Environment Agency

Evidence

Material comparators for end-of-waste decisions

Materials applied to land: PAS 100 compost

Report – SC130040/R1

Version 2

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Executive summary

This report details work carried out to define a key comparator, PAS 100 compost, for waste-derived materials intended to be applied to land.

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 us 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 PAS 100 compost 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.

Thirty-five samples of PAS 100 compost were collected from various compost 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 to assess other materials and wastes.

Article 6 of the Waste Framework Directive 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 environmental and human health impacts from materials to be considered in comparison with their non-waste material alternatives. In particular the Court of Appeal judgement in OSS Group Ltd v Environment Agency (2007) contained the statement:

> '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 (beneficial and potentially unbeneficial) of PAS 100 compost which is defined as an ordinary material comparator that is currently permitted for beneficial application to land. The report presents the results from the primary analysis of 35 PAS 100 compost samples.

Six other reports cover ordinary material comparators applied to land:

- manufactured fertilisers
- non-waste wood
- non-waste biochar
- peat
- soil improver
- straw

2 Definition

PAS 100 compost is defined as compost that meets the PAS 100 and Quality Protocol standards (WRAP et al, 2011, 2012). PAS 100:2011 Specification for Composted Materials (WRAP et al. 2011) includes a suite of parameters required to define the minimum quality of compost for general use together with recommended tests and declarations for compost parameters according to compost end use.

2.1 Properties

The beneficial properties associated with the use of PAS 100 compost vary according to the product grade. Desirable properties include high organic matter content and sufficient nutrients, especially phosphorus and potassium. Seven Potentially Toxic Elements (PTEs) that may be present in PAS 100 compost are identified with upper limits specified in PAS 100 (WRAP et al, 2011). Other undesirable properties include

high levels of *Salmonella* and *Escherichia coli*, weed seeds and propagules, microbial respiration, and physical contaminants.

3 Comparator sub-types

Thirty-five PAS 100 compost samples were taken from a variety of locations across England. The samples can be further divided into two sub-types based on composting process (Figure 3.1) and product grading (Figure 3.2).

The main composting process types include:

- open windrow
- in-vessel composting
- aerated static piles
- turned continuous block

A wide range of input materials are permitted. The main types include:

- green/woody plant materials (GWPM)
- GWPM + animal by-products (ABPs)
- GWPM + cardboard
- GWPM + paper/cardboard
- GWPM + farmyard manure
- GWPM + vegetable waste

The majority of the samples taken (32/35) had input materials defined as GWPM. The three samples taken from sites with in vessel composting had input materials defined as GWPM + ABPs.

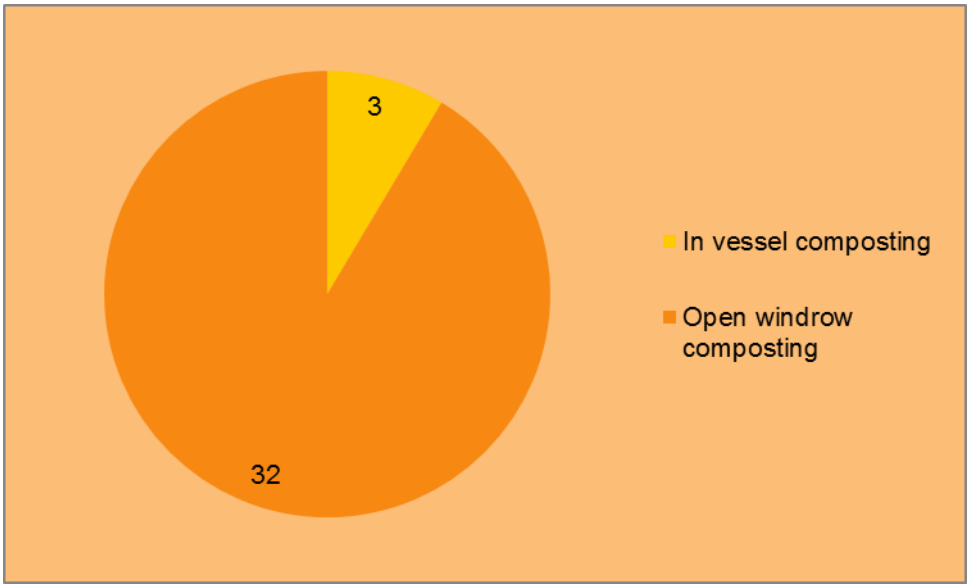

Figure 3.1 Breakdown of PAS 100 compost samples by type of composting process

Products are graded by particle size, although different gradings are produced by different composting facilities. The finest products (typically 0–10 mm) are often used as peat replacement in horticulture. Medium grade products (typically 0–20 mm to 0–40 mm) are used in agriculture (for example, on a large scale). Coarser grades (typically 10–40 mm) are used as mulch.

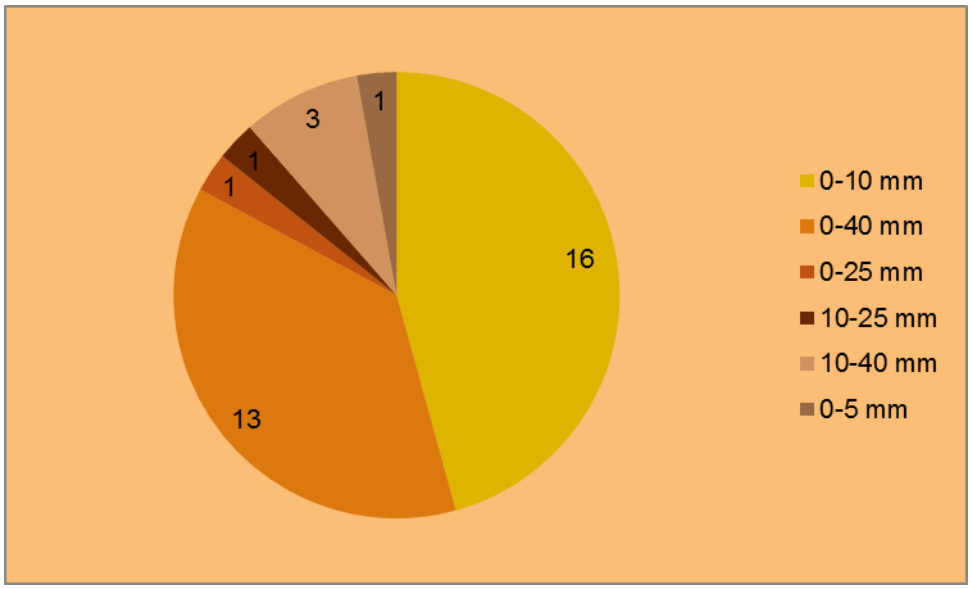

Figure 3.2 Breakdown of PAS 100 compost samples by product grade

Different producers give their products different names (for example, soil conditioner, soil improver, mulch or growing media), but all materials sampled met the PAS 100 and Quality Protocol standards.

4 Material sources

The Renewable Energy Association Limited (REAL) through its Compost Certification Scheme provides list of suppliers who produce compost that is compliant with ‘PAS 100 only' and to PAS 100 and the Compost Quality Protocol. (http://www.qualitycompost.org.uk/producers). This database also includes the status of certification, input material, general types, composting process type, contact details, output product grading and uses and annual throughput.

WRAP used to publish a list of compost suppliers. The list included certification status and was searchable by product type and location.

Compost samples were requested from a number of compost facilities from these two sources.

5 Sampling procedure

PAS 100 compost samples were taken in accordance with BS EN 12579:2000 (BSI 2000), which is referenced in PAS 100. Samples were taken from a variety of facilities across England to provide a geographical spread.

6 Analytical parameters

The main parameters determined are summarised in Tables 6.1 to 6.11. All laboratory work was carried out by the Environment Agency's National Laboratory Service (NLS).

Testing was carried out in accordance with relevant NLS documented in-house methods 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 and SAL refers to Scientific Analysis Laboratories Ltd.

Table 6.1 Analysis: beneficial properties

Parameter/ determinand	Test method used	Unit
pH	LE I pH and EC 01 pH and conductivity – water extracted, determined by specific electrode from ''as received' sample	–
Conductivity	LE I pH and EC 01 pH and conductivity – water extracted, determined by specific electrode from ''as received' sample	µS/cm
Dry solids @ 30°C	LE P soil preparation 01 – sample air dried at <30ºC in a controlled environment until constant weight is achieved	%
Dry solids @ 105°C	LE I dry solids and LoI 01 dry solids (105ºC) and loss on ignition (500ºC) – thermally treated, determined by gravimetry	%
Loss on ignition (LoI) @ 500°C (organic matter content)	LE I dry solids and LoI 01 dry solids (105ºC) and loss on ignition (500ºC) – thermally treated, determined by gravimetry	%
Carbon, organic as C	LE I TOC 01 – combusted with oxygen, thermal conductivity detection	%
Nitrogen as N	LE I nutrients (Kone) 01 NH_4, TON, NO_2 – 2M KCl extraction, determined colorimetrically by discrete analyser on ''as received' sample	mg/kg (DW)
Carbon	LE I TOC 01 TC % TN – combusted with oxygen, thermal conductivity detection	mg/kg (DW)
C:N	Calculated value, carbon divided by nitrogen as N	n/a
Neutralising value as calcium oxide	SAL determination of neutralising value – sample is dried and ground. Material is extracted with known volume of hydrochloric acid. A test aliquot from the extraction is titrated against phenolphthalein to the endpoint. The result is calculated from the difference in titres against a blank where the same sample has been extracted without acid.	%

EC = electrical conductivity; TOC = total organic carbon; TON = total organic nitrogen; TN = total nitrogen; DW = dry weight

Table 6.2 Analysis: particle size distribution

Parameter/ determinand	Test method used	Unit
Particle size distribution	SAL determination of percentage stones. 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).	%

Table 6.3 Analysis: primary nutrients

Parameter/ determinand	Test method used	Unit
Total nitrogen (N) Kjeldahl test	Parameter by calculation	mg/kg (DW)
Total P	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Total K	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Ammoniacal nitrogen as N	LE I nutrients (Kone) 01 NH_4, TON, NO_2 – 2M KCl extraction, determined colorimetrically by discrete analyser on 'as received' sample	mg/kg (DW)
Nitrate as N	Parameter by calculation	mg/kg (DW)

ICP-OES = inductively coupled plasma optical emission spectrometry

Table 6.4 Analysis: secondary nutrients

Parameter/ determinand	Test method used	Unit
Ca	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Mg	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Total sulphur	SAL determination of total sulphur – dried and ground aliquot of the sample is weighed into a ceramic crucible. The sample is then oxidised in the analyser's combustion chamber and any organic sulphur present is converted to sulphur dioxide. The sulphur dioxide in the combustion gases is measured by an infra-red detector.	%

Table 6.5 Analysis: trace nutrients

Parameter/ determinand	Test method used	Unit
B	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Cu	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Fe	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Mn	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Mo	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Zn	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Chloride	LE I halides chloride, bromide and sulphate – water extracted determined directly by ion chromatography on ‘‘as received’ sample	mg/kg (DW)

Table 6.6 Analysis: other elements found in plants which may not be essential for growth

Parameter/ determinand	Test method used	Unit
Co	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Na	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Ni	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Se	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)

Table 6.7 Analysis: Potentially Toxic Elements (PTEs)

Parameter/ determinand	Test method used	Unit
Cd	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Cr	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Cu	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Hg	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)

Parameter/ determinand	Test method used	Unit
Ni	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Pb	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Zn	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)

Table 6.8 Analysis: other potential contaminants

Parameter/ determinand	Test method used	Unit
V	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)

Table 6.8 Analysis: metals

Parameter/ determinand	Test method used	Unit
Al	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Ag	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
As	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Ba	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Be	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Li	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Sb	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Sn	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES.	mg/kg (DW)
Sr	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Ti	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)
Tl	LE I metals (ICP-OES) 01 – digestion block aqua regia extracted under reflux, determined by ICP-OES	mg/kg (DW)

Table 6.10 Analysis: other analytes

Parameter/ determinand	Test method used	Unit
Bromide	LE I halides chloride, bromide and sulphate – water extracted determined directly by ion chromatography on 'as received' sample	mg/kg (DW)
Cr VI	LE I Cr (VI) 01 chromate – alkaline extracted determined by comparator disc colorimetry on 'as received' sample	mg/kg (DW)
Fluoride	LE I fluoride – 1M H_2SO_4 extraction, determined by ion selective electrode on 'as received' sample.	mg/kg (DW)
Nitrite as N	LE I nutrients (Kone) 01 NH_4, TON, NO_2 – 2M KCl extraction, determined colorimetrically by discrete analyser on 'as received' sample.	mg/kg (DW)
Sulphate	LE I halides chloride, bromide and sulphate - water extracted determined directly by Ion Chromatography on 'as received' sample.	mg/kg (DW)
Total oxidised nitrogen as N	LE I nutrients (Kone) 01 NH_4, TON, NO_2 – 2M KCl extraction, determined colorimetrically by discrete analyser on 'as received' sample.	mg/kg (DW)
Visible contaminants (>2 mm)	SAL determination of percentage stones – the % >2 mm fraction of the soil sample (that is, the fraction of the sample which does not pass through the 2 mm sieve)	%

Table 6.11 Analysis: GCMS semi-volatile screen

Parameter/ determinand	Test method used	Unit
Various	NLS O SV screens – solvent extracted, determined by GCMS (scan mode)	mg/kg (DW)

O SV = organic semi-volatile; GCMS = gas chromatography–mass spectrometry

7 Existing data

A limited number of existing datasets related to PAS 100 compost were identified during the literature review. These data are presented in Tables 7.1 to 7.3.

Some data were also found in the Phyllis2 database (http://www.ecn.nl/phyllis2/Browse/Standard/ECN-Phyllis) and other online sources. However, these data did not meet the quality assurance criteria required for this project and are not reproduced here.

Table 7.1 PAS 100 compost: minimum quality requirements for general use [1]

	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Upper limit	1.5	100	200	200	1	50	400

Notes: [1] All units mg/kg (DW)
Source: PAS 100 (WRAP et al. 2011)

Table 7.2 Typical total nutrients contents (fresh weight basis)

Parameter	Compost type	
	Green	Green/food
Dry matter (%)	60	60
Total (kg N/t)	7.5	11
Readily available (kg N/t)	<0.2	0.6
Phosphate (kg P_2O_5/t)	3	3.8
Potash (kg K_2O/t)	5.5	8
Sulphur (kg SO_3/t)	2.6	3.4
Magnesium (kg MgO/t)	3.4	3.4

Source: Defra (2010)

Table 7.3 Potentially Toxic Element (PTE) content of PAS 100 compost [1]

	Hg	Cd	Ni	Cr	Cu	Zn	Pb
Maximum	1.16	1.32	74	229	316	797	1,450
Minimum	0	0	3.3	2.2	12.4	1.3	0.7
Median	0.16	0.65	14.8	18.4	44	183	100
Mean	0.19	0.66	15.8	22.6	50.7	194.3	114.2
Standard deviation (SD)	0.14	0.23	7.1	22	27.5	73.1	103.6
Mean + 1 SD	0.33	0.89	22.8	44.6	78.2	267.4	217.7
75th percentile	0.21	0.8	17.8	22.2	57	222	126.8
90th percentile	0.37	0.95	23	33.4	72.2	251	159.5
Confidence interval (CI) (95% level)	0.02	0.03	0.8	2.6	3.2	8.5	12
Upper confidence limit (mean +95% CI)	0.21	0.69	16.6	25.2	53.9	202.7	126.2
Number of samples	285	285	286	284	285	287	286
Current PAS 100 limit	1	1.5	50	100	200	400	400

Notes: [1] All units mg/kg (DW)
Source: WRAP and Environment Agency (2007)

8 Primary data

8.1 Statistical analysis of data

The mean, median, minimum and maximum values for each analyte were calculated. When the sample size was sufficient (that is, ≥10), the 90th percentile was also calculated. All analytical values determined as 'less than (<)' values were taken as the values themselves. A 90th percentile value has not been calculated if all values are determined as 'less than (<)'.

Box plots are used to graphically represent groups of quantitative data (Figure 8.1). 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 (Figure 8.1). The top of the box is the 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× the interquartile range. The box and whisker plot of copper concentration in PAS compost shown in Figure 8.1 demonstrates the issue of outliers in the dataset.

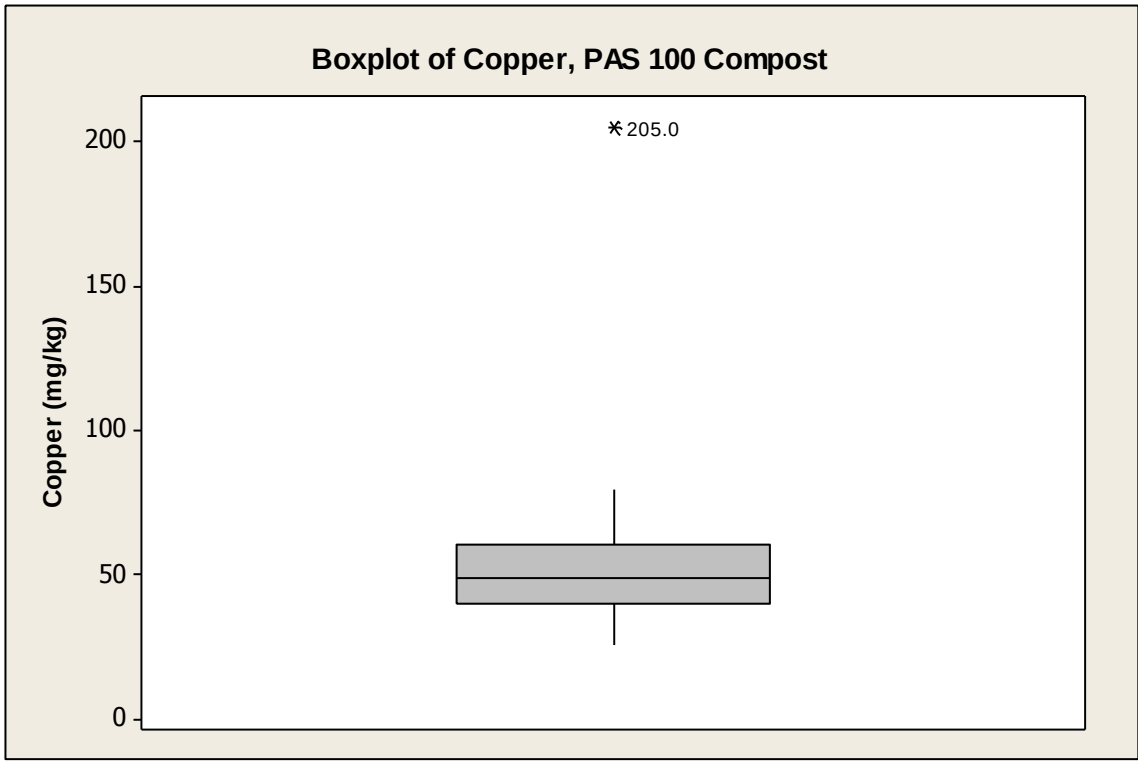

Figure 8.1 Box plot of copper concentration in PAS 100 compost

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

It is important to provide a reasonable dataset for comparison purposes. Where there are less than 10 samples, it is suggested that the maximum values of truncated datasets (after removal of outliers) could be used for comparison purposes in assessing end-of-waste submissions.

8.2 Using the data tables

The analytical data are presented in the following tables:

- beneficial properties (Table 8.1)
- particle size distribution (Table 8.2)
- primary, secondary and trace nutrients (Table 8.3)
- other elements found in plants which may not be essential for growth, Potentially Toxic Elements (PTEs) and other potential contaminants (Table 8.4)
- other metals and analytes (Table 8.5)
- GCMS semi-volatile screen (Table 8.6a,b)

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 for some analytes was higher than the target limit of detection.

8.3 Primary data tables

Primary data are shown in Tables 8.1 to 8.6. Table 8.7 presents a comparison of these primary data and summary statistics reported in WRAP and Environment Agency (2007). The data are comparable for the toxic heavy metals apart from lead, which has a maximum concentration an order of magnitude higher in the 2007 data and chromium which has a maximum concentration twice the 2014 data. For lead, the 2007 90th percentile concentration is ~1.5 times as high (159.5 versus 109 mg/kg). The same relationship pertains to chromium with the 2007 90th percentile also ~1.5 times as high (33.4 versus 23.6 mg/kg).

Table 8.1 Primary data for PAS 100 compost: beneficial properties and neutralising value

Sample ID	pH	Conductivity	Dry solids @ 30°C	Dry solids @ 105°C	LoI @ 500°C (organic matter content)	Carbon, organic as C	Nitrogen as N	Carbon	C:N [1]	Neutralising value as CaO
		µS/cm	%	%	%	%	mg/kg (DW)	mg/kg (DW)		%
Compost 01	8.02	1.55	51.8	81.8	61.9	15.2	16,200	225,000	13.9	7.20
Compost 02	7.70	1.29	50.4	65.3	62.1	19.6	15,300	219,000	14.3	7.10
Compost 03	7.82	1.95	42.7	78.5	76.4	21.9	21,500	263,000	12.2	8.20
Compost 04	5.39	7.32	50.0	75.2	68.1	19.5	20,300	285,000	14.0	1.10
Compost 05	8.29	2.04	63.3	62.5	35.7	19.0	11,700	167,000	14.3	4.20
Compost 06	7.81	1.46	59.7	45.6	78.8	37.0	12,700	294,000	23.1	5.50
Compost 07	6.77	2.34	77.9	75.6	45.8	9.09	9,250	104,000	11.2	3.70
Compost 08	7.54	1.34	51.3	75.5	57.1	21.3	11,200	200,000	17.9	3.60
Compost 09	7.55	3.45	85.4	84.2	24.4	14.5	13,200	157,000	11.9	1.30
Compost 10	8.04	1.50	52.3	78.8	58.0	19.9	11,500	171,000	14.9	3.30
Compost 11	8.13	2.56	58.6	75.0	52.5	16.6	141,000	189,000	1.34	5.20
Compost 12	7.98	1.97	56.6	79.0	56.5	15.9	14,300	154,000	10.8	4.10
Compost 13	8.04	1.90	56.0	73.3	54.3	19.6	16,000	186,000	11.6	3.30
Compost 14	8.14	3.65	69.7	79.8	47.2	25.8	20,900	196,000	9.38	3.30
Compost 15	8.02	1.98	55.8	78.1	56.6	15.8	21,300	251,000	11.8	4.30
Compost 16	7.13	2.29	65.2	74.5	58.5	21.3	15,100	247,000	16.4	6.50
Compost 17	7.78	0.82	50.3	70.5	58.1	26.7	15,200	232,000	15.3	3.50
Compost 18	7.75	2.22	65.2	67.6	38.1	20.4	16,300	180,000	11.0	4.70
Compost 19	8.22	3.65	62.3	79.8	56.0	17.6	24,000	259,000	10.8	10.8
Compost 20	8.27	2.23	49.6	75.5	74.0	20.9	20,100	276,000	13.7	10.4
Compost 21	8.08	3.86	48.7	68.8	52.9	20.7	22,100	206,000	9.32	7.40
Compost 22	7.95	3.45	54.4	61.5	41.4	13.3	18,500	164,000	8.86	9.40
Compost 23	8.57	3.30	72.8	63.0	47.3	15.9	15,500	169,000	10.9	12.8
Compost 24	8.06	3.20	63.7	70.0	69.4	21.3	18,800	252,000	13.4	11.5
Compost 25	7.74	1.74	69.5	74.2	44.1	10.5	6,620	120,000	18.1	4.70
Compost 26	7.99	2.13	72.7	58.8	52.4	13.2	8,440	115,000	13.6	6.70
Compost 27	7.46	2.52	75.1	73.0	38.9	12.1	11,700	124,000	10.6	7.40

Sample ID	pH	Conductivity	Dry solids @ 30°C	Dry solids @ 105°C	LoI @ 500°C (organic matter content)	Carbon, organic as C	Nitrogen as N	Carbon	C:N [1]	Neutralising value as CaO
		µS/cm	%	%	%	%	mg/kg (DW)	mg/kg (DW)		%
Compost 28	8.02	1.86	66.3	54.4	75.8	15.2	10,800	150,000	13.9	5.30
Compost 29	7.87	1.77	76.3	62.6	38.2	13.2	8,830	112,000	12.7	7.20
Compost 30	8.33	1.89	75.4	73.6	60.7	12.2	7,530	127,000	16.9	9.00
Compost 31	7.69	1.85	72.4	74.7	54.5	13.6	8,460	144,000	17.0	14.5
Compost 32	7.74	2.22	33.5	77.3	67.8	15.3	9,840	150,000	15.2	5.90
Compost 33	6.77	2.06	72.7	75.0	58.5	11.9	9,340	125,000	13.4	7.90
Compost 34	8.16	2.05	75.3	67.8	64.9	17.2	9,650	151,000	15.6	7.80
Compost 35	7.49	3.55	83.9	67.7	44.9	14.6	14,600	179,000	12.3	8.90
Mean	7.78	2.43	62.5	71.4	55.2	17.7	75,293	186,943	9.84	6.51
Median	7.95	2.06	63.3	74.2	56.5	16.6	14,600	179,000	12.3	6.50
Minimum	5.39	0.82	33.5	45.6	24.4	9.09	6,620	104,000	0.06	1.10
Maximum	8.57	7.32	85.4	84.2	78.8	37.0	276,000	294,000	23.1	14.5
No. of samples	35	35	35	35	35	35	35	35	35	35
90th percentile	8.25	3.61	75.9	79.5	72.2	21.7	241,000	261,400	17.0	10.6
LOD	0.2	10	0.5	0.5	0.5	0.3	200	1,000	n/a	0.1

Notes: [1] Calculated value
n/a = not applicable

Table 8.2 Primary data for PAS 100 compost: particle size distribution

Sample ID	Supplied grade (mm)	Fraction (% DW)		
		2–20 mm	20–50 mm	>50 mm
Compost 01	0–10	5.70	0.10	0.10
Compost 02	0–40	19.4	0.10	0.10
Compost 03	0–25	10.7	0.01	0.01
Compost 04	0–10	37.6	0.10	0.10
Compost 05	0–40	21.1	0.10	0.10
Compost 06	0–10	59.4	8.40	0.10
Compost 07	0–10	50.0	0.10	0.10
Compost 08	0–10	44.1	0.10	0.10
Compost 09	0–40	22.5	0.10	0.10
Compost 10	0–40	57.3	0.10	0.10
Compost 11	10–25	33.2	0.10	0.10
Compost 12	0–40	5.20	0.10	0.10
Compost 13	0–10	4.60	0.10	0.10
Compost 14	0–10	4.90	0.10	0.10
Compost 15	0–10	9.50	0.10	0.10
Compost 16	0–10	38.2	0.10	0.10
Compost 17	0–10	35.9	0.10	0.10
Compost 18	0–40	23.4	0.10	0.10
Compost 19	0–10	18.5	0.10	0.10
Compost 20	0–40	25.8	0.10	0.10
Compost 21	0–10	13.9	0.10	0.10
Compost 22	0–40	17.0	0.10	0.10
Compost 23	0–10	18.3	0.10	0.10
Compost 24	0–40	36.1	0.10	0.10
Compost 25	10–40	28.1	0.10	0.10
Compost 26	0–10	13.4	0.10	0.10
Compost 27	0–10	12.9	0.10	0.10
Compost 28	10–40	56.4	0.10	0.10

Sample ID	Supplied grade (mm)	Fraction (% DW)		
		2–20 mm	20–50 mm	>50 mm
Compost 29	0–5	10.3	0.10	0.10
Compost 30	0–40	41.9	0.10	0.10
Compost 31	0–10	15.1	0.10	0.10
Compost 32	0–40	24.5	0.10	0.10
Compost 33	0–40	25.6	0.10	0.10
Compost 34	10–40	42.7	0.10	0.10
Compost 35	0–40	17.7	0.10	0.10
Mean		25.7	0.33	0.10
Median		22.5	0.10	0.10
Minimum		4.60	0.01	0.01
Maximum		59.4	8.40	0.10
No. of samples		35	35	35
90th percentile		47.6	0.1	0.1
LOD		0	0	0

Table 8.3 Primary data for PAS 100 compost: primary, secondary and trace nutrients [1]

Sample ID	Primary nutrients					Secondary nutrients			Trace nutrients						
	Total nitrogen (N) Kjeldahl test	Total P	Total K	NH_3 as N	Nitrate as N	Ca	Mg	Total sulphur	B	Cu	Fe	Mn	Mo	Zn	Chloride
Compost 01	<16,200	2,020	4,330	4.35	<3.00	27,200	2,580	0.08	20.0	28.9	7,580	275	<10	110	862
Compost 02	<15,300	2,010	4,350	6.43	<3.00	23,000	2,130	0.09	18.6	25.8	9,480	268	<10	108	1,110
Compost 03	21,500	3,200	10,700	79.9	8.55	27,100	5,910	0.10	39.7	47.9	10,100	375	<10	163	1,430
Compost 04	<20,300	2,960	6,920	3,100	<6.00	18,300	2,450	0.18	11.9	48.8	12,600	287	2.34	154	2,890
Compost 05	11,600	2,560	7,800	275	37.3	22,500	3,620	0.06	17.6	67.3	11,700	334	2.26	251	1,960
Compost 06	12,700	2,020	6,590	108	3.84	20,200	2,570	<0.05	22.8	58.7	7,950	249	4.66	163	1,090
Compost 07	9,240	1,840	4,920	4.10	11.3	14,900	3,640	0.17	14.8	34.8	12,800	303	<2	159	1,270
Compost 08	11,000	2,560	7,200	571	186	24,100	4,000	0.15	18.7	48.5	11,800	606	<2	185	1,220
Compost 09	<13,200	2,090	6,590	179	<4.00	18,900	3,390	0.16	16.2	71.5	12,800	296	2.18	182	1,260
Compost 10	11,500	2,490	9,070	20.0	<17.9	31,200	4,410	0.12	24.0	71.9	12,800	380	3.52	226	1,190
Compost 11	141,000	2,940	10,500	442	6.68	26,100	4,990	0.19	25.3	46.6	14,900	536	2.27	227	1,620
Compost 12	14,200	2,390	8,590	<4	<110	20,800	3,300	0.14	26.7	58.9	10,100	387	<2	232	1,470
Compost 13	186,000	2,390	8,540	<4	111	19,200	3,360	0.17	26.2	57.1	10,300	361	<2	256	1,680
Compost 14	196,000	3,170	8,980	759	<13.1	20,100	2,970	0.14	21.3	54.2	10,500	379	<2	206	2,390
Compost 15	251,000	2,750	9,370	<4	111	23,200	3,940	0.12	31.5	70.3	11,800	433	2.12	275	1,500
Compost 16	<247,000	2,200	7,000	543	<5.00	20,700	5,540	0.11	21.0	40.2	11,300	408	<2	182	1,350
Compost 17	<232,000	2,230	4,780	15.0	<5.68	17,500	2,960	0.13	15.2	41.6	12,500	445	<2	165	421
Compost 18	180,000	2,520	6,800	409	4.03	21,600	3,950	0.15	27.5	59.5	15,100	491	2.10	227	2,680
Compost 19	<259,000	3,530	10,600	1,040	>5.00	44,000	2,960	0.18	170	60.4	19,700	502	2.44	195	2,700
Compost 20	276,000	2,770	9,220	21.0	7.27	46,600	3,270	0.18	61.9	51.0	15,200	481	<2	182	1,850
Compost 21	205,000	3,620	14,600	453	114	26,700	3,100	0.17	102	205	22,400	335	12.1	277	3,130
Compost 22	164,000	3,550	11,800	12.8	478	25,500	2,690	0.19	32.9	50.7	22,300	348	3.13	346	2,870
Compost 23	15,500	3,630	9,360	790	7.99	32,600	3,050	0.19	25.0	50.3	23,600	342	2.01	210	1,830
Compost 24	<18,800	3,970	10,400	542	<4.58	38,400	3,620	0.28	27.1	79.7	20,900	341	<2	189	1,570
Compost 25	<6,620	1,910	4,450	10.3	<4.00	19,600	3,020	0.13	18.0	38.9	14,200	338	<2	165	1,410
Compost 26	8,410	2,200	7,420	2.75	31.5	17,800	4,310	0.15	20.8	43.4	13,300	349	<2	154	1,200
Compost 27	11,300	2,440	8,020	2.22	<429	20,400	3,600	0.18	21.4	76.6	17,000	303	<2	154	1,020

Sample ID	Primary nutrients					Secondary nutrients			Trace nutrients							
	Total nitrogen (N) Kjeldahl test	Total P	Total K	NH_3 as N	Nitrate as N	Ca	Mg	Total sulphur	B	Cu	Fe	Mn	Mo	Zn	Chloride
Compost 28	<10,800	2,170	7,970	2.23	<5.00	18,200	4,280	0.16	41.1	41.6	11,000	318	<2	151	1,410
Compost 29	8,670	2,020	6,720	<3	<165	19,000	2,990	0.15	21.9	66.7	16,500	300	<2	152	657
Compost 30	<7,530	1,960	6,940	269	<4.00	22,800	3,580	0.17	21.7	41.9	18,300	279	<2	145	1,060
Compost 31	<8,460	1,870	4,750	5.02	<3.88	19,700	2,870	0.10	19.3	39.3	13,100	341	<2	165	1,310
Compost 32	9,800	2,070	7,240	8.39	<39.6	19,400	2,870	0.13	23.3	38.2	11,400	325	<2	166	2,550
Compost 33	9,310	2,230	7,120	4.07	26.6	19,000	4,270	0.13	22.2	39.7	13,300	345	<2	153	1,180
Compost 34	<9,650	1,960	8,310	172	<2.93	21,900	3,590	0.14	44.3	41.6	16,500	291	<2	129	1,540
Compost 35	<14,600	3,380	9,210	1,010	<3.47	51,600	2,830	0.16	19.9	39.4	18,100	376	<2	173	1,750
Mean	75,234	2,561	7,919	311	56.5	24,566	3,503	0.15	31.2	55.3	14,083	364	3.18	188	1,612
Median	14,600	2,390	7,800	21.0	7.27	21,600	3,360	0.15	22.2	48.8	12,800	342	2.00	173	1,430
Minimum	6,620	1,840	4,330	2.22	2.93	14,900	2,130	0.05	11.9	25.8	7,580	249	2.00	108	421
Maximum	276,000	3,970	14,600	3,100	478	51,600	5,910	0.28	170	205	23,600	606	12.1	346	3,130
No. of samples	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
90th percentile	241,000	3,542	10,560	778	144.6	36,080	4,370	0.19	43	71.7	20,420	487	7.86	254	2,692
LOD	n/a	10	50	2	n/a	60	20	0.05	1	0.1	1	2	1	2	3

Notes: [1] All units mg/kg (DW) apart from total sulphur for which the units are % (DW).

Table 8.4 Primary data for PAS 100 compost: other elements found in plants which may not be essential for growth, Potentially Toxic Elements (PTEs) and other potential contaminants [1]

Sample ID	Other elements found in plants which may not be essential for growth			PTEs							Other potential contaminants
	Co	Se	Na	Cd	Cr	Cu	Pb	Hg	Ni	Zn	V
Compost 01	2.75	<5	358	<1	12.1	28.9	64.2	<10	8.20	110	18.7
Compost 02	3.60	<5	419	<1	12.7	25.8	51.3	<10	29.5	108	67.6
Compost 03	4.15	<5	474	<1	18.3	47.9	62.1	<10	12.1	163	17.7
Compost 04	3.91	<1	1,660	0.485	20.3	48.8	81.1	<2	13.6	154	22.1
Compost 05	4.15	<1	907	0.491	20.0	67.3	135	<2	13.9	251	16.8
Compost 06	3.32	<1	813	0.362	104	58.7	82.6	<2	51.0	163	12.9
Compost 07	4.37	<1	531	0.341	18.4	34.8	101	<2	13.9	159	21.2
Compost 08	7.49	<1	628	0.448	19.4	48.5	78.9	<2	13.9	185	18.6
Compost 09	5.04	<1	737	0.683	17.7	71.5	114	<2	15.0	182	19.2
Compost 10	5.66	<1	909	0.675	24.2	71.9	120	<2	16.2	226	23.3
Compost 11	5.56	<1	696	0.760	18.5	46.6	91.5	<2	17.1	227	25.2
Compost 12	3.70	<1	553	0.610	15.0	58.9	95.1	<2	12.1	232	15.0
Compost 13	4.06	<1	534	0.595	14.0	57.1	88.0	<2	12.2	256	14.7
Compost 14	3.90	<1	1,250	0.513	16.6	54.2	71.8	<2	15.6	206	29.6
Compost 15	4.69	<1	645	1.260	17.2	70.3	97.0	<2	14.4	275	16.6
Compost 16	4.40	<1	609	0.470	15.6	40.2	73.5	<2	14.2	182	28.3
Compost 17	4.37	<1	434	0.478	15.5	41.6	71.5	<2	14.4	165	30.3
Compost 18	6.25	<1	1,320	0.570	18.3	59.5	86.4	<2	16.4	227	32.6
Compost 19	7.27	<1	818	0.376	18.9	60.4	72.7	<2	15.9	195	28.0
Compost 20	5.50	<1	689	0.436	16.4	51.0	60.3	<2	15.5	182	22.9
Compost 21	5.75	<1	900	0.302	22.7	205	76.6	<2	17.1	277	33.2
Compost 22	5.42	<1	631	<0.25	21.6	50.7	69.0	<2	16.3	346	33.7
Compost 23	5.80	<1	721	<0.25	24.9	50.3	67.1	<2	14.4	210	34.5
Compost 24	6.27	<1	1,270	<0.3	27.2	79.7	61.7	<2	28.6	189	74.3
Compost 25	4.69	<1	821	0.385	18.5	38.9	90.3	<2	13.8	165	27.5
Compost 26	4.29	<1	528	0.294	14.1	43.4	61.3	<2	12.6	154	24.2

Sample ID	Other elements found in plants which may not be essential for growth			PTEs							Other potential contaminants
	Co	Se	Na	Cd	Cr	Cu	Pb	Hg	Ni	Zn	V
Compost 27	5.00	<1	439	0.258	19.2	76.6	75.8	<2	13.3	154	23.2
Compost 28	3.98	<1	563	0.319	13.7	41.6	67.4	<2	12.5	151	24.9
Compost 29	4.43	<1	371	<0.3	15.6	66.7	74.1	<2	12.1	152	21.3
Compost 30	4.59	<1	470	<0.25	22.3	41.9	75.6	<2	13.8	145	35.3
Compost 31	4.00	<1	848	0.345	18.4	39.3	79.6	<2	12.8	165	25.3
Compost 32	3.72	<1	590	0.401	15.5	38.2	68.7	<2	12.1	166	22.6
Compost 33	4.59	<1	526	0.829	14.2	39.7	120	<2	13.2	153	24.3
Compost 34	4.70	<1	594	0.478	15.3	41.6	88.8	<2	12.9	129	21.2
Compost 35	5.20	<1	1,180	<0.25	21.4	39.4	67.8	<2	15.9	173	38.7
Mean	4.76	1.34	727	0.508	20.5	55.3	81.2	2.69	15.9	188	27.0
Median	4.59	1.00	631	0.448	18.3	48.8	75.8	2	13.9	173	24.2
Minimum	2.75	1.00	358	0.250	12.1	25.8	51.3	2	8.20	108	12.9
Maximum	7.49	5.00	1,660	1.260	104	205	135	10.0	51.0	346	74.3
No. of samples	35	35	35	35	35	35	35	35	35	35	35
90th percentile	6.07	1	1,222	0.932	23.6	71.7	109	1 [2]	17.1	254	35.0
LOD	0.1	1	10	0.2	0.5	1	1	2	0.6	2	0.1

Notes [1] All units mg/kg (DW).
[2] The Hg LOD achievable during laboratory testing (2 mg/kg) was greater than that PAS100 limit of 1 mg/kg. It is therefore suggested that this PAS 100 limit is a more appropriate benchmark)

Table 8.5 Primary data for PAS 100 compost: other metals and analytes [1]

Sample ID	Metals											Other analytes					
	Al	Sb	As	Ba	Be	Li	Ag	Sr	Tl	Sn	Ti	Cr VI	Fluoride	Bromide	Sulphate	Nitrite as N	TON as N
Compost 01	3,830	<50	7.42	83.1	0.137	<30	<50	50.7	<20	<100	66.9	<0.8	<40	<3	208	<0.1	<3
Compost 02	4,480	<50	7.57	78.3	0.211	<30	<50	51.9	<10	<100	77.0	<0.8	<40	<3	268	<0.1	<3
Compost 03	6,440	<50	5.51	157	0.469	<30	<50	73.0	<20	<100	111	<0.9	<50	<3	272	0.33	8.88
Compost 04	6,430	<10	7.86	225	0.474	9.63	<10	44.0	<3	<20	86.7	<0.4	<40	<6	1,170	<0.2	<6
Compost 05	7,080	<10	9.04	184	0.452	11.4	<10	61.0	<3	<20	118	<2	<30	<2	304	20.9	58.2
Compost 06	4,500	<10	6.50	120	0.296	7.27	<10	50.4	<3	<20	69.9	<0.7	<30	<3	152	1.42	5.26
Compost 07	8,750	<10	7.88	176	0.521	13.7	<10	44.5	<3	<20	139	<0.4	35.0	<4	1,030	0.36	11.7
Compost 08	7,190	<10	7.31	180	0.429	12.0	<10	74.7	<3	<20	132	<0.4	<40	<3	642	0.29	186
Compost 09	7,470	<10	11.5	154	0.626	11.8	<10	47.9	<3	<20	111	<0.4	34.5	<4	168	<0.1	<4
Compost 10	8,730	<10	11.2	405	0.550	13.9	<10	85.9	<3	<20	131	<0.4	47.4	<6	273	<0.2	17.90
Compost 11	9,640	<10	8.79	311	0.913	15.8	<10	68.8	<3	<20	125	<0.4	37.9	<3	238	0.70	7.37
Compost 12	6,440	<10	5.96	148	0.529	10.7	<10	60.9	<3	<20	124	<0.4	<40	<3	220	<0.2	110
Compost 13	6,080	<10	6.19	136	0.493	10.0	<10	55.5	<3	<20	107	<0.4	<40	<3	272	0.18	111
Compost 14	6,030	<10	7.61	134	0.507	9.34	<10	57.9	<3	<20	97.9	<0.4	42.8	<3	1,030	1.39	14.50
Compost 15	7,210	<10	6.93	165	0.580	11.7	<10	67.9	<3	<20	134	<0.4	<40	<3	208	<0.2	111
Compost 16	7,820	<10	6.87	165	0.741	13.1	<10	49.5	<3	<20	114	<0.4	<30	<3	800	<0.2	<5
Compost 17	6,930	<10	7.38	169	0.456	10.2	<10	46.7	<3	<20	101	<0.4	<40	<3	195	0.32	<6
Compost 18	9,030	<10	7.64	164	0.661	12.9	<10	69.3	<3	<20	213	<0.6	<30	<3	110	<0.2	4.03
Compost 19	9,420	<10	12.4	141	0.658	10.7	<10	101	<3	<20	143	<0.6	<30	4.34	314	<0.2	<5
Compost 20	8,740	<10	9.87	144	0.565	10.0	<10	108	<3	<20	107	<0.8	<40	<3	453	0.21	7.48
Compost 21	7,060	<10	17.4	97.8	0.650	9.07	<10	83.6	<3	<20	125	<0.8	<40	<3	694	565	679
Compost 22	6,940	<10	15.4	97.7	0.558	8.77	<10	80.5	<3	<20	101	<0.7	<40	<3	868	0.41	478
Compost 23	8,540	<10	13.8	105	0.721	9.58	<10	88.7	<3	<20	123	<0.5	32.3	3.91	382	1.91	9.90
Compost 24	9,710	<10	16.3	112	0.659	9.82	<10	105	<3	<20	95.0	<0.6	<30	3.49	346	0.42	<5
Compost 25	6,790	<10	7.95	144	0.400	8.85	<10	61.9	<3	<20	133	<0.6	<30	<6	562	<0.1	<4
Compost 26	6,030	<10	6.36	117	0.449	9.80	<10	51.4	<3	<20	124	<0.6	<30	<3	250	0.34	31.80
Compost 27	8,700	<10	8.29	109	0.586	13.8	<10	64.2	<3	39.1	131	<0.5	<30	<3	229	<0.1	429
Compost 28	5,470	<10	6.37	151	0.414	8.96	<10	52.6	<3	<20	93.8	<0.3	<30	2.19	175	<0.2	<5

Sample ID	Metals											Other analytes					
	Al	Sb	As	Ba	Be	Li	Ag	Sr	Tl	Sn	Ti	Cr VI	Fluoride	Bromide	Sulphate	Nitrite as N	TON as N
Compost 29	6,890	<10	8.36	113	0.473	10.3	<10	62.1	<3	<20	112	<0.5	<30	<3	217	<0.1	165
Compost 30	8,660	<10	12.1	96.6	0.557	13.9	<10	68.0	<3	<20	132	<0.5	<30	<6	337	<0.1	<4
Compost 31	6,110	<10	6.95	118	0.345	7.67	<10	61.8	<3	<20	114	<0.6	<30	<3	218	0.12	<4
Compost 32	5,870	<10	6.09	100	0.329	7.87	<10	59.7	<3	<20	112	<1	<60	<6	1,120	<0.3	39.6
Compost 33	6,130	<10	6.92	164	0.526	9.53	<10	55.0	<3	<20	118	<0.6	<30	<3	243	0.60	27.2
Compost 34	8,390	<10	9.53	99.2	0.591	14.5	<10	74.0	<3	<20	139	<0.5	<30	3.03	336	1.07	<4
Compost 35	9,070	<10	13.5	95.8	0.564	10.0	<10	78.9	<3	<20	103	<1		2.74	517	0.53	<4
Mean	7,217	13.4	9.05	147	0.517	12.5	13.4	66.2	4.17	27.4	116	0.61	36.2	3.51	423	17.1	73.6
Median	7,060	10.0	7.86	141	0.526	10.3	10.0	61.9	3.00	20.0	114	0.50	34.8	3.00	273	0.21	7.48
Minimum	3,830	10.0	5.51	78.3	0.137	7.27	10.0	44.0	3.00	20.0	66.9	0.30	30.0	2.00	110	0.10	3.00
Maximum	9,710	50.0	17.4	405	0.913	30.0	50.0	108	20.0	100	213	2.00	60.0	6.00	1,170	565	679
No. of samples	35	35	35	35	35	35	35	35	35	35	35	35	34	35	35	35	35
90th percentile	9,054	10	13.7	182	0.660	15.3	10	87.6	3	31.5	137	0.86	42.0	6	965	1.41	178
LOD	50	1	0.5	0.5	0.1	1	1	1	1	1	3	0.3	20	0.3	5	0.1	3

Notes [1] All units mg/kg (DW).

Table 8.6 Primary data for PAS 100 compost: GCMS semi-volatile screen [1,2]

(a)

Sample ID	(3.beta)-ergost -5-en-3-ol	(4aS-*trans*)-2,3,4,4a,10,10a-hexahydro-6-hydroxy-1,1,4a-trimethyl-7-(1-methylethyl)-9(1H)-phenanthrenone	(4bS-*trans*)-4b,5,6,7,8,8a,9,10-octahydro-4b,8,8-trimethyl-1-(1- methylethyl)-2-phenanthrenol	17-norkaur-15-ene,13-methyl-,(8.beta,13.beta)	1-heptadecene	2-phenanthreol,4b,5,6,7,8,8a,9,10-octahydro-4b, 8,8-trimethyl-8-(1-methylethyl)-,(4aS-trans)	2-propenoic acid,3-phenyl-,ethyl ester,(E)	4,4,6a,6b,8a,11,12,14b-octamethyl-1,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12,12a,14,14a,14b-octadecahydro-2H-picen-3-one	9,19-cyclolanost-24-en-3-ol, (3.beta)-	α-amyrin	β-amyrin	β-sitosterol	butanoic acid	caffeine	cholesterol	D:A-friedooleanan-3-ol,(3.alpha)	di(2-ethylhexyl) phthalate (DEHP)	di-*n*-octyl phthalate	docosane	dodecanoic acid	eicosane
Compost 01																				
Compost 02										22	41									
Compost 03											15									
Compost 04				21	34		12					15		37		20		27	21	16
Compost 05		14	41							31	49									
Compost 06	10									25	58									
Compost 07										19					<11					
Compost 08																	11			
Compost 09						11		20												
Compost 10						11		12		19										
Compost 11																				
Compost 12										11	23									
Compost 13						15				12						20				
Compost 14										12										
Compost 15																				

Sample ID	(3.beta)-ergost -5-en-3-ol	(4aS-*trans*)-2,3,4,4a,10,10a-hexahydro-6-hydroxy-1,1,4a-trimethyl-7-(1-methylethyl)-9(1H)-phenanthrenone	(4bS-*trans*)-4b,5,6,7,8,8a,9,10-octahydro-4b,8,8-trimethyl-1-(1- methylethyl)-2-phenanthrenol	17-norkaur-15-ene,13-methyl-,(8.beta,13.beta)	1-heptadecene	2-phenanthreol,4b,5,6,7,8,8a,9,10-octahydro-4b, 8,8-trimethyl-8-(1-methylethyl)-,(4aS-trans)	2-propenoic acid,3-phenyl-,ethyl ester,(E)	1,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12,12a,14,14a,14b-octadecahydro-2H-picen-3-one	4,4,6a,6b,8a,11,12,14b-octamethyl-	9,19-cyclolanost-24-en-3-ol, (3.beta)-	α-amyrin	β-amyrin	β-sitosterol	butanoic acid	caffeine	cholesterol	D:A-friedooleanan-3-ol,(3.alpha)	di(2-ethylhexyl) phthalate (DEHP)	di-*n*-octyl phthalate	docosane	dodecanoic acid	eicosane
Compost 16						28					19										
Compost 17																					
Compost 18																					
Compost 19						22		14													
Compost 20						10.9		10.4			13										
Compost 21									23		15										
Compost 22											10										
Compost 23						17		13													
Compost 24						12		20			13					11					
Compost 25						15															
Compost 26													13								
Compost 27								25.5			19	10									
Compost 28											20		23								
Compost 29								14			17										
Compost 30						15.9		13.2			13										
Compost 31						15					13							11			
Compost 32								37													

Sample ID	(3.beta)-ergost -5-en-3-ol	(4aS-*trans*)-2,3,4,4a,10,10a-hexahydro-6-hydroxy-1,1,4a-trimethyl-7-(1-methylethyl)-9(1H)-phenanthrenone	(4bS-*trans*)-4b,5,6,7,8,8a,9,10-octahydro-4b,8,8-trimethyl-1-(1- methylethyl)-2-phenanthrenol	17-norkaur-15-ene,13-methyl-,(8.beta,13.beta)	1-heptadecene	2-phenanthreol,4b,5,6,7,8,8a,9,10-octahydro-4b, 8,8-trimethyl-8-(1-methylethyl)-,(4aS-trans)	2-propenoic acid,3-phenyl-,ethyl ester,(E)	4,4,6a,6b,8a,11,12,14b-octamethyl-1,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12,12a,14,14a,14b-octadecahydro-2H-picen-3-one	9,19-cyclolanost-24-en-3-ol, (3.beta)-	α-amyrin	β-amyrin	β-sitosterol	butanoic acid	caffeine	cholesterol	D:A-friedooleanan-3-ol,(3.alpha)	di(2-ethylhexyl) phthalate (DEHP)	di-*n*-octyl phthalate	docosane	dodecanoic acid	eicosane
Compost 33																					
Compost 34										11											
Compost 35						21		17		20											

(b)

Sample ID	ferruginol	friedelan -3- one	γ-sstosterol	heneicosane	hentriacontane	hexadecane	hexadecanoic acid, methyl ester	hexanoic acid	*n*-hexadecanoic acid	nonacosane	octadec-9-enoic acid	olean-18-ene	phytol	squalene	stigmast-4-en-3-one	stigmastanol	stigmasterol	sulfur (S8)	tetracosane	tetradecanoic acid	*trans*-13-octadecadienoic acid, methyl ester	possible presence of specialised heavy refined oil
Compost 01		21	71																			
Compost 02		32	64																			
Compost 03		78	30																			
Compost 04		23	60	44		21	10	12	40		1150				23					17	11	
Compost 05	13	101	233		24					37			15	20	56		24					
Compost 06		34	110												19	18	12					
Compost 07	<35	22	52																			
Compost 08			28																			
Compost 09		13																				
Compost 10		17	27												10							
Compost 11		12																				
Compost 12		13													10							
Compost 13		19	19																			
Compost 14		13																				
Compost 15		18	24																			
Compost 16		39	71	16						23					27		11					
Compost 17																						
Compost 18		12	48												12							
Compost 19		13	67		32										12							
Compost 20		32	17																			

Sample ID	ferruginol	friedelan -3- one	γ-sstosterol	heneicosane	hentriacontane	hexadecane	hexadecanoic acid, methyl ester	hexanoic acid	*n*-hexadecanoic acid	nonacosane	octadec-9-enoic acid	olean-18-ene	phytol	squalene	stigmast-4-en-3-one	stigmastanol	stigmasterol	sulfur (S8)	tetracosane	tetradecanoic acid	*trans*-13-octadecadienoic acid, methyl ester	possible presence of specialised heavy refined oil
Compost 21																						
Compost 22			10																			
Compost 23																						
Compost 24			39														12					
Compost 25		11	16																			
Compost 26		11																				
Compost 27		21	18																			
Compost 28		14																				
Compost 29		11	17																			
Compost 30			20															15				
Compost 31		18	16									20			17				11			
Compost 32		13	30												14							
Compost 33																						
Compost 34		12	17																			
Compost 35			44												13							Yes

Notes: [1] Analytes >10 mg/kg (DW) only; analytes not detected or those with <10mg/kg (DW) have not been reported.
[2] The full GCMS screen data with <10 mg/kg values will be included in the comparator spreadsheet tool. The compounds identified at concentrations greater than the detection level during the GCMS screen are believed to be, in the vast majority of cases, naturally occurring substances within the sample matrix, rather than pollutants.

Table 8.7 Comparison of primary data with data from data from WRAP (2007) and Environment Agency (2014)

	Cd		Ni		Cr		Cu		Zn		Pb	
	2007	**2014**	**2007**	**2014**	**2007**	**2014**	**2007**	**2014**	**2007**	**2014**	**2007**	**2014**
Mean	0.66	0.508	15.8	15.9	22.6	20.5	50.7	55.3	194.3	188	114.2	81.2
Median	0.65	0.448	14.8	13.9	18.4	18.3	44	48.8	183	173	100	75.8
Minimum	0	0.25	3.3	8.2	2.2	12.1	12.4	25.8	1.3	108	0.7	51.3
Maximum	1.32	1.26	74	51	229	104	316	205	797	346	1,450	135
No. of samples	285	35	286	35	284	35	285	35	287	35	286	35
90th percentile	0.95	0.932	23	17.1	33.4	23.6	72.2	71.7	251	254	159.5	109

9 Conclusions

Data are presented for 35 samples of PAS 100 compliant compost. Physical properties and chemical analyses are provided. These data can be used by companies and individuals to assist in the process of applying for end-of-waste status for their products, either by confirming their product's comparable composition or identifying problems to be rectified before such status can be achieved.

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List of abbreviations

AAS	atomic absorption spectrometry
1M	1 molar
2M	2 molar
Ag	Silver
Al	Aluminium
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
C	Carbon
Ca	Calcium
CaO	Calcium oxide
Cd	Cadmium
Chromium VI	Chromium Hexavalent
Co	Cobalt
Cr	Chromium
Cu	Copper
DW	dry weight
EC	electrical conductivity
Fe	Iron
GCMS	gas chromatography–mass spectrometry
GWPM	green/woody plant materials
H_2SO_4	Sulphuric acid
Hg	Mercury
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICP-OES	inductively coupled plasma optical emission spectrometry
K	Potassium
KCL	Potassium chloride
LE	Leeds laboratory of NLS
Li	Lithium
LOD	limit of detection

LoI	loss on ignition
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
N	Nitrogen
Na	Sodium
NH_3 as N	Ammoniacal nitrogen
NH_4	Ammonium
Ni	Nickel
NLS	National Laboratory Service [Environment Agency]
NO_2	Nitrogen dioxide
O SV	Organic semi volatile
P	Phosphorus
PAS	Publically Available Standard
Pb	Lead
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
TOC	total organic carbon
TON	total organic nitrogen
V	Vanadium
Zn	Zinc

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