	1.25	<0.6	322	15900	<1	<1	48.8	17.70	<1	<1	<3.00	<0.100	6.83
Biomass 36	3180	64.5	<0.2	<1.00	<0.6	9720	9750	<1	<1	63.5	12.80	<1	<1	5.79	0.306	57.00
Biomass 37	456	33.1	<0.2	1.09	<0.6	617	10600	<1	<1	1370.0	55.30	<1	<1	<3.00	<0.100	6.59
Biomass 38	917	52.0	<0.2	2.39	<0.6	548	22100	<1	<1	146.0	20.70	<1	<1	<3.00	0.225	19.60
Biomass 39	747	22.7	<0.2	2.61	<0.6	292	16900	<1	<1	105.0	15.50	<1	<1	<3.00	<0.100	6.02
Biomass 40	704	14.9	<0.2	1.64	<0.6	412	15100	<1	<1	58.6	15.90	<1	<1	<3.00	<0.100	3.47
Biomass 41	353	20.0	<0.2	<1.00	<0.6	412	8530	<1	<1	955.0	39.90	<1	<1	<3.00	<0.100	5.45
Biomass 42	304	22.4	<0.2	<1.00	<0.6	337	4800	<1	<1	492.0	40.40	<1	<1	<3.00	<0.100	5.84
Mean	873	47.3	0.2	1.40	0.6	1414	12280	1	1	345.3	22.97	1	1	4.37	0.226	14.11
Median	676	22.6	0.2	1.05	0.6	480	10600	1	1	125.5	16.80	1	1	3.00	0.100	6.31
Minimum	304	14.6	0.2	1.00	0.6	292	4800	1	1	48.8	4.14	1	1	3.00	0.100	3.47
Maximum	3180	214.0	0.2	2.61	0.6	9720	22100	1	1	1370.0	55.30	1	1	13.90	0.769	57.00
No. of samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
90^{th} percentile	1143	79.4	0.2	2.41	0.6	1670	17420	1	1	996.5	41.89	1	1	6.60	0.404	27.66
LOD	20	2	0.2	1	0.6	10	50	1	1	10	1	1	1	3	0.1	2

Table 7.21 Primary data for biomass: PAHs – straw (μg/kg DW)

(a)

Sample ID	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(ghi)perylene**	**Benzo(k)fluoranthene**
Biomass 33	1.75	<2	<40	<40	<40	<40	<10	<40
Biomass 34	4.07	<8	<200	<200	<200	<200	<50	<200
Biomass 35	<2.00	<20	<400	<400	<400	<400	<100	<400
Biomass 36	<8.00	<8	<200	<200	<200	<200	<50	<200
Biomass 37	<2.00	<20	<400	<400	<400	<400	<100	<400
Biomass 38	<2.00	<20	<300	<300	<300	<300	<100	<300
Biomass 39	2.89	<10	<300	<300	<300	<300	<80	<300
Biomass 40	2.27	<10	<300	<300	<300	<300	<90	<300
Biomass 41	6.65	<20	<300	<300	<300	<300	<100	<300
Biomass 42	7.78	<20	<400	<400	<400	<400	<100	<400
Mean	3.94	14	284	284	284	284	78	284
Median	2.58	15	300	300	300	300	95	300
Minimum	1.75	2	40	40	40	40	10	40
Maximum	8.00	20	400	400	400	400	100	400
No. of samples	10	10	10	10	10	10	10	10
90^{th} percentile	7.80	2	40	40	40	40	10	40
LOD	0.1	1	20	20	20	20	6	20

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	Chrysene	Dibenzo(ah)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
Biomass 33	<60	39	<40	<20	<60	<20	<40	<40
Biomass 34	<200	<20	<200	<80	<200	<80	<200	<200
Biomass 35	<600	<60	<400	<200	<600	<200	<400	<400
Biomass 36	<200	<20	<200	<80	<200	<80	<200	<200
Biomass 37	<500	<50	<400	<200	<500	<200	<400	<400
Biomass 38	<500	<50	<300	<200	<500	<200	<300	<300
Biomass 39	<400	<40	<300	<100	<400	<100	<300	<300
Biomass 40	<400	<40	<300	<100	<400	<100	<300	<300
Biomass 41	<500	<50	<300	<200	<500	<200	<300	<300
Biomass 42	<600	<60	<400	<200	<600	<200	<400	<400
Mean	396	43	284	138	396	138	284	284
Median	450	45	300	150	450	150	300	300
Minimum	60	20	40	20	60	20	40	40
Maximum	600	60	400	200	600	200	400	400
No. of samples	10	10	10	10	10	10	10	10
90th percentile	60	60	40	20	60	20	40	40
LOD	30	3	20	10	30	10	20	20

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.22 Primary data for biomass: organochlorine pesticides (OCPs) – straw (μg/kg DW)

(a)

Sample ID	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	1,3,5-Trichlorobenzene	2,3,5,6-Tetrachloroaniline	2,3,5,6-Tetrachlorothioanisole	Aldrin	Chlordane -cis [Chlordane – alpha]	Chlordane -trans [Chlordane - gamma]
Biomass 33	<2	<2	<2	<4	<2	<4	<4	<4
Biomass 34	<6	<6	<8	<20	<8	<20	<20	<20
Biomass 35	<20	<20	<20	<40	<20	<40	<40	<40
Biomass 36	<6	<6	<8	<20	<8	<20	<20	<20
Biomass 37	<10	<10	<20	<40	<20	<40	<40	<40
Biomass 38	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 39	<10	<10	<10	<30	<10	<30	<30	<30
Biomass 40	<10	<10	<10	<30	<10	<30	<30	<30
Biomass 41	<10	<10	<20	<30	<20	<30	<30	<30
Biomass 42	<20	<20	<20	<40	<20	<40	<40	<40
Mean	10	10	14	28	14	28	28	28
Median	10	10	15	30	15	30	30	30
Minimum	2	2	2	4	2	4	4	4
Maximum	20	20	20	40	20	40	40	40
No. of samples	10	10	10	10	10	10	10	10
90th percentile	2	2	2	4	2	4	4	4
LOD	0.8	0.8	1	2	1	2	2	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	Chlorpropham	DDD -op	DDE -op	DDE -pp	DDT -op + DDD pp	DDT -pp	Dichlobenil	Dieldrin
Biomass 33	<4	<4	<4	<4	<2	<4	<2	<4
Biomass 34	<20	<20	<20	<20	<2	<20	<7	<20
Biomass 35	<40	<40	<40	<40	<2	<40	<20	<40
Biomass 36	<20	<20	<20	<20	<2	<20	<7	<20
Biomass 37	<40	<40	<40	<40	<2	<40	<20	<40
Biomass 38	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 39	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 40	<30	<30	<30	<30	<2	<30	<10	<30
Biomass 41	<30	<30	<30	<30	<2	<30	<20	<30
Biomass 42	<40	<40	<40	<40	<2	<40	<20	<40
Mean	28	28	28	28	2	28	13	28
Median	30	30	30	30	2	30	10	30
Minimum	4	4	4	4	2	4	2	4
Maximum	40	40	40	40	2	40	20	40
No. of samples	10	10	10	10	10	10	10	10
90^{th} percentile	4	4	4	4	2	4	2	4
LOD	2	2	2	2	2	2	0.9	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(c)

Sample ID	Endosulfan A	Endosulfan B	Endrin	HCH -alpha	HCH -beta	HCH -delta	HCH -epsilon	HCH -gamma [lindane]
Biomass 33	<4	<4	<4	<4	<4	<4	<4	<4
Biomass 34	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 35	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 36	<20	<20	<20	<20	<20	<20	<20	<20
Biomass 37	<40	<40	<40	<40	<40	<40	<40	<40
Biomass 38	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 39	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 40	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 41	<30	<30	<30	<30	<30	<30	<30	<30
Biomass 42	<40	<40	<40	<40	<40	<40	<40	<40
Mean	28	28	28	28	28	28	28	28
Median	30	30	30	30	30	30	30	30
Minimum	4	4	4	4	4	4	4	4
Maximum	40	40	40	40	40	40	40	40
No. of samples	10	10	10	10	10	10	10	10
90th percentile	4	4	4	4	4	4	4	4
LOD	2	2	2	2	2	2	2	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(d)

Sample ID	Heptachlor	Heptachlor epoxide -cis	Heptachlor epoxide -trans	Hexachlorobenzene	Hexachlorobutadiene	Isodrin	Metazachlor	Methoxychlor
Biomass 33	<4	<4	<4	<2	<2	<4	<4	<4
Biomass 34	<20	<20	<20	<7	<7	<20	<20	<20
Biomass 35	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 36	<20	<20	<20	<7	<7	<20	<20	<20
Biomass 37	<40	<40	<40	<20	<20	<40	<40	<40
Biomass 38	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 39	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 40	<30	<30	<30	<10	<10	<30	<30	<30
Biomass 41	<30	<30	<30	<20	<20	<30	<30	<30
Biomass 42	<40	<40	<40	<20	<20	<40	<40	<40
Mean	28	28	28	13	13	28	28	28
Median	30	30	30	10	10	30	30	30
Minimum	4	4	4	2	2	4	4	4
Maximum	40	40	40	20	20	40	40	40
No. of samples	10	10	10	10	10	10	10	10
90th percentile	4	4	4	2	2	4	4	4
LOD	2	2	2	0.9	0.9	2	2	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(e)

Sample ID	Pendimethalin	Permethrin -cis	Permethrin -trans	Propachlor	Tecnazene	Trifluralin	Vinclozolin
Biomass 33	<4	<4	<4	<4	<4	<2	<4
Biomass 34	<20	<20	<20	<20	<20	<7	<20
Biomass 35	<40	<40	<40	<40	<40	<20	<40
Biomass 36	<20	<20	<20	<20	<20	<7	<20
Biomass 37	<40	<40	<40	<40	<40	<20	<40
Biomass 38	<30	<30	<30	<30	<30	<10	<30
Biomass 39	<30	<30	<30	<30	<30	<10	<30
Biomass 40	<30	<30	<30	<30	<30	<10	<30
Biomass 41	<30	<30	<30	<30	<30	<20	<30
Biomass 42	<40	<40	<40	<40	<40	<20	<40
Mean	28	28	28	28	28	13	28
Median	30	30	30	30	30	10	30
Minimum	4	4	4	4	4	2	4
Maximum	40	40	40	40	40	20	40
No. of samples	10	10	10	10	10	10	10
90th percentile	4	4	4	4	4	2	4
LOD	2	2	2	2	2	0.9	2

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.23 Primary data for biomass: PCBs – straw (μg/kg DW)

(a)

Sample ID	PCB-008	PCB-020	PCB-028	PCB-035	PCB-052	PCB-077	PCB-101	PCB-105	PCB-118
Biomass 33	<4	<4	<2	<4	<1	<4	<4	<2	<2
Biomass 34	<20	<20	<2	<20	<8	<20	<20	<8	<8
Biomass 35	<40	<40	<2	<40	<20	<40	<40	<20	<20
Biomass 36	<20	<20	<2	<20	<8	<20	<20	<8	<8
Biomass 37	<40	<40	<2	<40	<20	<40	<40	<20	<20
Biomass 38	<30	<30	<2	<30	<20	<30	<30	<20	<20
Biomass 39	<30	<30	<2	<30	<10	<30	<30	<10	<10
Biomass 40	<30	<30	<2	<30	<10	<30	<30	<10	<10
Biomass 41	<30	<30	<2	<30	<20	<30	<30	<20	<20
Biomass 42	<40	<40	<2	<40	<20	<40	<40	<20	<20
Mean	28	28	2	28	14	28	28	14	14
Median	30	30	2	30	15	30	30	15	15
Minimum	4	4	2	4	1	4	4	2	2
Maximum	40	40	2	40	20	40	40	20	20
No. of samples	10	10	10	10	10	10	10	10	10
90^{th} percentile	4	4	2	4	1	4	4	2	2
LOD	2	2	2	2	1	2	2	1	1

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	PCB-126	PCB-128	PCB-138	PCB-149	PCB-153	PCB-156	PCB-169	PCB-170	PCB-180
Biomass 33	<1	<2	<2	<2	<2	<2	<2	<2	<2
Biomass 34	<8	<8	<8	<8	<8	<7	<7	<2	<8
Biomass 35	<20	<20	<20	<20	<20	<20	<20	<2	<20
Biomass 36	<8	<8	<8	<8	<8	<7	<7	<2	<8
Biomass 37	<20	<20	<20	<20	<20	<20	<20	<2	<20
Biomass 38	<20	<20	<20	<20	<20	<10	<10	<2	<20
Biomass 39	<10	<10	<10	<10	<10	<10	<10	<2	<10
Biomass 40	<10	<10	<10	<10	<10	<10	<10	<2	<10
Biomass 41	<20	<20	<20	<20	<20	<20	<20	<2	<20
Biomass 42	<20	<20	<20	<20	<20	<20	<20	<2	<20
Mean	14	14	14	14	14	13	13	2	14
Median	15	15	15	15	15	10	10	2	15
Minimum	1	2	2	2	2	2	2	2	2
Maximum	20	20	20	20	20	20	20	2	20
No. of samples	10	10	10	10	10	10	10	10	10
90^{th} percentile	1	2	2	2	2	2	2	2	2
LOD	1	1	1	1	1	0.9	0.9	2	1

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.24 Primary data for biomass: phenols – straw (μg/kg DW)

(a)

Sample ID	**2,3,4,6-Tetrachlorophenol**	**2,4,5-Trichlorophenol**	**2,4-Dichlorophenol**	**2,4-Dinitrophenol**	**2-Nitrophenol**	**3,4-Dimethylphenol [3,4-Xylenol]**	**3,5-Dimethylphenol [3,5-Xylenol]**
Biomass 33	<2000	<2000	<2000	<2000	10700	<2000	<2000
Biomass 34	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 35	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 36	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 37	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 38	<100000	<100000	<100000	<100000	<100000	<100000	<100000
Biomass 39	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 40	<60000	<60000	<60000	<60000	<60000	<60000	<60000
Biomass 41	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 42	<60000	<60000	<60000	<60000	<60000	<60000	<60000
Mean	36600	36600	36600	36600	37470	36600	36600
Median	35000	35000	35000	35000	35000	35000	35000
Minimum	2000	2000	2000	2000	2000	2000	2000
Maximum	100000	100000	100000	100000	100000	100000	100000
No. of samples	10	10	10	10	10	10	10
90^{th} percentile	2000	2000	2000	2000	64000	2000	2000
LOD	1000	1000	1000	1000	1000	1000	1000

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

(b)

Sample ID	4-Chloro-3-methylphenol [*p*-chloro-*m*-cresol]	4-Methylphenol [*p*-Cresol]	DNOC	Dinoseb [2-Methyl-n-propyl-4,6-dinitrophenol]	Pentachlorophenol	Phenol	Resorcinol [1,3-Dihydroxybenzene]
Biomass 33	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 34	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 35	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 36	<2000	<2000	<2000	<2000	<2000	<2000	<2000
Biomass 37	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 38	<100000	<100000	<100000	<100000	<100000	<100000	<100000
Biomass 39	<50000	<50000	<50000	<50000	<50000	<50000	<50000
Biomass 40	<60000	<60000	<60000	<60000	<60000	<60000	<60000
Biomass 41	<20000	<20000	<20000	<20000	<20000	<20000	<20000
Biomass 42	<60000	<60000	<60000	<60000	<60000	<60000	<60000
Mean	36600	36600	36600	36600	36600	36600	36600
Median	35000	35000	35000	35000	35000	35000	35000
Minimum	2000	2000	2000	2000	2000	2000	2000
Maximum	100000	100000	100000	100000	100000	100000	100000
No. of samples	10	10	10	10	10	10	10
90th percentile	2000	2000	2000	2000	2000	2000	2000
LOD	1000	1000	1000	1000	1000	1000	1000

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.25 Primary data for biomass: BTEX – straw

Sample ID	1,2-Dimethylbenzene [o-Xylene]	Benzene	Dimethylbenzene	Ethylbenzene	Toluene [Methylbenzene]
	μg/kg (DW)	μg/kg (DW)	μg/kg (DW) sum of (1,3- 1,4-isomers)	μg/kg (DW)	μg/kg (DW)
Biomass 33	1.37	<1	2.35	0.907	<3
Biomass 34	<2.00	<2	<4.00	<1.000	<7
Biomass 35	<7.00	<7	<10.00	<4.000	<20
Biomass 36	<2.00	<2	<5.00	<1.000	<7
Biomass 37	<10.00	<10	<20.00	<5.000	<30
Biomass 38	<8.00	<8	<20.00	<4.000	<30
Biomass 39	<10.00	<10	<20.00	<5.000	<30
Biomass 40	<8.00	<8	<20.00	<4.000	<20
Biomass 41	<8.00	<8	<20.00	<4.000	<20
Biomass 42	<8.00	<8	<20.00	<4.000	<20
Mean	6.44	6	14.14	3.291	19
Median	8.00	8	20.00	4.000	20
Minimum	1.37	1	2.35	0.907	3
Maximum	10.00	10	20.00	5.000	30
No. of samples	10	10	10	10	10
90^{th} percentile	10	1	20	5	3
LOD	1	1	2	0.5	3

Numbers in red represent target concentrations, see Section 7.1.1 above for the full explanation

Table 7.26 Primary data for biomass: calorific value and proximate analysis – straw

Sample ID	Calorific value (gross)	Calorific value (net)	Total moisture	Ash	Volatile matter	Fixed carbon
	kJ/kg	kJ/kg	%	%	%	%
Biomass 33	17546	16161	7.7	3.4	72.8	16.1
Biomass 34	16505	15228	8.7	7.9	67.0	16.4
Biomass 35	16118	14732	12.0	5.9	66.8	15.3
Biomass 36	19369	17756	15.6	5.8	65.6	13.0
Biomass 37	15135	13681	17.3	5.4	63.4	13.9
Biomass 38	15873	14481	13.7	7.1	63.8	15.4
Biomass 39	15852	14461	13.0	7.0	64.3	15.7
Biomass 40	15032	13570	17.3	6.3	61.1	15.3
Biomass 41	14890	13409	18.9	4.9	62.5	13.7
Biomass 42	14600	13108	20.2	4.9	60.7	14.2
Mean	16092	14659	14.4	5.9	64.8	14.9
Median	15863	14471	14.7	5.9	64.1	15.3
Minimum	14600	13108	7.7	3.4	60.7	13.0
Maximum	19369	17756	20.2	7.9	72.8	16.4
No. of samples	10	10	10	10	10	10
90th percentile	17728	16321	19.0	7.2	67.6	16.1
LOD	100	100	0.1	0.1	1.1	Calculated

Table 7.27 Primary data for biomass: ultimate analysis – straw

Sample ID	Bromine	Carbon	Chlorine	Fluorine	Hydrogen	Nitrogen	Oxygen	Sulphur
	mg/kg	%	%	mg/kg	%	%	%	%
Biomass 33	<100.0	44.28	0.13	<10	5.50	0.25	38.7	0.08
Biomass 34	<100.0	38.68	0.28	<10	4.86	0.68	38.8	0.09
Biomass 35	<100.0	39.58	0.25	<10	5.01	0.12	37.0	0.12
Biomass 36	<100.0	43.79	0.01	<10	5.69	4.19	24.4	0.52
Biomass 37	<100.0	38.15	0.30	<10	4.73	0.25	33.6	0.25
Biomass 38	<100.0	39.18	0.17	<10	4.85	0.32	34.5	0.16
Biomass 39	<100.0	39.41	0.22	<10	4.92	0.31	35.0	0.17
Biomass 40	<100.0	37.27	0.33	<10	4.77	0.12	33.8	0.08
Biomass 41	<100.0	36.89	0.27	<10	4.67	0.63	33.5	0.23
Biomass 42	139.1	36.21	0.32	<10	4.58	0.37	33.2	0.27
Mean	103.9	39.34	0.23	10	4.96	0.72	34.3	0.20
Median	100.0	38.93	0.26	10	4.86	0.32	34.2	0.17
Minimum	100.0	36.21	0.01	10	4.58	0.12	24.4	0.08
Maximum	139.1	44.28	0.33	10	5.69	4.19	38.8	0.52
No. of samples	10	10	10	10	10	10	10	10.0
90^{th} percentile	103.9	43.84	0.32	10	5.52	1.03	38.7	0.30
LOD	100	0.41	0.01	10	0.06	0.1	Calculated	0.02

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List of abbreviations

Ag	Silver
Al	Aluminium
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
BTEX	Benzene, toluene, ethylbenzene, xylene
C	Carbon
Ca	Calcium
Cd	Cadmium
Chromium VI	Chromium Hexavalent
Co	Cobalt
Cr	Chromium
Cu	Copper
DCM	dichloromethane
DW	dry weight
ESG	Environmental Scientifics Group Limited
Fe	Iron
GCMS	gas chromatography–mass spectrometry
Hg	Mercury
HR	high resolution
K	Potassium
LE	Leeds laboratory of NLS
Li	Lithium
LOD	limit of detection
MCERTS	Environment Agency's Monitoring Certification Scheme
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
N	Nitrogen
Na	Sodium
Ni	Nickel

NLS	National Laboratory Service [Environment Agency]
NO_2	Nitrogen dioxide
P	Phosphorus
PAHs	polycyclic aromatic hydrocarbons
Pb	Lead
PCB	polychlorinated biphenyl
PSD	particle size distribution
PTEs	Potentially Toxic Elements
SAL	Scientific Analysis Laboratories Limited
Sb	Antimony
Se	Selenium
Sn	Tin
Sr	Strontium
TC	total carbon
Ti	Titanium
Tl	Thallium
TN	total nitrogen
USEPA	United States Environmental Protection Agency
V	Vanadium
Zn	Zinc

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