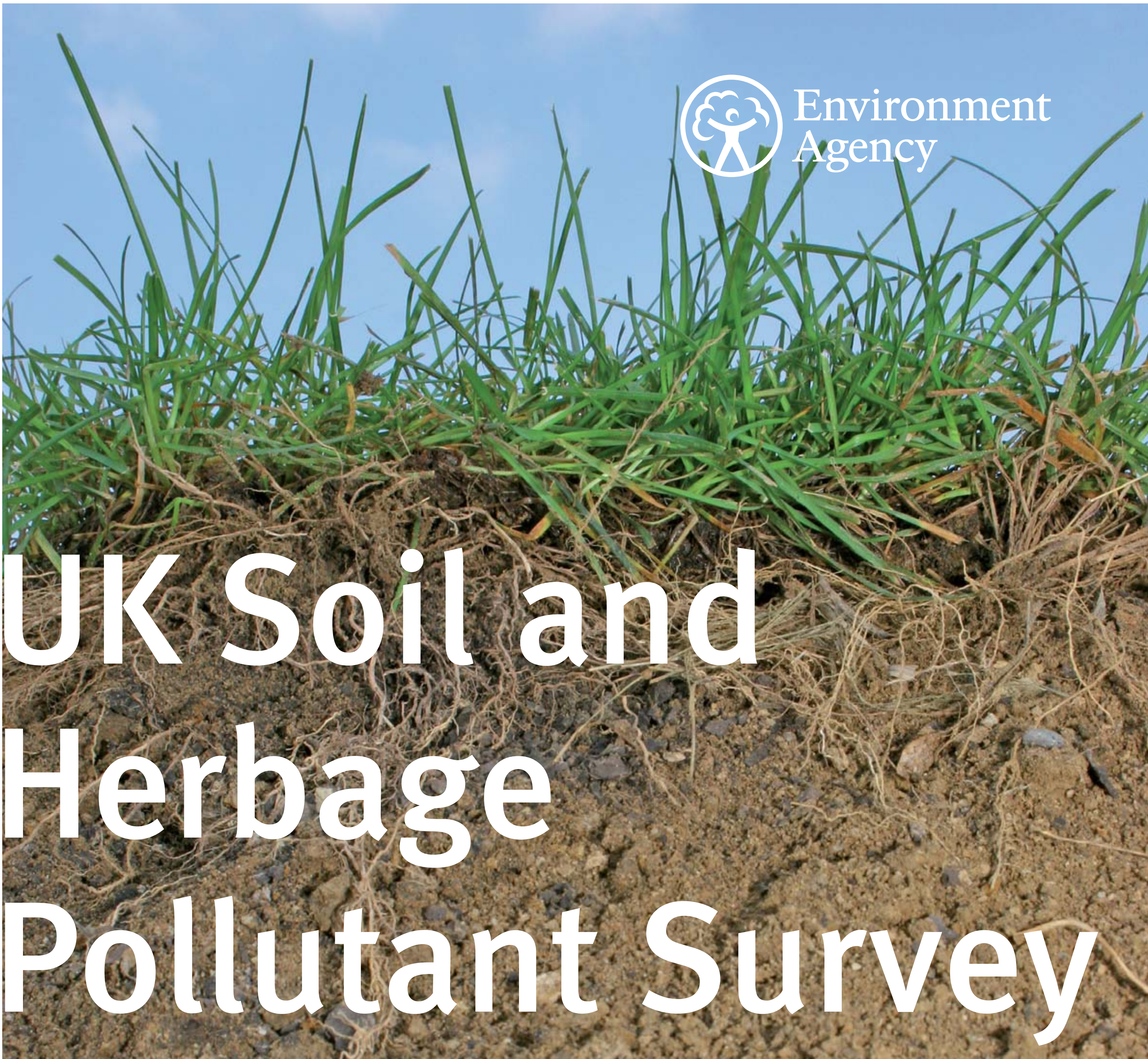

Environment Agency

UK Soil and Herbage Pollutant Survey

UKSHS Report No. 6

Intensive sampling and spatial variability in UK soils

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Published by:

Environment Agency, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, BS32 4UD
Tel: 01454 624400 Fax: 01454 624409

ISBN: 978-1-84432-771-3

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Dissemination Status:
Publicly available / released to all regions

Keywords:
Soil, herbage, pollutant, polychlorinatedbiphenyls, dioxins, survey, polyaromatichydrocarbons

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Science Project Number:
SC000027

Product Code:
SCHO0607BMSZ-E-P

Executive Summary

The UK Soil and Herbage Pollutant Survey (UKSHS) has been a research project jointly sponsored by the Environment Agency, the Department for Environment, Food and Rural Affairs (Defra), the Environment and Heritage Service (Northern Ireland), the Food Standards Agency, the Food Standards Agency Scotland, the National Assembly for Wales, the Scottish Environment Protection Agency (SEPA) and the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER). Dr Peter Crook from the Environment Agency provided overall project management on behalf of the sponsors. A consortium led by the University of Liverpool's School of Biological Sciences was commissioned to undertake the work.

The primary aim of the project was to establish a baseline for pollutant levels in soil and herbage in the UK. The three-year project has led to wealth of data and the results are presented in a series of 11 reports.

This report, No. 6 in the UKSHS report series, discusses the spatial variability of soil contaminant data and was conducted to justify the UKSHS soil sampling methodology (see UKSHS Report No. 2). An evaluation is also made of the spatial variance of soil contaminant data compared with the 'uncertainty of measurement' of soil contaminants in laboratory analyses (see UKSHS Report No. 3 which describes the analytical methodologies used in the UKSHS).

The results generated by this intensive sampling study indicate that field sampling uncertainties lie well within the ranges of uncertainties found in other studies. The semivariograms produced in this study for soil properties, inorganic contaminants and organic contaminants were found to be unstable. This was thought to be due to the small sample size and because the areas between lags of 150–300 m on the sampling grid were under-sampled. Despite this, the form of the variograms confirms that the chosen scale of sub-sampling (three sub-samples collected within 20 m of each other) at each rural and urban location in the main UKSHS Project (see UKSHS Report No. 2) would have captured the greater part of any spatial dependence in soil contaminants for a wide range of inorganic determinands.

Large variations in the example UKSHS organic contaminants, illustrated by the semivariograms, indicate that a much larger dataset, collected over a more intensive and more closely spaced sampling grid, would be required to detect spatial patterns in organic contaminants.

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Glossary of terms

Base position	South west corner of a northerly orientated 20 m x 20 m sampling area from which GPS readings and triangulation bearings were taken.
Effective stack height	The effective stack height is equal to the physical stack height plus the plume rise.
Industrial	A site dominated by some form of industry.
Isopleth	A line drawn on a map through all points of equal value of some measurable quantity.
Rural	All other areas not categorised as industrial, urban, semi-urban or semi-rural. Predominantly agricultural land or undeveloped countryside.
Semi-rural	Any area within a small town or village. A small town is taken as being 3–20 km^2 in area and a village as being <3 km^2 in area.
Semi-urban	All areas that abut urban centres and/or 25 per cent urbanised/built up. Normally up to 3 km outside the urban core. May also be known as the urban-fringe.
Semi-variogram	A mathematical expression of the way in which variance of a property changes as distance and/or direction separating two points varies. Compares overall variance in a dataset to covariance for each set of distances.
Total standard deviation (s_t)	Standard deviation is a statistical value representing how widely members of a dataset deviate from the mean. Calculated as the square root of the variance. In this context, it includes the field sample and laboratory standard deviation.
Uncertainty of Measurement (UoM)	The known interval on a measurement scale within which the true value lies with a specific probability.
Undisturbed site	Unploughed land which has not had chemicals applied (pesticides/herbicides). May include common land, meadows, rough pasture, parkland and fields that are infrequently grazed (if at all). Avoids wooded areas where possible.
Urban	An area which is ≥90% urbanised/built up. A conurbation may be formed when a large town and city merge. Urban areas include large towns (20–50 km^2 in area) and cities (>50 km^2 in area).
Variance	A value for the amount by which a property or characteristic changes or is different over space or time.

List of abbreviations and acronyms

CRM	Certified Reference Material
Defra	Department for Environment, Food and Rural Affairs
DGPS	Differential global positioning system
Dioxins	polychlorinated dibenzodioxins and dibenzofurans
IUPAC	International Union of Pure and Applied Chemistry
LOD	limit of detection
NLS	Environment Agency’s National Laboratory Service
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppb	parts per billion
ppm	parts per million
RSD	relative standard deviation
SD	standard deviation
SEPA	Scottish Environment Protection Agency
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SRM	Standard Reference Material
SSEW	Soil Survey of England and Wales
TEF	toxic equivalent factor
UKAS	United Kingdom Accreditation Service
UKSHS	UK Soil and Herbage Pollutant Survey
UoL	University of Liverpool
UoM	Uncertainty of Measurement

1 Introduction

The UK Soil and Herbage Pollutant Survey (UKSHS) is a research project sponsored jointly by:

- Environment Agency;
- Department for Environment, Food and Rural Affairs (Defra);
- National Assembly for Wales;
- Food Standards Agency;
- Food Standards Agency Scotland;
- Scottish Environment Protection Agency (SEPA);
- Environment and Heritage Service (Northern Ireland);
- Scotland and Northern Ireland Forum for Environmental Research (SNIFFER).

Dr Peter Crook from the Environment Agency provided overall project management on behalf of the sponsors. A consortium led by the University of Liverpool's School of Biological Sciences was commissioned to undertake the work. The consortium consisted of the Environment Agency's National Laboratory Service (NLS), Nottingham Trent University, the University of Stirling and the University of Liverpool (UoL), with additional assistance being provided by Parkman Ltd.

The project's primary objective was to establish a baseline for pollutant levels in soil and herbage in the UK. The UKSHS has involved the collection of soil and herbage samples for chemical and radiometric analysis from industrial, rural and urban sites throughout the UK. Full details of the number of samples/sites visited and sampling techniques used are given in UKSHS Report No. 1.

The scale of the UKSHS has resulted in a wealth of methodological information and analytical data. This made the presentation of the whole study in one report unwieldy and a series of 12 stand-alone reports has therefore been prepared, which users can read individually or as a complete set. This report discusses the spatial variability of soil contaminant data and is Report No. 6 in the series. Full details of the other reports in the series can be found on the CD-ROM included with UKSHS Report No. 1 or from the Environment Agency website (www.environment-agency.gov.uk). The objectives of this report are to:

- indicate the purpose of, and outline the approach for, carrying out an assessment of spatial variability of soil contaminants both inorganic and organic (Section 2);
- indicate and assess the spatial variability of selected soil properties and soil contaminants (Section 3);
- assess the appropriateness of the UKSHS soil sampling scheme in relation to prevailing spatial variability of soil properties and soil contaminants (Section 4);
- compare levels of contaminant spatial variability in the UKSHS with 'uncertainty of measurement' estimates evaluated for the UKSHS' laboratory analyses (Section 4).
- compare levels of contaminant spatial variability in the UKSHS with the results of previous studies (where available) in order to evaluate UKSHS conditions against those obtained elsewhere (Section 5).

2 Purpose and methodology for assessing spatial variability of soil contaminants

This section describes:

- the purpose of the UKSHS intensive sampling study;
- the methodology used to assess *in situ* spatial variability of soil properties and soil contaminants.

The methodology section describes the location of the study, the field sampling procedures adopted and the statistical analyses used.

2.1 Purpose of the intensive sampling survey

The distribution of various contaminants in soils is likely to depend on a range of different factors including:

- local rock type;
- proximity of urban centres, industrial developments and/or roads;
- previous additives to the soil;
- previous uses of land on or adjacent to the site.

In addition to these factors, other influences such as air pollution have affected the quality of surface soils over hundreds of years. Soil properties themselves determine the aeration, moisture status and ion retention ability of different soils. The interaction of all of these influences contributes to both the spatial and temporal variability of soil contaminants.

There are many reasons why knowledge of the spatial variability of soil properties and soil contaminants is important. For the UKSHS, the prime purpose in assessing the spatial variability of a few basic soil properties and organic and inorganic soil contaminants was to make an informed decision about the most appropriate spatial scale for soil sampling at sites across the UK.

When estimating spatial variability in soil properties, it is often possible to detect a directional bias in different properties as a result, for example, of the predominant direction of wind (blowing a plume of air pollution) or the direction of a geological outcrop. It may even be possible to interpolate values of soil properties at locations on a map that were not sampled. The reliability of such assessments depends on the degree of variability found in a large number of samples (usually taken from >100 points) sampled over a grid of locations whose nearest neighbour distances range from several metres to several hundreds of metres.

Ideally, spatial variability assessments should be carried out in each location where further field sampling is anticipated. Since it is impossible to predict whether the spatial variance of soil properties and soil contaminants will be similar, spatial variability assessments should also be made for each determinand at each different location. For the UKSHS this would, of course, not be possible since it would mean the sampling and analysis of an impossibly large number of samples.

For this reason, the UKSHS intensive sampling study examined the spatial variability of three soil properties, plus all the soil chemical determinands included within the main UKSHS study (13 metals/metalloids, 26 polychlorinated biphenyls, 22 polycyclic aromatic hydrocarbons and 17 dioxins) at one location only.

2.2 Methodology of the intensive sampling survey

There are three components to the methodology:

- field soil sampling
- laboratory analyses
- data analysis and interpretation.

These three stages are described in Sections 2.3 and 2.4.

2.3 Field sampling and laboratory analyses for the intensive sampling survey

A location, 1000 m x 700 m, at Tatton Park, Cheshire, was chosen for carrying out the intensive sampling study. Tatton Park is part of a National Trust estate and was selected because the soil at this site was relatively undisturbed and not subject to any obvious direct source of pollution (e.g. there is no heavy industrial activity on the land bordering the site). Thus any contamination at the site is likely to be due to aerial deposition from ambient air contamination. Spatial variability should therefore be a reflection of the natural variability in the soil rather than due to contaminant plume grounding.

The soil in this location is described by the Soil Survey of England and Wales (SSEW) as Wick 1 Association (Jarvis 1984). Wick 1 Association is a deep, well-drained coarse loamy and sandy soil generally over glacio-fluvial or river terrace drift.

Soil samples were collected from the field site according to the methods outlined in UKSHS Report No. 2. These samples were then prepared in the laboratory prior to analysis according to the methodologies outlined in UKSHS Report Nos. 3 and 4. The samples were analysed for:

- soil properties (soil bulk density, soil organic matter, soil organic carbon and pH);
- metals and metalloids;
- polychlorinated biphenyls (PCBs);
- polycyclic aromatic hydrocarbons (PAHs);
- dioxins/furans.

All the analytical results are provided in Appendices 2, 3 and 4.

Seventy soil samples were collected on a grid as laid out in Figure 2.1. A theodolite and ranging pole were used, in conjunction with tape measures, to ensure that the distances between samples were measured accurately. This grid was designed to capture all variation found at both short spatial scales (<10 m) and larger spatial scales (hundreds of metres). There was no information available on the likely soil spatial variability at the survey site prior to this project.

2.4 Methodology for data analyses for the intensive sampling survey

Variation in soil properties over short and long distances has been recognised by soil scientists for many years. Matheron (1971) first brought together a number of statistical approaches into a coherent method for analysing the spatial variability of properties in geology and earth sciences when he introduced his theory of regionalised variables. Techniques for the analysis of spatial variability of soil properties have been refined over the past 2–3 decades and have been amply described, discussed and illustrated for UK soils by authors such as Burgess and Webster (1980), Webster (1985), Oliver (1987), and Oliver and Webster (1991). Use of these techniques for choosing and optimising soil sampling schemes was discussed and defined by McBratney *et al.* (1981), and has subsequently become an important preliminary stage in most large-scale soil sampling projects.

Our basic premise on the variability of a soil property is that we would expect data from points close to each other to exhibit strong similarity, then progressively less similarity as distances increase. This is a pattern of high autocorrelation of data at points close together with autocorrelation decreasing as distance increases.

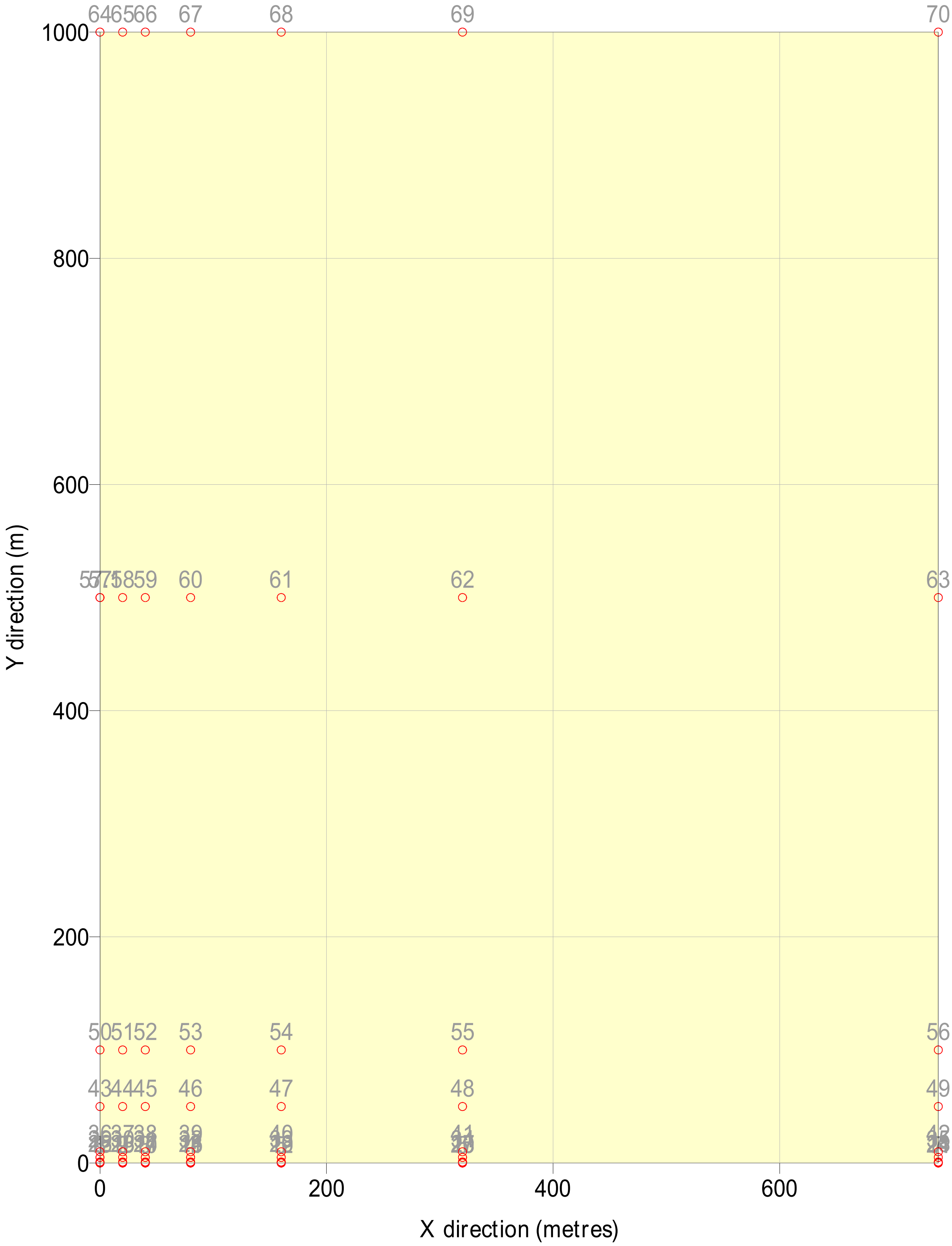

Figure 2.1 – Sampling grid for the intensive survey at Tatton Hall, Cheshire: 70 sample locations taken over a 1000 m x 700 m grid

The semivariogram is the statistical technique used in the analysis of soil data in this intensive sampling project. The calculation and production of a semivariogram for a soil property involved a number of steps:

1. Calculation of nearest neighbour distances (called lags – see below) for every point on the selected field sampling grid
2. Calculation of the spatial autocorrelation (Geary Index) for each determinand at each lag
3. Plotting the semivariogram for each determinand, based on lags between points (x-axis) and the semivariance (y-axis)
4. Applying a model to the semivariogram data.

Each of these steps is described below.

The nearest neighbours between each point on the field sampling grid were determined in both orthogonal and diagonal directions (see Figure 2.2). The next step was to calculate 1, 2 and 3 lags for each point on the grid (see Figure 2.3). The Geary Index of autocorrelation was then used to test whether the observed value of a variable at one location was independent of values of that variable at neighbouring locations.

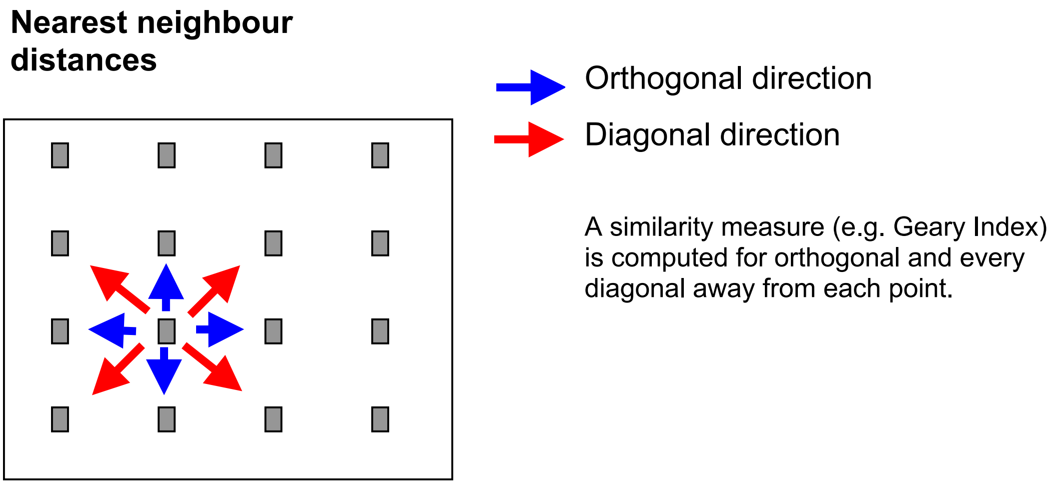

Figure 2.2 – Identification of orthogonal and diagonal nearest neighbours

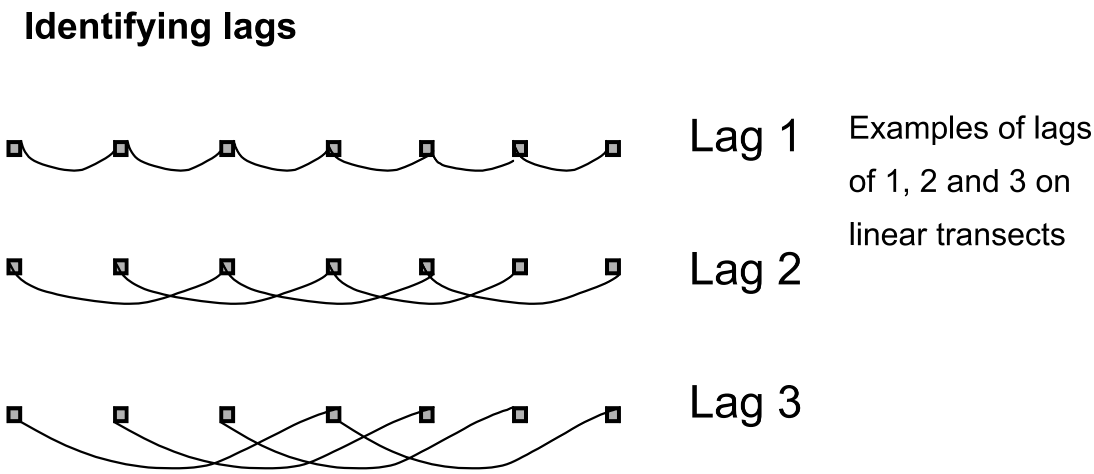

Figure 2.3 – Examples of 1, 2 and 3 lags on linear transects

The semivariogram expresses mathematically the way in which the variance of a soil property changes as the distance and direction separating any two points varies. Thus, the semivariogram compares the overall variation in the whole dataset to the joint variation (covariance) for each set of distances (lags) computed in the nearest neighbour analysis. In simple terms, it plots the dissimilarity among values as a function of distance. This technique is described below.

The semivariance is calculated as:

$$\gamma(h) = \frac{1}{2} E[\{Y(x+h) - Y(x)\}^2]$$

where: $Y(x)$ = value of the variable, Y, at distance (lag) h

$Y(x+h)$ = value of the variable, Y, at distance (lag) $x+h$

E[..] = the expected value

Thus, the semivariogram is defined as half the expected value (or mean) of the squared difference between pairs of points $Y(x)$ and $Y(x+h)$, separated by distance (lag) h.

The most widely used semivariogram model is the spherical model used below (Figure 2.4) to illustrate the description of the semivariogram.

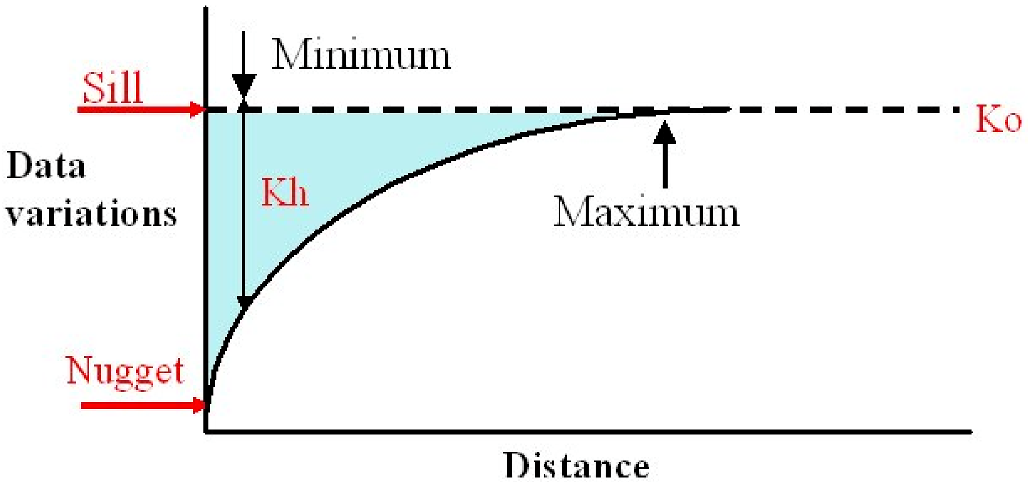

Figure 2.4 – The semivariogram (spherical model)

The smallest distance (one orthogonal step) between points in the dataset is termed the *minimum range* of the variogram. If most of the shaded area lies below this distance, there is insufficient spatial dependency in the dataset to warrant interpolation of data for points which were not measured (i.e. an isopleth map of the data cannot be drawn). The *maximum range* of the variogram is the distance between sampling points beyond which the data values are considered to be independent of one another. In Figure 2.4, Ko represents the overall variation of the whole dataset, while Kh represents the joint variation, i.e. the variation-reflected pairs of points at various distances. The *nugget variance* is the point at which the variogram intersects the y-axis. This represents the 'white noise' present due to error resulting from measurement errors, random errors or spatial variability occurring over shorter distances than the shortest lag interval. The sill of the variogram is the plateau of the plot. Observations over this value are spatially independent.

The semivariogram represents the pattern of spatial variation in a soil property and the average rate of change of that property with distance. The steepness of the initial slope of the semivariogram indicates the intensity of change and the rate of decrease in spatial dependence of that soil property with distance.

Semivariogram analysis for the UKSHS intensive sampling study was carried out using Golden Software's Surface Mapping System – Surfer for Windows Version 7.05. Semivariances for selected determinands were plotted as scatter diagrams and visually inspected to locate sills.

3 Spatial variability of selected soil properties and contaminants

As a precursor to assessing the spatial variability of soil properties, a preliminary inspection was made of the correlation plots between four soil properties and 12 heavy metals, and among these 12 heavy metals. The overall matrix of plots is provided in Figure 3.1. It can be seen from this matrix that there are key positive relationships among the determinands, e.g. Ni/Cr, Pb/Cd, V/Cr and Zn/Cd.

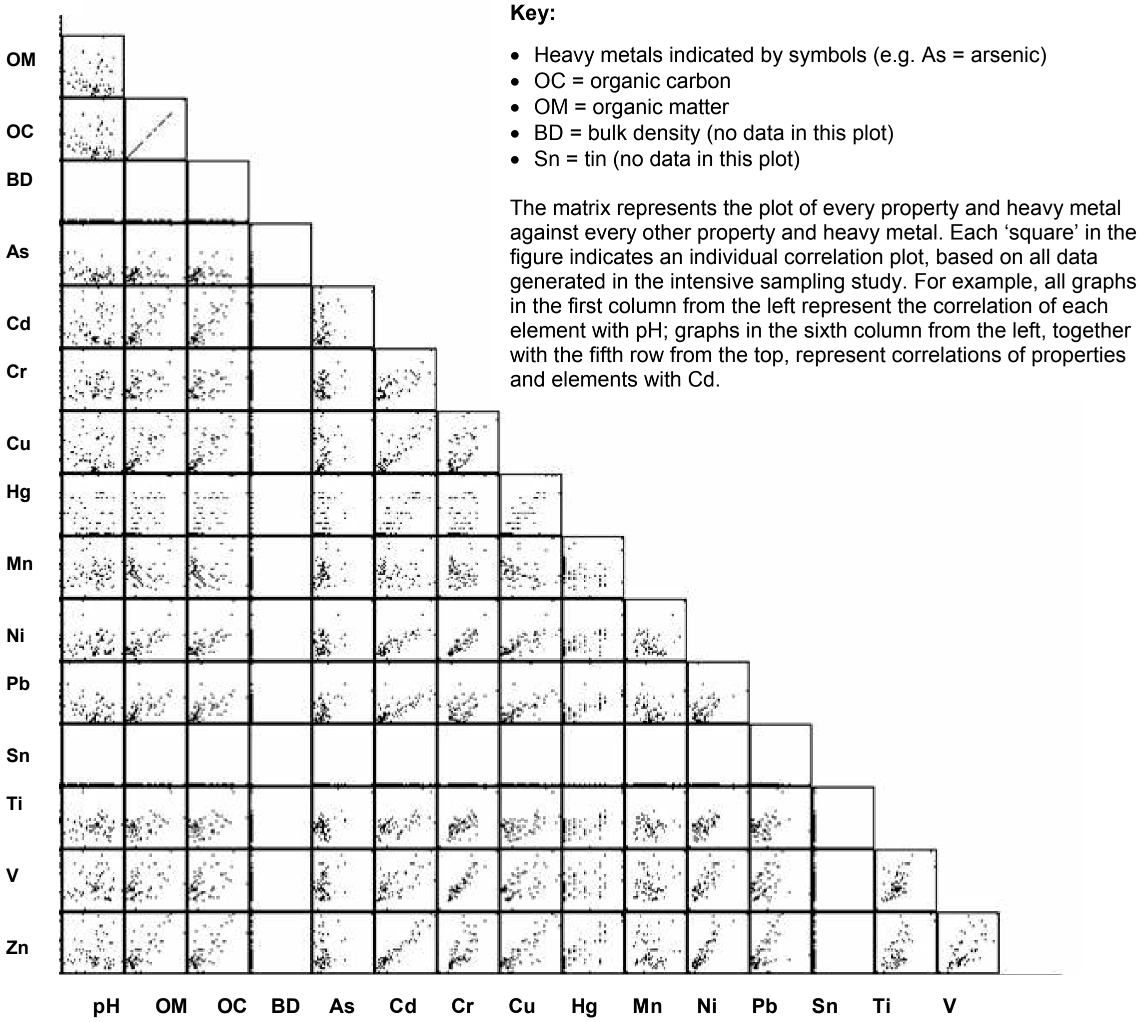

Figure 3.1 –Overall matrix of plots

3.1 Preliminary comments on spatial variability

A total of 70 samples were used in the data analysis. Because this is a relatively small dataset to use for semivariogram analysis, the results are considered to be exploratory and should be interpreted with caution. Over the entire sampling grid, the average nearest neighbour distance was 29.15 m. The minimum nearest neighbour distance was 10 cm and the maximum nearest neighbour distance was 420 m.

Omnidirectional semivariograms (using both orthogonal and diagonal lags) were plotted for four soil properties, 12 metals and one example each of a PAH, a PCB and a dioxin. A series of standard variograms were produced at lag intervals of 5 m, 10 m, 25 m and 50 m, representing 82, 41, 16 and 8 lags respectively. These are illustrated as four differently coloured plots for each determinand in Figures 3.2–3.4.

Many of the points on all semivariograms are based on a very small number of pairs. The small sample numbers combined with the uneven spread of sampling points in the grid means that little confidence should be placed on lag distances >200 m.

In all variograms, small changes in lag distance produce differently shaped plots. The four different plots for each determinand are thus designed to provide a first impression of the instability of the data. The scatter of points in all variograms shows a ‘dip’ in the region of lags 150–300 m (see Figures 3.2–3.4). This indicates an under-sampling in this part of the grid.

3.2 Spatial variability of three soil properties

The semivariograms for soil pH, soil organic matter and bulk density are shown in Figure 3.2. The semivariograms for organic matter and bulk density show a characteristic ‘dip’ at lags of 150–250 m. This can be seen most clearly in the plot for lags of 50 m. Neither of the semivariograms for these two soil properties shows the classic form illustrated in Figure 2.4. No attempt has been made to fit models.

For bulk density, there is a gradual rising limb in the semivariogram from a ‘nugget’ variance (background variation or ‘white noise’) of approximately 0.01 to a high at approximately 0.08. If the ‘dip’ associated with under-sampling in the grid had not occurred, this level could have marked the sill position. However, it would be unsafe to make this interpretation on the basis of the present data.

For soil organic matter, there is no obvious trend because the ‘nugget’ variance is high. The same is true for soil pH. For both organic matter and pH, the ‘nugget’ variance can be seen in plots of all four lags, indicating no spatial dependence in these properties over the scales sampled.

Overall, the semivariograms for soil properties show that the chosen UKSHS sampling scheme (see UKSHS Report No. 2) in which three sub-samples were taken within 20 m of each other would capture the greater part of any spatial dependence in the data.

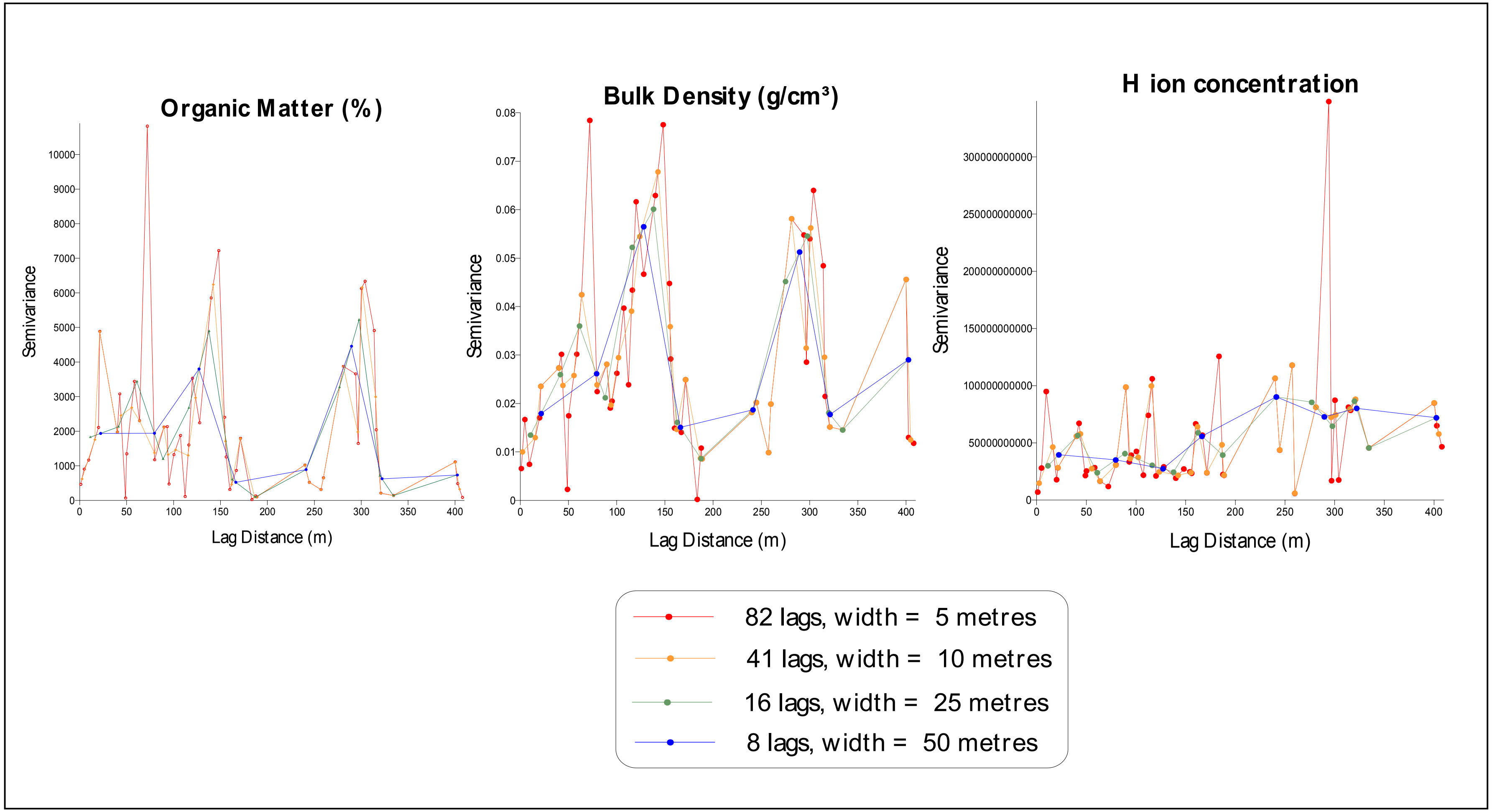

Figure 3.2 – Omnidirectional semivariograms for soil organic matter, bulk density and pH (transformed as pH = –log [H^+])

3.3 Spatial variability of selected inorganic soil contaminants

Although 12 semivariograms were plotted, only six are discussed here. The semivariograms for cadmium (Cd), chromium (Cr), mercury (Hg), manganese (Mn), lead (Pb) and zinc (Zn) are shown in Figure 3.3. They all show the same overall pattern of a ‘dip’ at lags of 150–300 m and a general overall instability. Again, no models were applied. Instead, the semivariograms were inspected visually to locate sills. All six elements show a steeply rising limb in the first 10–20 m of the variogram. This becomes gentler from 20–50 m, although there are no clear sills in any of the plots. Similar unstable plots were obtained for the five elements whose semivariograms are shown in Appendix 1.

Overall, the semivariograms for inorganic determinands given in both Figure 3.3 and Appendix 1 show that the chosen UKSHS sampling scheme (see UKSHS Report No. 2), in which three sub-samples were taken within 20 m of each other, would capture the greater part of any spatial dependence in the data.

3.4 Spatial variability of selected organic soil contaminants

Only three semivariograms were plotted for examples (benzo(a)pyrene, dioxin WHO-TEQ upper limit and PCB 101) from the organic contaminants dataset. These are shown in Figure 3.4 and are even less stable than those for inorganic determinands.

The plots for benzo(a)pyrene and PCB 101 again show the same overall pattern of a ‘dip’ at lags of 150–300 m. No models were applied. Instead, the semivariograms were inspected visually to locate sills. None of the three plots show the clear pattern expected for a semivariogram. These results indicate that a much larger dataset would be required to detect any spatial trends for organic determinands.

Overall, the semivariograms for organic determinands shown in Figure 3.4 indicate high background (white noise) variability for these determinands, which may not be spatially dependent. The spatial analysis and semivariograms do not identify whether the UKSHS sampling scheme (see UKSHS Report No. 2), in which three sub-samples were taken within 20 m of each other, would capture the greater part of any spatial variability in the organic determinand data. A further, more detailed, spatial sampling campaign based on a few organic determinands would be required to determine whether or not there is any clear spatial trend and, if so, what the scale of that pattern is.

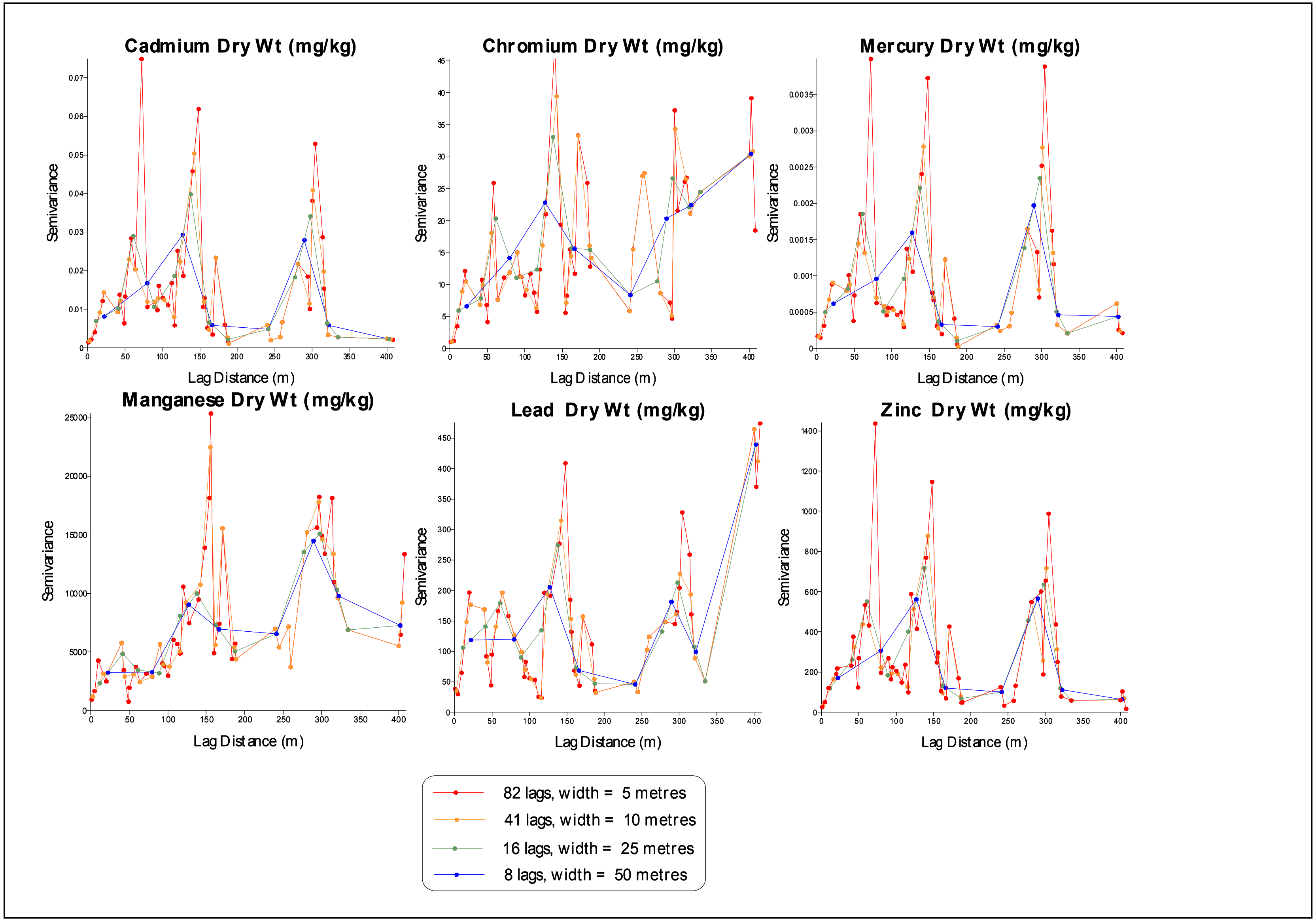

Figure 3.3 – Omnidirectional semivariograms for six selected inorganic determinands. (Cd, Cr, Hg, Mn, Pb and Zn)

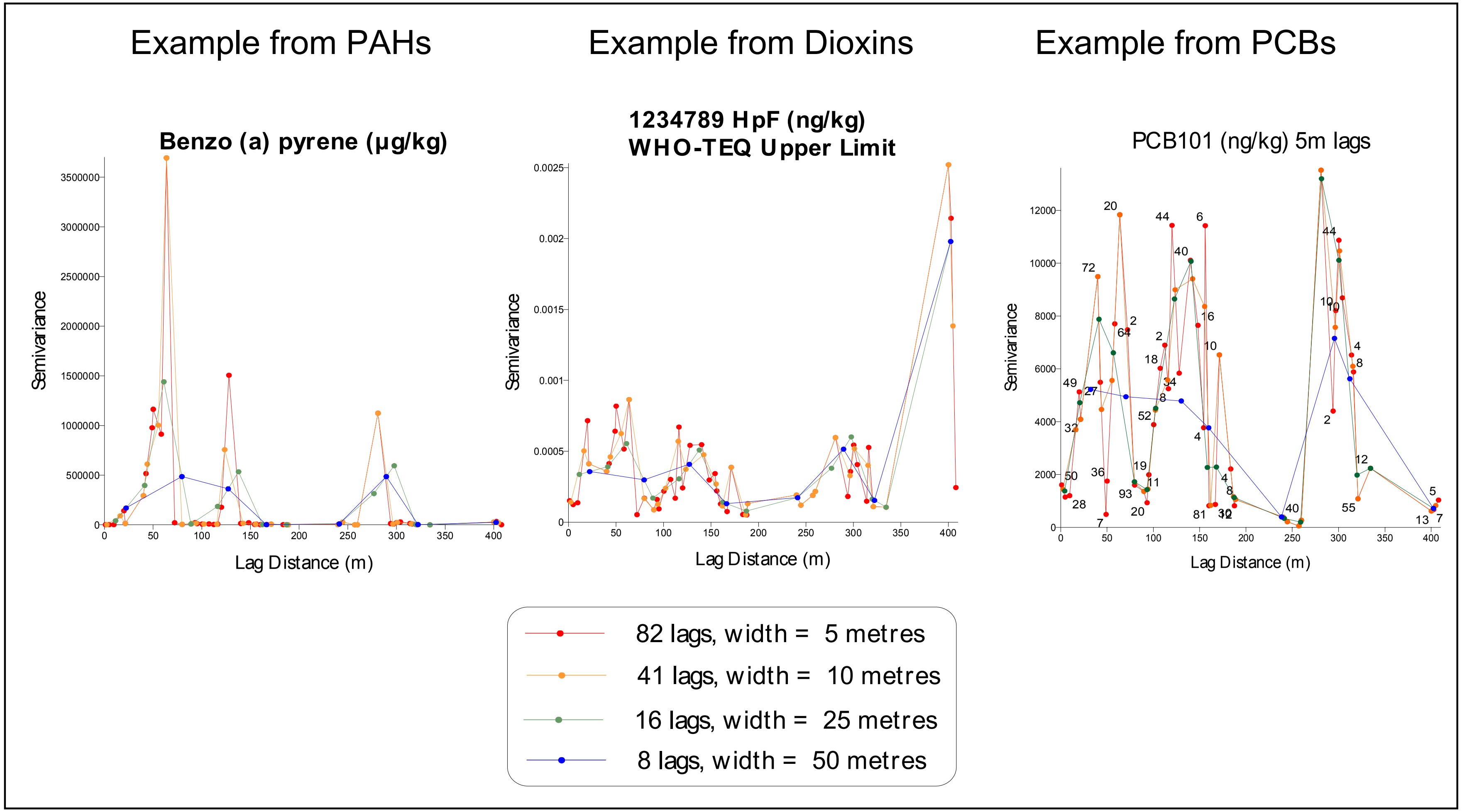

Figure 3.4 – Omnidirectional semivariograms for benzo(a)pyrene, dioxin WHO-TEQ upper limit and PCB 101

4 Comparison of 'uncertainties' associated with field sampling and laboratory analyses

4.1 Introduction

Tables 4.1–4.4 give the relative standard deviation (RSD), bias and uncertainty of laboratory analyses of inorganic and organic determinands. The method of calculating these statistics is described in UKSHS Report No. 3.

To compare the relative 'uncertainties' of contaminant results derived from laboratory analyses and field sampling procedures, the relative standard deviation and the uncertainty were calculated for each determinand in the intensive sampling study. This was carried out for data points lying within 20 m of each other, the maximum distance between samples collected from a single site as part of the main UKSHS sampling programme. In the sampling grid at Tatton Hall, this involved calculating the %RSDs for the 12 points lying within the 10 m x 20 m portion of the grid. Tables 4.5 and 4.6 give the field sampling %RSDs for inorganic and organic determinands respectively.

4.2 Uncertainty of field sampling and laboratory measurement

This section assesses and compares the degree of uncertainty attached to:

- the UKSHS field sampling strategy;
- the laboratory analysis and measurement of metal and organic determinands.

Statistical data for field sampling and laboratory determination of all 13 metals and metalloids are compared, but consideration of the organic determinands (dioxins, PCBs and PAHs) is restricted to the totals data.

4.2.1 Uncertainty of measurement (UoM)

UKSHS Report No. 3 describes the uncertainty of measurement (UoM) calculation used for all metal and organic laboratory determinations carried out in the UKSHS. The UoM is the interval on the measurement scale within which the true value lies with a specified probability when all relevant sources of error have been taken into account. For the purposes of this assessment, the UoM for laboratory determinations is given as 2 x RSD as described in UKSHS Report No. 3.

A similar calculation was applied to field sampled data in the intensive sampling study using only those data that lay within the first 20 m of the sampling grid; this represents the approximate area within which replicate soil samples were taken at each UKSHS site (see UKSHS Report No. 2).

The section compares UoM values obtained from soil sampling during the intensive sampling project and those obtained from analysing Certified Reference Materials (CRMs) in the laboratory.

4.2.2 Relative standard deviations (%RSDs)

As well as comparing the UoM, the proportion of uncertainty due to (a) laboratory and (b) field data was estimated as described below.

The total variance (S_{TOT}^2) of the data is related to the field sample variance (S_F^2) (i.e. the sampling variability) and the laboratory associated variance (S_{AN}^2) as follows:

$S_{TOT}^2 = S_F^2 + S_{AN}^2$ (S = standard deviation) and so $S_F^2 = S_{TOT}^2 - S_{AN}^2$

With unlimited resources, the best approach to take would be to determine the laboratory precision (S_{AN}) at a particular concentration by analysis of replicates of each sample collected. However, this was not possible within the financial constraints of the UKSHS and, as is shown later, it was reasonable to assume that S_{AN} did not show significant variation for samples with similar concentrations.

Therefore, *field uncertainty* can be calculated as follows:

i. Calculate the value of S_{AN} expected at the mean concentration for the samples using the laboratory %RSD for the same determinand.
ii. Estimate the value of S_F from S_{TOT} and the calculated S_{AN} using the equation above.
iii. Calculate the %RSD from S_F and the mean value.

The data for benzo(a)pyrene[1] are used to illustrate this approach:

1) S_{AN} = (150.12 x 13.53)/100 = 20.3

2) So, $S_F^2 = (104.86)^2 - (20.3)^2 = 10583$

3) Therefore, S_F = 102.87 and %RSD = (102.87/150.12) x 100 = 68.5

This result (the proportion of the 'total uncertainty' due to field sampling) of 68.5 per cent indicates that *virtually all of the uncertainty in the result* is associated with the soil heterogeneity; it compares well with the value of 69.9 per cent (the uncertainty calculated using 2 x RSD) from Table 4.6.

Note that the estimated S_F includes the variability for:

- the determinand across the sampling region;
- the sampling, sub-sampling, drying and other sample preparation processes.

Finally it is necessary to address the issue of the change in precision with concentration. The assumption is made that, for benzo(a)pyrene, the precision at the field mean concentration (150.12 mg/kg) is *twice* as bad as at the laboratory mean concentration (351.76 mg/kg) – a very pessimistic assumption. When 27.0 is substituted for 13.5 in the calculation above, the RSD drops to 64.4 per cent, which is not a big difference from 68.5 per cent. Thus the assumption is fair unless the field and laboratory concentrations are very different.

[1] Field mean concentration from Table 4.6 and laboratory %RSD from Table 4.4

4.3 Uncertainty associated with inorganic determinands

The uncertainty data for field sampling and laboratory analysis of inorganic CRMs are given in Tables 4.1 and 4.5. A direct comparison of field and laboratory UoM and %RSD data is presented in Tables 4.7 and 4.8 respectively.

There is little difference in the directly calculated field uncertainty and the estimated proportion of total uncertainty for all metals. The results therefore indicate that the vast majority of the uncertainty is due to relatively small-scale field heterogeneity.

4.4 Uncertainty associated with organic determinands

The uncertainty data for field sampling and laboratory analysis of the three types of organic CRMs are given in Tables 4.9–4.11.

Since there is little difference in the directly calculated field uncertainty and the estimated proportion of total uncertainty for all metals, the above results indicate that the vast majority of the uncertainty is due to relatively small-scale field heterogeneity.

4.5 Conclusions

The study of the spatial variability of determinands (including soil properties, inorganic and organic determinands) measured in the UKSHS has shown that the soils in this intensive study are spatially variable even at a relatively small scale.

For both metals and organics, an estimate of the proportion of total uncertainty due to field spatial variability has indicated that the vast majority of the uncertainty is due to relatively small-scale field heterogeneity.

A study entitled 'Comparative Evaluation of European Methods on Sampling and Sample Preparation of Soils' (CEEM Soil) carried out for the European Commission (Wagner *et al.* 2000) included 15 institutions from 13 European countries. Participants used their own standard methods of soil sampling on a single (common) test site of 0.61 ha, which consisted of four different soil mapping units and three different types of land use.

The study concluded that there was insufficient comparability of results. This is illustrated by the fact that the participants came to different conclusions for up to 61% of the 18 soil quality criteria investigated. It was concluded that, in general, sampling and sample preparation errors were of about the same order of magnitude as the errors in chemical analysis.

These conclusions are consistent with findings of this current study. Wagner *et al.* (2000) emphasised the need to establish quality assurance (QA) and quality control (QC) measures for sampling, just as there are for analysis. They pointed out that there was no agreement among the participants on:

- how many samples need to be taken;
- whether single or composite samples should be taken;
- how many samples there should be in a composite (different methods involved <20).

Table 4.1 – Precision/bias/uncertainty data for laboratory determination of metal CRMs

Metal CRM	Ref (mg/kg)	SD (mg/kg)	%RSD	%Bias	Uncertainty (%)
As	[6.12]	0.54	9		18
As + 5 spike		0.93	8.5	(–8.7)	17
Cd	14.0	0.37	2.65	–4.8	5.3
Cr	134.8	6.99	5.2	–1.5	10.4
Cu	46.9	1.4	3.0	–15.0	6.0
Hg	0.24	0.0225	9.4	7.7	18.8
Hg +0.5 spike		0.041	5.55	(5.9)	11.1
Mn	653	32.56	5.0	–12.7	10.0
Ni	94	3.16	3.35	–8.6	6.7
Pb	51.3	2.66	5.2	–2.5	10.4
Pt +1 spike	1.0	0.05	5.0	–1.0	10.0
Sn	[6.7]	0.64	9.5		19.0
Sn +10 spike		2.2	13	(–19)	26
Ti	[225]	21.65	9.5		19
V	[46.3]	1.56	3.35		6.7
V + 10 spike		1.46	2.6	(–9.3)	5.2
Zn	270	7.8	2.9	–14.0	5.8

[ ] Estimate of reference concentration (i.e. no certified reference value available)
( ) Bias estimated from spike recovery rather than certified reference value
UoM calculation used includes no bias component (i.e. % UoM = 2 x RSD).
SD = standard deviation

Table 4.2 – Laboratory uncertainties for organic determinands (dioxins) based on relative standard deviations for CRMs analysed during the UKSHS Project

	Mean*	SD*	%RSD	% Bias	Uncertainty (%)
2378-TCDF	77.49	8.10	10.46	–3.14	20.92
2378-TCDD	76.71	7.84	10.22	–4.11	20.45
12378-PeCDF	381.31	49.46	12.97	–4.67	25.94
23478-PeCDF	389.57	33.48	8.59	–2.61	17.19
12378-PeCDD	364.65	59.96	16.44	–8.84	32.89
234678-HxCDF	372.46	33.75	9.06	–6.88	18.12
123789-HxCDF	381.07	36.52	9.58	–4.73	19.17
123678-HxCDF	380.90	36.66	9.62	–4.77	19.25
123478-HxCDF	382.42	44.73	11.70	–4.40	23.39
123478-HxCDD	376.90	32.41	8.60	–5.78	17.20
123678-HxCDD	387.70	37.83	9.76	–3.08	19.52
123789-HxCDD	395.44	40.24	10.18	–1.14	20.35
1234678-HpCDF	384.33	34.94	9.09	–3.92	18.18
1234789-HpCDF	384.87	32.69	8.49	–3.78	16.99
1234678-HpCDD	399.69	37.95	9.50	–0.08	18.99
OCDF	781.66	103.05	13.18	–2.29	26.37
OCDD	785.90	105.52	13.43	–1.76	26.85

Data derived from ongoing QC data over duration of survey (108 datasets)
* Expressed in pg/g (ng/kg)

Table 4.3 – Laboratory uncertainties for organic determinands (PCBs) based on relative standard deviations for CRMs analysed during the UKSHS Project

	Mean*	SD*	%RSD	% Bias	Uncertainty (%)
PCB 18	1757.93	181.31	10.31	–12.10	20.63
PCB 28	2089.96	195.70	9.36	4.50	18.73
PCB 31	2062.56	178.43	8.65	3.13	17.30
PCB 47	1489.02	221.31	14.86	–25.55	29.73
PCB 49	1411.74	212.82	15.07	–29.41	30.15
PCB 51	1194.46	219.30	18.36	–40.28	36.72
PCB 52	1364.51	180.75	13.25	–31.78	26.49
PCB 77	1920.64	150.98	7.86	–3.97	15.72
PCB 81	1964.16	182.47	9.29	–1.79	18.58
PCB 99	1725.17	162.61	9.43	–13.74	18.85
PCB 101	1675.87	193.73	11.56	–16.21	23.12
PCB 105	1888.42	168.80	8.94	–5.58	17.88
PCB 114	1882.34	195.68	10.40	–5.88	20.79
PCB 118	1942.34	156.85	8.08	–2.88	16.15
PCB 123	1966.90	175.14	8.90	–1.66	17.81
PCB 126	1934.64	169.46	8.76	–3.27	17.52
PCB 128	1921.75	170.38	8.87	–3.91	17.73
PCB 138	1847.71	210.87	11.41	–7.62	22.83
PCB 153	1796.03	252.96	14.08	–10.20	28.17
PCB 156	1934.05	184.62	9.55	–3.30	19.09
PCB 157	1931.86	177.23	9.17	–3.41	18.35
PCB 167	1961.28	194.80	9.93	–1.94	19.87
PCB 169	1962.22	169.69	8.65	–1.89	17.30
PCB 170	1874.77	215.98	11.52	–6.26	23.04
PCB 180	1866.83	196.14	10.51	–6.66	21.01
PCB 189	1920.42	216.31	11.26	–3.98	22.53

Data derived from ongoing QC data over duration of survey (121 datasets)
* Expressed in pg/g (ng/kg)

Table 4.4 – Laboratory uncertainties for organic determinands (PAHs) based on relative standard deviations for CRMs analysed during the UKSHS Project

	Mean*	SD*	Ref.*	%RSD	%Bias	Uncertainty (%)
1-methyl-phenanthrene	63.64	11.84	68.1	18.60	–7.00	37.20
2-methyl-phenanthrene	107.51	12.23	113.1	11.38	–5.20	22.76
Acenaphthylene	79.76	13.51	84.15	16.93	–5.50	33.87
Acenaphthene	20.80	3.33	22.25	16.00	–6.96	32.00
Anthracene	91.06	12.34	90.65	13.56	0.45	27.11
Benzo-(a)-anthracene	378.84	70.66	416.8	18.65	–10.02	37.30
Benzo-(a)-pyrene	351.76	47.60	361.3	13.53	–2.71	27.06
Benzo-(b)+(j)-fluoranthene	546.66	62.68	582.8	11.47	–6.61	22.93
Benzo-(e)-pyrene	386.90	47.69	413.25	12.33	–6.81	24.65
Benzo-(ghi)-perylene	314.49	33.60	328.2	10.69	–4.36	21.37
Benzo-(k)-fluoranthene	379.57	49.04	398.55	12.92	–5.00	25.84
Chrysene	523.35	61.72	570.45	11.79	–9.00	23.59
Coronene	138.73	15.48	140.45	11.16	–1.24	22.32
Dibenzo-(ah)+(ac)-anthracene	67.89	2.90	67.45	4.28	0.65	8.56
Fluorene	33.53	6.77	36.5	20.19	–8.86	40.38
Fluoranthene	672.16	111.33	737.35	16.56	–9.70	33.13
Indeno-(123cd)-pyrene	347.66	36.41	354.7	10.47	–2.02	20.95
Perylene	93.18	10.74	93.65	11.53	–0.50	23.05
Phenanthrene	424.74	71.50	455.35	16.83	–7.21	33.67
Pyrene	488.85	92.37	542.7	18.90	–11.02	37.79

Ref. = reference material
Data derived from ongoing QC data (Ref.) over duration of survey (129 datasets)
* Expressed in ng/g

Table 4.5 – Mean/standard deviation/uncertainty data for field sampling for inorganic determinands

Determinand	Mean (mg/kg)	SD (mg/kg)	RSD (%)	Uncertainty (%)
Arsenic	6.18	1.10	17.80	35.6
Cadmium	0.37	0.11	29.80	59.6
Chromium	18.25	2.19	12.00	24
Copper	17.18	4.22	24.56	49.12
Lead	45.68	13.53	29.62	59.24
Manganese	212.58	38.78	18.24	36.48
Mercury	0.11	0.03	27.27	54.54
Nickel	11.81	1.78	15.07	30.14
Platinum	0.02	0.00	0.00	0
Tin	2.73	0.69	25.27	50.54
Titanium	111.91	12.62	11.28	22.56
Vanadium	24.63	3.86	15.67	31.34
Zinc	61.98	14.00	22.59	45.18

Table 4.6 – Mean/standard deviation/uncertainty data for field sampling for organic determinands

Determinand	Mean (mg/kg)	SD (mg/kg)	RSD (%)	Uncertainty (%)
Total PCBs	1704.86	657.86	38.58	77.16
Seven PCBs (28, 52, 101, 118, 138, 153, 180)	1161.43	48.53	4.18	8.36
Total PAHs	2287.71	1527.05	66.75	133.5
Benzo-(a)-pyrene	150.12	104.86	69.9	139.8

Table 4.7 – Comparison of UoM data for field sampling and laboratory determination for inorganic determinands

Determinand	Field sampling uncertainty (%)	Laboratory uncertainty (%)
Arsenic	35.6	17–18
Cadmium	59.6	5.3
Chromium	24	10.4
Copper	49.12	6.0
Lead	59.24	10.4
Manganese	36.48	10.0
Mercury	54.54	11.1–18.8
Nickel	30.14	6.7
Platinum	0	10.0
Tin	50.54	19.0–26
Titanium	22.56	19
Vanadium	31.34	5.2–6.7
Zinc	45.18	5.8

Table 4.8 – Comparison of %RSD data for field sampling and laboratory determination of inorganic determinands

	Intensive sampling mean	Intensive sampling SD	Intensive sampling %RSD	Laboratory %RSD	Estimated proportion of total uncertainty due to field sampling %RSD (S_F)
Arsenic	6.2	1.1	17.8	9.0	15.4%
Cadmium	0.4	0.1	29.7	2.7	29.6%
Chromium	18.3	2.2	12.0	5.2	10.8%
Copper	16.2	5.4	33.2	3.0	33.1%
Lead	54.1	15.0	27.8	5.2	27.3%
Manganese	285.4	100.5	35.2	5.0	34.9%
Mercury	0.1	0.0	27.3	9.4	25.6%
Nickel	9.5	3.7	38.9	3.4	38.8%
Platinum	0.0	0.0	0.0	5.0	–
Tin	2.6	0.6	23.9	9.5	22.0%
Titanium	111.1	20.6	18.5	9.5	15.9%
Vanadium	21.2	5.2	24.4	3.4	24.1%
Zinc	50.3	17.0	33.8	2.9	33.7%

Table 4.9 – Comparison of %RSD data for field sampling and laboratory determination for organic determinands (dioxins)

	Intensive sampling mean	Intensive sampling SD	Intensive sampling %RSD	Laboratory %RSD	Estimated field sampling %RSD
2378-TCDF	3.3	2.3	69.0	10.5	68.2
2378-TCDD	0.6	0.6	94.8	10.2	94.3
12378-PeCDF	3.9	2.9	74.6	13.0	73.5
23478-PeCDF	4.3	2.7	63.4	8.6	62.8
12378-PeCDD	1.2	1.2	94.4	16.4	92.9
234678-HxCDF	4.1	3.3	79.2	9.1	78.7
123789-HxCDF	1.8	1.8	97.8	9.6	97.3
123678-HxCDF	3.8	3.2	84.0	9.6	83.4
123478-HxCDF	7.5	5.0	66.2	11.7	65.1
123678-HxCDD	2.1	1.5	69.5	9.8	68.8
123789-HxCDD	2.7	2.1	77.7	10.2	77.1
1234678-HpCDF	33.0	21.8	66.1	9.1	65.5
1234789-HpCDF	3.8	2.7	69.9	8.5	69.4
1234678-HpCDD	17.7	14.5	81.8	9.5	81.3
OCDF	60.1	55.5	92.4	13.2	91.4
OCDD	82.9	50.8	61.2	13.4	59.7
Total	43.7	32.1	73.3	10.8	72.5

Table 4.10 – Comparison of %RSD data for field sampling and laboratory determination for organic determinands (PCBs)

	Intensive sampling mean	Intensive sampling SD	Intensive sampling %RSD	Laboratory %RSD	Estimated field sampling %RSD
PCB 18	60.0	46.0	76.7	10.3	76.0
PCB 28	44.6	49.5	111.0	9.4	110.6
PCB 31	40.9	45.3	110.8	8.7	110.5
PCB 47	9.4	28.4	303.9	14.9	303.5
PCB 49	15.0	12.4	82.7	15.1	81.3
PCB 51	3.2	3.4	107.0	18.4	105.4
PCB 52	19.3	21.5	111.1	13.3	110.3
PCB 77	7.4	10.1	136.5	7.9	136.3
PCB 81	0.8	2.0	244.6	9.3	244.4
PCB 99	37.8	29.9	78.9	9.4	78.3
PCB 101	66.5	63.1	95.0	11.6	94.3
PCB 105	23.8	33.4	139.9	8.9	139.6
PCB 114	1.7	6.4	379.8	10.4	379.6
PCB 118	74.1	79.3	107.0	8.1	106.7
PCB 123	4.9	6.2	128.4	8.9	128.1
PCB 126	4.4	4.1	94.7	8.8	94.3
PCB 128	42.9	55.4	129.2	8.9	128.9
PCB 138	126.1	134.6	106.7	11.4	106.1
PCB 153	186.5	150.9	80.9	14.1	79.7
PCB 156	16.7	12.6	75.3	9.6	74.6
PCB 157	4.8	3.8	78.8	9.2	78.2
PCB 167	7.8	5.6	72.0	9.9	71.3
PCB 169	1.3	1.3	101.5	8.7	101.1
PCB 170	72.3	41.9	57.9	11.5	56.7
PCB 180	101.2	73.4	72.5	10.5	71.8
PCB 189	3.8	7.7	205.3	11.3	205.0

Table 4.11 – Comparison of %RSD data for field sampling and laboratory determination for organic determinands (PAHs)

	Intensive sampling mean	Intensive sampling SD	Intensive sampling %RSD	Laboratory %RSD	Estimated proportion of total uncertainty due to field sampling %RSD (S_F)
1-methyl-phenanthrene	15.7	19.1	121.7	18.6	120.3%
2-methyl-phenanthrene	24.7	29.9	121.4	11.4	120.9%
Acenaphthylene	15.2	10.6	69.4	16.9	67.3%
Acenaphthene	13.7	27.0	197.1	16.0	196.4%
Anthracene	33.2	91.6	275.8	13.6	275.5%
Benzo-(a)-anthracene	147.1	265.0	180.2	18.7	179.2%
Benzo(a)pyrene	211.0	460.5	218.2	13.5	217.8%
Benzo-(b)+(j)-fluoranthene	269.3	689.5	256.0	11.5	255.7%
Benzo-(e)-pyrene	153.2	255.8	167.0	12.3	166.5%
Benzo-(ghi)-perylene	179.6	439.5	244.6	10.7	244.4%
Benzo-(k)-fluoranthene	182.2	215.2	118.2	12.9	117.4%
Chrysene	192.4	282.1	146.7	11.8	146.2%
Coronene	63.1	85.0	134.8	11.2	134.3%
Dibenzo-(ah)+(ac)-anthracene	35.6	137.6	387.0	4.3	387.0%
Fluorene	18.3	16.4	89.5	20.2	87.1%
Fluoranthene	288.6	538.1	186.5	16.6	185.7%
Indeno-(123cd)-pyrene	167.0	329.6	197.4	10.5	197.1%
Perylene	53.6	115.3	215.2	11.5	214.9%
Phenanthrene	141.2	211.4	149.7	16.8	148.8%
Pyrene	262.0	497.9	190.0	18.9	189.1%

5 Comparing the assessment of spatial variability for the UKSHS with that of previous studies

Although spatial variability analyses are widely used in soil classification and, more recently, in soil nutrition and fertilising studies, there are few studies on the spatial variability of soil contaminants. Those that exist document heavy metal fallout (e.g. lead or cadmium from stacks or smelting). No similar comprehensive studies on organic contaminants have been found.

5.1 Spatial variability of inorganic soil contaminants.

Raw data from a number of other studies have been used to calculate the 'uncertainty' from intensive sampling campaigns, which can be compared with those encountered in the UKSHS intensive sampling project (Table 5.1).

Table 5.1 – Calculation of field sampling 'uncertainties' for other soil sampling studies, using the technique outlined in Section 4

Study	No. of samples	Statistic	Cd	Cu	Mn	Pb	Zn
UKSHS	70	Mean (mg/kg)	6.18	17.18	212.58	45.68	61.98
		%RSD	17.80	24.56	18.24	29.62	22.59
		Uncertainty	35.6	49.12	36.48	59.24	45.18
von Steiger *et al.* (1996)	204	Mean	0.238	20.4	-	23.3	53.8
		%RSD	46.22	62.25	-	51.50	34.57
		Uncertainty	92.44	124.45	-	103	69.14
Wu *et al.* (2002)	124	Mean	0.34	-	-	-	-
		%RSD	17.65	-	-	-	-
		Uncertainty	35.29	-	-	-	-
Arrouays *et al.*(1996)	60	Mean	-	-	331	211	-
		%RSD	-	-	23.63	37.83	-
		Uncertainty	-	-	47.25	75.67	-

A relatively high range of field sampling 'uncertainties' (calculated as outlined in Section 4) were discovered in the data for an urbanised area in north-east Switzerland where 204 samples were collected over an 8 km^2 area (von Steiger *et al*. 1996). All uncertainties are significantly higher than in the UKSHS, with uncertainties in the Swiss study around 2.5 times higher for Pb and Cd. The uncertainties calculated for Cd in the USA (Wu *et al*. 2002) and Mn/Pb in France (Arrouays *et al.* 1996) are approximately the same as, or a little higher, than those obtained in the UKSHS.

The field sampling uncertainties generated in the UKSHS are thus within the ranges of uncertainties generated elsewhere.

5.2 Spatial variability of organic soil contaminants.

Spatial variability of organic contaminants within soils cannot currently be compared with other datasets due to a lack of comparable intensive surveys.

6 Conclusions

Geostatistical methods to analyse and study the spatial variability of soil properties are widely used in soil classification and mapping and, increasingly, in soil fertility studies. However, there are relatively few studies of soil inorganic contaminants and none have been found that focus on the organic contaminants (dioxins, PAHs and PCBs) studied in the UKSHS Project.

Geostatistical methods, particularly analysis of the semivariance of soil properties on intensively sampled grids, are now an important first step in determining appropriate soil sampling scales for large-scale soil sampling projects. This intensive soil sampling study was introduced into the UKSHS Project to assess appropriate scales for soil sampling at each of the rural and urban sites in the main study.

Overall, the results presented in this report indicate that there was an under-sampling of certain regions in the sampling grid used for the intensive sampling study, particularly between lags 150–300 m. The resulting semivariograms showed ‘dips’ in these lag regions of the plots. A larger dataset, collected over a more evenly and intensively sampled grid, might generate more stable semivariograms than those presented in this report.

However, the results confirm that the chosen scale of sub-sampling (three sub-samples collected within 20 m of each other) at each point in the main UKSHS Project (see UKSHS Report No. 2) would have captured the greater part of any spatial dependence in soil contaminants for a wide range of inorganic determinands.

The apparently large variations in the example UKSHS organic contaminants (as illustrated in the semivariograms presented in Section 3.4) indicate that a much bigger dataset, collected over a more intensive and more closely spaced sampling grid, would be required to detect spatial patterns in organic contaminants.

Statistical analysis of field sampling uncertainties in the UKSHS Project indicates that they lie well within the uncertainties found in similar studies elsewhere.

Estimates of the proportion of total uncertainty due to field spatial variability have shown that there is little difference in the directly calculated field uncertainty and the estimated proportion of total uncertainty for all metal and organic determinations. These results indicate that the vast majority of the uncertainty is due to relatively small-scale field heterogeneity.

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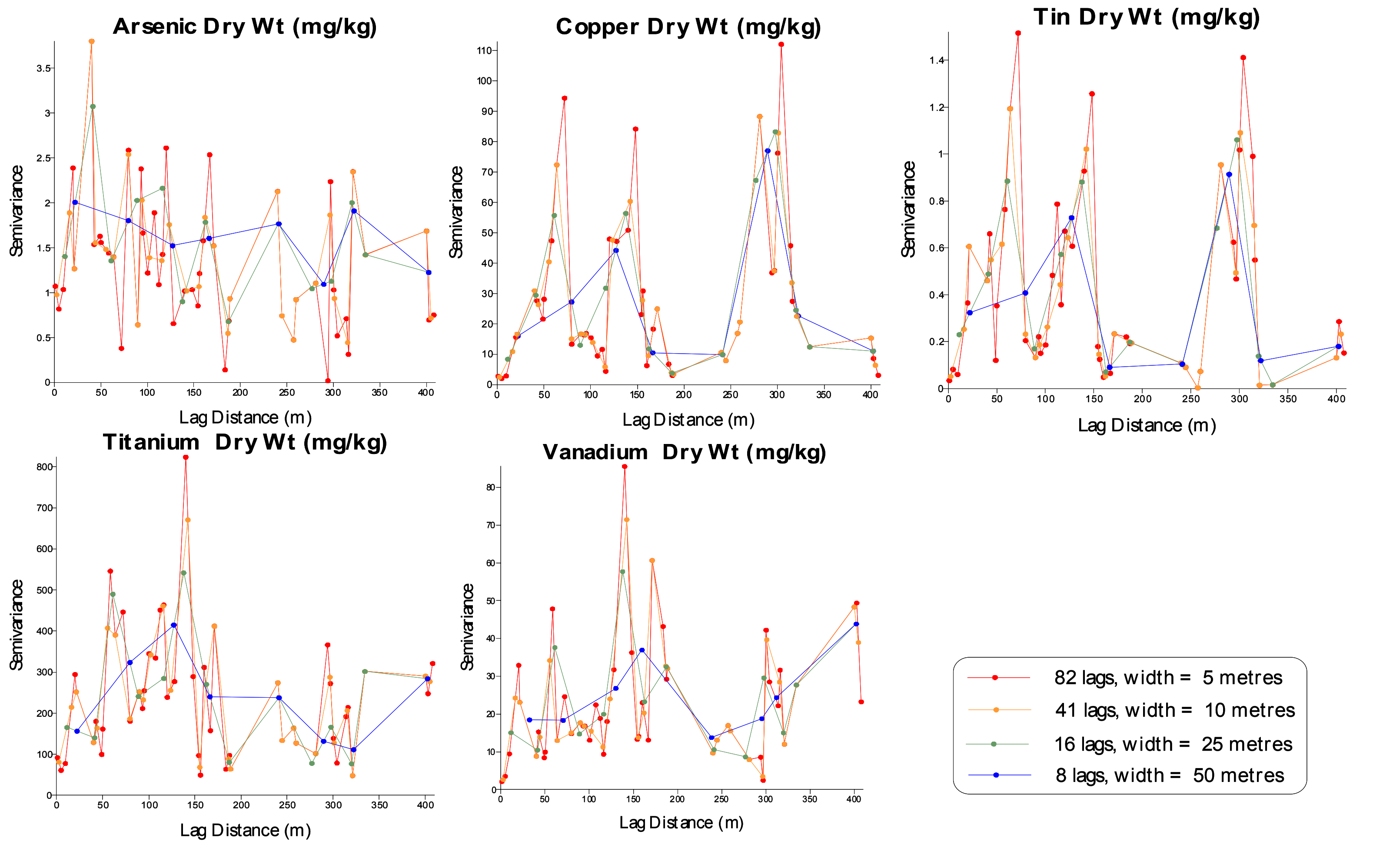
Appendix 1 Semivariograms for inorganic determinands



Omnidirectional semivariograms for five selected inorganic determinands (As, Cu, Sn, Ti, V)

Appendix 2 Full soil properties dataset for intensive sampling project

a) Soil properties

Sample No	X	Y	pH	OM	OC	Bulk Density	Texture
1	0	0	5.33	91.01	52.91		Sandy clay loam
2	20	0	5.28	157.10	91.34	0.447	Organic rich
3	40	0	5.22	78.00	46.00		Organic rich
4	80	0	4.5	136.90	79.59	0.555	Sandy clay loam
5	160	0	5.7	72.30	42.03	0.831	Sandy clay loam
6	320	0	5.27	73.00	43.00	0.691	Sandy clay loam
7	740	0	5.25	69.00	40.12	0.851	Loamy sand
8	0	0.1	4.85	89.60	52.09	0.666	Sandy clay loam
9	20	0.1	5.57	165.62	96.29		Organic rich
10	40	0.1	5.28	164.30	95.52	0.414	Organic rich
11	80	0.1	4.65	132.90	77.27	0.599	Sandy clay loam
12	160	0.1	5.55	67.10	39.01	0.905	Sandy clay loam
13	320	0.1	5.1	78.00	45.35	0.686	Sandy clay loam
14	740	0.1	5.04	61.50	35.76	0.951	Loamy sand
15	0	0.5	4.96	89.20	51.86	0.747	Sandy clay loam
16	20	0.5	5.19	139.40	81.05	0.647	Sandy clay loam
17	40	0.5	5.73	145.85	84.79		Organic rich
18	80	0.5	4.75	108.60	63.14	0.625	Loamy sand
19	160	0.5	5.52	74.70	43.43	0.842	Loamy sand
20	320	0.5	5.14	78.30	45.52	0.724	Loamy sand
21	740	0.5	5.15	70.00	40.70	0.871	Loamy sand
22	0	1	4.99	94.90	55.17	0.694	Sandy clay loam
23	20	1	5.39	185.70	107.97	0.485	Organic rich
24	40	1	5.41	183.70	106.80	0.514	Sandy clay loam
25	80	1	4.75	86.80	50.47	0.848	Sandy clay loam
26	160	1	5.64	79.60	46.28	0.824	Loamy sand
27	320	1	5.17	69.90	40.64	0.829	Loamy sand
28	740	1	5.16	68.00	39.53	0.964	Sandy clay loam
29	0	5	4.83	73.40	42.67	0.505	Organic rich
30	20	5	5.41	112.70	65.52	0.617	Organic rich
31	40	5	5.71	145.70	84.71	0.451	Organic rich
32	80	5	5.17	73.10	42.50	0.751	Loamy sand
33	160	5	5.64	54.09	31.45		Loamy sand
34	320	5	5.12	61.50	35.76	0.959	Loamy sand
35	740	5	5.13	52.30	30.41	0.925	Sandy clay loam

a) Soil properties (cont'd)

Sample No	X	Y	pH	OM	OC	Bulk Density	Texture
36	0	10	4.66	76.60	44.53	0.87	Organic rich
37	20	10	5.48	266.60	155.00	0.354	Organic rich
38	40	10	5.79	193.60	112.56	0.488	Organic rich
39	80	10	4.47	107.30	62.38	0.588	Loamy sand
40	160	10	5.67	82.40	47.91	0.815	Loamy sand
41	320	10	6.09	76.51	44.48		Loamy sand
42	740	10	5.03	56.80	33.02	0.938	Sandy clay loam
43	0	50	4.84	105.10	61.10	0.739	Sandy clay loam
44	20	50	5.3	208.40	121.16	0.385	Sandy clay loam
45	40	50	5.34	176.90	102.85	0.444	Sandy clay loam
46	80	50	5.22	84.80	49.30	0.876	Sandy clay loam
47	160	50	5.67	62.50	36.34	0.885	Sandy clay loam
48	320	50	5.21	67.50	39.24	0.904	Loamy sand
49	740	50	5.83	68.63	39.90		Sandy clay loam
50	0	100	5.65	90.79	52.79		Sandy clay loam
51	20	100	5.84	83.00	48.26	0.776	Sandy clay loam
52	40	100	5.19	91.80	53.37	0.734	Sandy clay loam
53	80	100	5.44	94.00	54.65	0.925	Loamy sand
54	160	100	5.52	72.70	42.27	0.842	Sandy clay loam
55	320	100	5.11	73.60	42.79	0.819	Loamy sand
56	740	100	5.53	56.80	33.02	1.133	Sandy clay loam
57	0	500	4.28	101.20	58.84	0.675	Organic rich
57.1	0	500	4.4	87.00	50.58	0.777	Organic rich
58	20	500	4.81	88.94	51.71		Organic rich
59	40	500	4.04	145.00	84.30	0.661	Organic rich
60	80	500	4.45	79.60	46.28	0.877	Sandy clay loam
61	160	500	4.88	72.30	42.03	0.841	Sandy clay loam
62	320	500	4.34	134.20	78.02	0.63	Sandy clay loam
63	740	500	4.97	172.50	100.29	0.377	Sandy clay loam
64	0	1000	4.64	96.50	56.10	0.558	Sandy clay loam
65	20	1000	4.46	154.10	89.59	0.644	Sandy clay loam
66	40	1000	5.4	141.99	82.55		Sandy clay loam
67	80	1000	4.73	218.50	127.03	0.336	Sandy clay loam
68	160	1000	4.71	212.10	123.31	0.233	Sandy clay loam
69	320	1000	4.21	97.30	56.57	0.654	Sandy clay loam
70	740	1000	4.6	110.30	64.13	0.494	Sandy clay loam

Appendix 3 Full inorganics dataset for intensive soil sampling project

a) Metal and metalloid results (mg/kg)

Sample No	X	Y	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Mercury	Nickel	Platinum	Tin	Titanium	Vanadium	Zinc
1	0	0	5.39	0.275	17.3	13.9	35.7	284	0.0853	10.8	0.200	2.00	101	23.9	55.2
2	20	0	5.82	0.453	19.5	21.1	48.0	187	0.138	13.3	0.200	3.16	131	29.2	66.3
3	40	0	3.47	0.440	16.4	24.0	55.7	152	0.146	13.4	0.200	3.31	110	19.1	78.0
4	80	0	6.09	0.327	12.6	14.5	44.9	298	0.114	8.56	0.200	2.37	91.7	17.7	55.7
5	160	0	7.49	0.165	9.95	11.6	35.7	306	0.0700	5.94	0.200	2.00	71.5	14.1	35.7
6	320	0	4.55	0.207	10.7	8.64	37.6	336	0.0700	5.16	0.200	2.00	105	18.1	38.2
7	740	0	4.46	0.161	12.9	9.52	29.0	248	0.0700	7.56	0.200	2.00	108	18.9	44.9
8	0	0.1	8.30	0.218	15.4	12.3	34.7	214	0.0797	9.57	0.200	2.26	96.1	20.9	44.0
9	20	0.1	6.07	0.430	20.8	20.7	51.3	197	0.140	13.5	0.200	3.26	127	29.6	74.3
10	40	0.1	4.18	0.343	12.3	20.1	38.7	112	0.0926	9.60	0.200	3.32	87.7	14.5	58.3
11	80	0.1	6.06	0.265	12.0	12.0	39.7	243	0.0841	8.27	0.200	2.42	109	15.5	50.3
12	160	0.1	5.18	0.148	9.35	9.70	32.8	246	0.0700	5.14	0.200	2.00	81.1	13.9	37.8
13	320	0.1	4.91	0.184	9.88	8.50	34.4	328	0.0700	4.70	0.200	2.00	103	17.3	34.2
14	740	0.1	5.54	0.194	12.6	9.55	30.4	268	0.0700	7.08	0.200	2.00	90.5	19.6	44.1
15	0	0.5	4.67	0.253	15.1	12.5	27.3	211	0.0700	9.49	0.200	2.00	93.8	20.6	45.6
16	20	0.5	7.43	0.487	19.5	20.4	68.2	237	0.144	12.5	0.200	3.08	109	28.3	73.8
17	40	0.5	3.62	0.400	13.4	20.3	54.7	121	0.106	10.5	0.200	3.15	96.7	19.1	62.0
18	80	0.5	6.81	0.314	11.5	14.0	45.4	320	0.0985	7.78	0.200	2.33	77.9	16.8	54.4
19	160	0.5	5.64	0.183	10.1	10.5	31.6	301	0.0700	6.20	0.200	2.17	88.7	13.8	34.0
20	320	0.5	3.99	0.202	10.2	8.22	34.3	369	0.0700	4.72	0.200	2.00	107	17.6	36.9
21	740	0.5	4.47	0.179	12.3	9.04	29.5	254	0.0700	6.27	0.200	2.00	99.9	18.9	43.4
22	0	1	7.43	0.247	16.0	11.9	29.7	199	0.0877	10.5	0.200	2.10	117	20.7	44.4
23	20	1	5.51	0.367	18.6	16.2	44.0	229	0.111	12.1	0.200	3.10	120	24.9	64.7
24	40	1	5.82	0.396	12.3	21.6	64.0	205	0.137	10.6	0.200	3.46	103	19.0	64.6
25	80	1	7.38	0.323	10.1	12.8	44.5	259	0.0767	7.28	0.200	2.85	84.7	15.8	55.4
26	160	1	6.02	0.199	9.90	12.0	36.0	307	0.0700	5.87	0.200	2.00	99.3	14.5	31.8
27	320	1	5.95	0.201	11.2	9.97	37.8	343	0.0700	5.53	0.200	2.00	107	18.5	39.3
28	740	1	6.16	0.205	14.3	12.5	32.0	279	0.0700	7.61	0.200	2.00	108	20.6	45.5
29	0	5	6.93	0.305	16.3	15.0	35.3	256	0.0997	9.41	0.200	2.34	102	21.2	49.3
30	20	5	5.21	0.570	20.5	23.8	61.0	162	0.144	14.5	0.200	3.57	122	29.8	84.7
31	40	5	3.44	0.351	13.2	18.7	48.6	222	0.107	9.83	0.200	2.43	92.6	18.1	63.7
32	80	5	6.04	0.208	10.1	11.1	35.1	282	0.0700	6.21	0.200	2.00	87.7	14.1	37.5
33	160	5	7.92	0.146	9.54	10.9	35.9	321	0.0700	5.43	0.200	2.00	79.3	14.1	34.3
34	320	5	4.61	0.213	10.6	9.15	41.1	410	0.0700	5.23	0.200	2.00	105	19.2	41.6
35	740	5	5.12	0.163	12.7	9.37	31.9	242	0.0700	7.49	0.200	2.00	117	18.0	38.9

a) Metal and metalloid results (mg/kg) (cont'd)

Sample No	X	Y	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Mercury	Nickel	Platinum	Tin	Titanium	Vanadium	Zinc
36	0	10	6.12	0.374	21.4	16.4	50.3	231	0.127	13.3	0.200	2.00	103	26.1	65.1
37	20	10	5.30	0.487	18.6	22.0	62.7	144	0.151	12.7	0.200	3.93	121	20.4	76.3
38	40	10	6.17	0.460	15.4	20.9	54.0	346	0.142	12.6	0.200	3.43	113	22.8	87.7
39	80	10	5.78	0.146	8.65	11.0	54.7	194	0.0700	5.24	0.200	2.14	71.9	12.8	28.2
40	160	10	6.40	0.134	9.34	10.1	30.8	278	0.0700	5.51	0.200	2.00	80.0	13.4	31.0
41	320	10	6.37	0.212	10.7	8.70	47.9	358	0.0700	5.41	0.200	2.00	107	17.9	40.9
42	740	10	4.05	0.151	12.6	8.69	28.8	206	0.0700	7.69	0.200	2.00	102	17.2	37.3
43	0	50	3.26	0.181	16.8	11.8	30.4	171	0.0700	9.43	0.200	2.00	101	21.3	40.7
44	20	50	5.77	0.610	15.2	28.0	67.4	171	0.180	12.4	0.200	4.10	111	22.0	95.8
45	40	50	6.01	0.480	17.3	29.2	59.3	234	0.145	14.5	0.200	4.17	127	24.0	84.7
46	80	50	6.53	0.197	17.4	12.6	41.0	254	0.0889	8.23	0.200	2.44	105	24.1	42.0
47	160	50	4.03	0.185	12.0	11.8	30.8	380	0.0700	6.47	0.200	2.00	99.0	17.7	40.3
48	320	50	5.88	0.212	11.0	9.45	38.2	361	0.0700	6.25	0.200	2.00	107	17.4	43.9
49	740	50	5.38	0.159	13.9	9.94	29.3	267	0.0700	7.51	0.200	2.00	99.6	18.6	36.6
50	0	100	6.91	0.170	18.1	14.3	48.8	202	0.0764	9.23	0.200	2.17	72.7	27.3	44.5
51	20	100	4.40	0.232	16.0	10.9	41.7	146	0.0917	6.83	0.200	2.93	111	21.7	42.3
52	40	100	6.64	0.161	13.6	13.0	46.1	118	0.0813	6.56	0.200	2.67	73.6	20.6	36.1
53	80	100	6.50	0.312	20.9	17.0	53.4	227	0.105	10.4	0.200	2.06	86.5	25.6	54.3
54	160	100	5.62	0.171	10.1	10.8	32.3	398	0.0700	5.13	0.200	2.93	94.0	14.9	32.8
55	320	100	6.19	0.193	10.9	9.55	30.0	276	0.0700	6.24	0.200	2.00	94.3	17.6	38.9
56	740	100	5.35	0.154	13.2	9.50	28.5	323	0.0700	6.87	0.200	2.00	116	17.0	41.8
57	0	500	7.48	0.228	10.4	18.9	112	215	0.122	6.87	0.200	2.62	94.0	16.3	47.6
57.1	0	500	7.42	0.165	9.83	15.6	47.0	143	0.144	4.90	0.200	2.67	96.3	15.4	38.7
58	20	500	4.46	0.217	4.87	12.2	51.5	35.4	0.121	3.21	0.200	3.15	56.6	9.09	26.8
59	40	500	6.56	0.237	9.61	19.8	50.6	118	0.107	5.85	0.200	2.79	88.7	14.6	37.6
60	80	500	4.87	0.220	14.7	10.4	37.8	210	0.0947	7.33	0.200	2.00	111	18.1	41.7
61	160	500	7.06	0.244	18.7	14.7	39.0	494	0.0834	10.2	0.200	2.00	114	23.5	52.0
62	320	500	8.38	0.319	10.2	15.2	55.3	144	0.139	5.89	0.200	2.67	77.3	14.6	39.3
63	740	500	6.88	0.236	18.4	14.8	39.4	528	0.0854	11.6	0.200	2.04	105	25.0	52.6
64	0	1000	5.90	0.292	17.2	12.4	40.5	336	0.0731	10.4	0.200	2.00	112	25.1	54.5
65	20	1000	13.0	0.416	21.0	17.0	53.3	349	0.102	12.7	0.200	2.13	115	29.7	67.0
66	40	1000	11.6	0.464	19.1	21.3	62.5	291	0.148	11.0	0.200	2.92	139	33.2	64.2
67	80	1000	20.8	0.594	29.6	26.8	72.7	574	0.178	24.9	0.200	3.27	178	34.3	97.2
68	160	1000	10.8	0.515	25.0	24.5	66.7	478	0.180	20.1	0.200	3.55	184	28.0	89.5
69	320	1000	13.0	0.209	14.3	13.1	83.0	183	0.112	8.82	0.200	2.25	120	17.2	41.7
70	740	1000	9.52	0.263	12.0	21.3	63.7	135	0.141	8.13	0.200	3.53	121	17.2	41.3

Appendix 4 Full organics dataset for intensive soil sampling project

a) Dioxins (ng/kg)

Sample No	X	Y	2,3,7,8-tetrachlorodibenzo-p-dioxin	1,2,3,7,8-pentachlorodibenzo-p-dioxin	1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	octachlorodibenzo-p-dioxin	2,3,7,8-tetrachlorodibenzofuran	1,2,3,7,8-pentachlorodibenzofuran	2,3,4,7,8-pentachlorodibenzofuran	1,2,3,4,7,8-hexachlorodibenzofuran	1,2,3,6,7,8-hexachlorodibenzofuran	1,2,3,7,8,9-hexachlorodibenzofuran	2,3,4,6,7,8-hexachlorodibenzofuran	1,2,3,4,6,7,8-heptachlorodibenzofuran	1,2,3,4,7,8,9-heptachlorodibenzofuran	octachlorodibenzofuran
1	0	0	0.299	1.79	0.913	1.99	1.55	18.6	40.9	2.15	2.54	1.56	4.08	3.27	2.09	4.68	20.9	1.70	25.3
2	20	0	0.172	2.31	1.55	2.95	3.24	28.3	86.4	5.89	4.24	8.21	8.83	6.34	3.66	6.42	48.4	4.41	51.3
3	40	0	0.182	1.07	0.816	3.19	2.75	21.4	87.3	3.35	4.22	5.95	7.59	7.12	2.89	4.62	40.5	2.95	55.3
4	80	0	0.438	1.63	0.963	0.834	1.36	18.4	68.5	2.87	3.07	5.19	4.19	3.25	1.66	5.31	26.9	1.67	19.3
5	160	0	0.348	1.15	1.00	1.90	1.29	13.3	50.0	3.20	3.02	3.75	5.03	3.65	1.31	3.79	22.1	2.63	39.9
6	320	0	0.130	0.536	0.619	0.696	0.635	1.97	7.90	1.44	0.159	1.48	1.07	1.83	0.386	1.62	2.10	0.973	7.15
7	740	0	0.0850	0.838	0.605	2.20	0.763	15.6	58.8	0.958	1.92	2.80	3.43	2.56	0.341	2.79	19.8	1.82	31.0
8	0	0.1	0.196	1.25	1.86	1.24	2.47	22.4	65.3	1.83	0.547	2.24	5.61	2.42	2.02	4.47	23.0	4.70	17.2
9	20	0.1	0.277	2.13	1.62	1.72	1.21	25.2	144	5.90	4.63	5.58	12.0	5.31	3.01	5.52	36.6	7.61	71.6
10	40	0.1	0.294	0.950	1.84	2.25	1.36	23.3	68.6	3.65	2.93	5.12	6.99	3.75	2.18	4.00	32.6	4.59	38.7
11	80	0.1	0.660	1.55	1.35	2.65	1.02	22.1	87.9	2.97	3.84	5.07	6.74	3.92	1.25	4.75	27.7	3.70	49.6
12	160	0.1	0.482	1.08	1.05	1.84	1.76	14.5	50.6	1.67	2.55	3.24	5.04	2.66	1.38	3.44	20.9	2.52	42.3
13	320	0.1	0.143	0.976	1.39	0.895	3.71	2.79	25.6	0.359	1.22	4.18	1.89	0.701	0.936	2.33	15.6	1.23	13.2
14	740	0.1	0.205	1.05	0.377	1.75	1.15	3.30	70.1	2.21	2.71	3.97	1.58	0.562	1.13	2.18	24.2	0.627	43.1
15	0	0.5	0.198	1.00	1.11	0.644	0.814	19.3	58.8	1.07	1.39	2.15	2.47	2.81	0.882	2.03	13.9	1.01	19.0
16	20	0.5	0.331	3.39	1.82	3.67	3.26	21.5	83.9	4.58	5.10	1.51	9.87	4.82	5.24	6.66	39.8	4.70	45.4
17	40	0.5	0.285	2.33	2.58	2.70	0.659	24.7	76.3	3.43	4.26	5.93	9.63	4.64	2.40	4.12	33.3	3.30	52.7
18	80	0.5	0.507	2.26	2.32	3.33	2.55	23.3	74.9	3.69	4.51	5.37	7.27	3.31	0.785	5.76	30.5	3.24	49.7
19	160	0.5	0.288	0.867	0.448	0.525	0.851	15.5	45.0	1.95	2.18	2.99	3.95	1.71	0.357	2.33	18.9	1.80	41.0
20	320	0.5	0.0330	0.500	1.11	1.87	2.12	1.36	43.3	0.653	1.07	3.23	1.28	1.43	1.10	3.74	5.89	1.56	2.06
21	740	0.5	0.590	1.01	0.924	1.20	3.35	8.02	103	1.53	1.67	2.12	2.61	2.33	2.03	0.932	18.2	3.20	28.1
22	0	1	0.808	1.04	0.933	2.18	1.86	6.51	34.8	2.38	1.57	2.27	2.24	2.14	9.87	2.59	12.5	1.98	8.04
23	20	1	0.316	1.79	2.35	0.284	0.428	31.2	111	3.99	5.50	6.73	15.0	9.92	4.17	7.46	49.1	2.46	38.6
24	40	1	0.529	3.27	1.49	4.26	1.51	31.8	83.5	6.56	4.70	8.00	7.85	6.11	3.31	7.86	37.0	5.56	60.1
25	80	1	0.676	0.843	1.54	2.71	2.47	24.2	82.5	4.33	4.93	2.91	8.45	4.93	1.95	6.48	35.2	4.39	63.2
26	160	1	0.626	2.34	2.79	3.45	3.16	15.4	57.5	3.04	4.69	5.12	6.65	4.11	2.46	3.90	22.8	2.91	39.3
27	320	1	3.63	0.235	0.423	1.85	1.85	4.06	3.58	0.483	0.322	0.997	1.51	0.954	1.66	1.16	4.65	1.84	3.07
28	740	1	0.113	0.663	0.334	1.98	0.570	35.0	32.5	0.801	1.33	1.56	2.33	1.39	1.32	1.78	15.4	2.78	16.5
29	0	5	0.518	0.691	0.674	0.715	0.556	12.6	58.0	1.23	1.67	3.05	4.28	2.42	0.915	2.66	12.3	0.334	17.8
30	20	5	0.348	1.93	2.53	2.86	0.396	34.3	112	4.29	5.92	7.40	16.2	8.20	4.48	8.02	48.2	2.61	41.5
31	40	5	0.218	1.57	1.42	2.44	1.59	19.3	95.9	3.90	3.65	2.92	6.23	3.87	1.77	3.89	26.2	3.25	56.9
32	80	5	0.135	1.29	0.954	1.63	0.519	18.5	43.7	2.08	2.71	3.26	5.21	3.40	0.702	4.26	24.6	3.40	31.8
33	160	5	0.553	0.757	1.12	1.31	0.572	14.4	65.9	1.96	3.03	3.21	5.11	2.70	0.189	3.40	20.1	2.68	42.3
34	320	5	0.163	0.814	1.68	0.259	0.551	2.07	42.5	1.57	2.30	1.92	4.22	3.76	2.02	3.18	25.3	1.36	13.5
35	740	5	0.160	0.453	0.830	1.15	0.471	8.70	35.8	2.03	2.01	1.19	5.48	2.54	1.86	3.49	23.0	2.22	32.1

a) Dioxins (ng/kg) (cont'd)

Sample No	X	Y	Total tetrachlorodibenzo-p-dioxin	Total pentachlorodibenzo-p-dioxin	Total hexachlorodibenzo-p-dioxin	Total heptachlorodibenzo-p-dioxin	Total tetrachlorodibenzofuran	Total pentachlorodibenzofuran	Total hexachlorodibenzofuran	Total heptachlorodibenzofuran	ITEQ upper	ITEQ lower	WHO-TEQ upper	WHO-TEQ lower
1	0	0	7.66	16.0	10.6	15.5	11.2	11.3	25.9	12.9	4.65	3.20	5.49	4.04
2	20	0	13.8	14.1	40.3	61.1	38.6	50.2	47.0	58.7	10.5	10.5	11.5	11.5
3	40	0	11.6	11.9	41.2	52.1	33.1	45.9	41.5	45.5	7.93	7.21	8.33	7.08
4	80	0	3.82	9.70	22.5	19.1	16.3	16.0	25.2	22.2	6.60	5.86	7.34	6.60
5	160	0	6.04	12.5	16.8	14.1	18.8	28.9	30.7	28.4	5.54	5.54	6.03	6.03
6	320	0									2.04		2.30	
7	740	0	2.45	10.3	13.0	24.8	14.1	16.8	10.3	22.3	3.83	3.60	4.16	3.94
8	0	0.1	6.75	7.34	28.5	31.4	17.7	19.0	18.2	26.2	4.74	4.74	5.29	5.29
9	20	0.1	13.3	20.8	32.3	52.0	42.7	47.2	51.2	38.4	8.90	8.57	9.77	9.44
10	40	0.1	12.0	23.5	18.7	36.5	34.5	24.9	31.6	41.1	6.79	6.61	7.17	6.98
11	80	0.1	13.2	21.9	47.9	22.4	31.3	43.1	43.2	38.2	7.30	6.41	7.95	7.06
12	160	0.1	2.84	6.51	14.8	13.5	14.6	22.2	21.6	28.8	5.13	4.64	5.58	5.10
13	320	0.1								18.6	4.24	2.35	4.69	2.31
14	740	0.1		4.21	2.73	9.16	9.66	8.53	23.9	6.29	4.34	3.04	4.76	2.94
15	0	0.5	8.15	9.94	7.87	28.1	11.7	12.6	3.07	13.5	3.45	3.30	3.88	3.73
16	20	0.5	11.6	1.92	64.9	46.3	47.2	39.0	55.6	52.4	7.82	7.82	9.40	9.40
17	40	0.5	10.6	15.5	34.6	44.6	43.7	45.9	41.9	43.7	8.39	8.32	9.43	9.37
18	80	0.5	13.4	24.7	51.6	23.4	35.6	38.2	41.7	40.6	8.14	6.43	9.16	6.32
19	160	0.5	2.07	3.33	17.2	26.6	8.24	17.5	19.7	27.0	3.99	3.77	4.34	4.12
20	320	0.5									3.42	0.0433	3.62	0.00433
21	740	0.5									4.15	0.285	4.54	0.192
22	0	1									5.21	0.160	5.69	0.128
23	20	1	14.5	23.5	28.8	73.9	48.3	46.2	51.4	59.8	10.2	9.54	10.9	10.3
24	40	1	30.1	19.5	63.6	79.3	43.3	52.3	53.9	46.4	11.2	10.5	12.7	12.0
25	80	1	12.4	46.8	56.1	24.7	33.4	40.8	54.0	49.7	6.87	4.23	7.16	4.18
26	160	1	8.23	10.2	31.9	31.7	16.0	19.4	11.6	31.7	8.05	8.05	9.14	9.14
27	320	1		1.49							5.36		5.47	
28	740	1			8.86		1.33		9.57	10.0	2.92	1.06	3.21	1.03
29	0	5	8.24	12.8	33.6	20.1	9.22	22.1	23.1	14.5	4.15	3.21	4.42	3.49
30	20	5	19.0	26.6	31.6	71.3	56.5	42.1	46.3	55.0	11.0	10.3	11.8	11.1
31	40	5	6.76	10.6	35.6	46.4	30.1	25.7	37.3	33.9	5.80	5.80	6.44	6.44
32	80	5	5.39	8.92	20.6	33.6	13.8	24.2	19.1	25.6	4.96	2.43	5.54	2.36
33	160	5	1.72	1.83	29.6	15.2	18.5	23.6	27.0	27.6	4.80	3.80	5.09	3.70
34	320	5	1.87	7.14			6.41	15.9	9.36	11.8	3.71	3.06	4.07	3.42
35	740	5	4.09		13.5	20.4	14.5	15.2	33.7	28.6	3.27	3.27	3.44	3.44

a) Dioxins (ng/kg) (cont'd)

Sample No	X	Y	2,3,7,8-tetrachlorodibenzo-p-dioxin	1,2,3,7,8-pentachlorodibenzo-p-dioxin	1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	octachlorodibenzo-p-dioxin	2,3,7,8-tetrachlorodibenzofuran	1,2,3,7,8-pentachlorodibenzofuran	2,3,4,7,8-pentachlorodibenzofuran	1,2,3,4,7,8-hexachlorodibenzofuran	1,2,3,6,7,8-hexachlorodibenzofuran	1,2,3,7,8,9-hexachlorodibenzofuran	2,3,4,6,7,8-hexachlorodibenzofuran	1,2,3,4,6,7,8-heptachlorodibenzofuran	1,2,3,4,7,8,9-heptachlorodibenzofuran	octachlorodibenzofuran
36	0	10	0.272	1.02	0.572	1.24	0.991	17.6	64.6	2.44	2.60	3.16	3.64	3.87	1.67	2.64	14.7	0.563	17.8
37	20	10	0.772	2.93	1.82	2.26	3.43	32.0	89.0	3.29	4.93	6.57	10.2	4.22	2.57	4.15	48.7	3.33	48.6
38	40	10	0.364	2.12	1.71	3.28	4.41	30.0	113	6.43	4.67	6.50	11.1	6.81	3.56	7.48	48.6	3.27	96.7
39	80	10	0.257	1.01	0.680	1.58	2.24	19.8	73.1	2.66	3.07	4.58	7.54	4.54	1.21	3.57	42.4	2.46	71.3
40	160	10	0.417	0.520	0.455	0.937	1.87	11.9	52.4	2.45	3.02	1.91	4.24	2.30	0.749	3.72	21.8	2.47	42.1
41	320	10	0.662	4.97	0.635	0.767	13.1	2.25	36.8	1.92	1.39	6.36	2.14	1.65	2.95	0.887	3.67	2.15	16.6
42	740	10	0.198	0.227	0.429	1.46	1.12	17.5	7.44	0.494	0.592	1.61	1.17	1.22	0.586	0.923	24.0	0.303	9.40
43	0	50	0.387	0.966	0.979	1.33	1.37	13.1	77.4	1.51	2.17	2.96	3.17	1.98	1.93	2.63	15.7	1.84	22.3
44	20	50	0.435	1.94	1.07	3.15	5.33	26.4	119	5.74	5.49	6.49	8.53	4.60	1.88	9.33	49.5	2.67	51.7
45	40	50	0.851	4.18	2.58	4.27	5.80	50.8	144	7.16	6.09	9.67	11.9	7.65	5.32	11.6	55.8	7.73	78.0
46	80	50	0.419	0.804	1.26	2.03	0.958	12.1	56.0	2.09	2.95	3.26	4.60	2.73	1.37	2.57	18.2	1.89	39.7
47	160	50	0.185	0.994	0.783	1.58	0.431	23.5	67.2	1.71	1.97	2.79	6.32	3.14	0.565	3.77	25.1	0.936	35.4
48	320	50	0.429	0.592	0.173	1.16	0.440	2.78	52.6	0.358	0.909	0.613	1.31	0.650	1.03	1.27	15.0	1.10	4.86
49	740	50	0.0380	0.559	0.489	0.772	0.335	11.4	38.7	0.868	1.47	1.75	3.68	1.68	0.466	1.54	17.7	1.24	24.0
50	0	100	0.137	1.15	0.987	2.22	1.38	17.6	74.9	2.21	3.28	3.81	4.90	2.54	0.376	3.20	22.5	2.60	49.1
51	20	100	0.0240	0.580	2.04	2.24	2.25	18.6	70.5	4.18	3.49	4.22	4.77	2.74	2.36	3.99	23.4	2.80	43.8
52	40	100	0.232	0.982	0.915	2.19	1.70	16.2	61.1	3.14	4.40	4.36	7.50	4.21	0.681	4.27	29.5	3.31	59.3
53	80	100	0.143	0.543	0.383	0.514	0.323	2.07	32.0	2.00	1.10	0.990	3.56	1.48	0.180	0.441	12.5	0.0780	10.8
54	160	100	0.292	1.05	0.342	1.40	1.10	16.7	38.8	2.29	2.11	1.45	5.13	2.99	0.499	4.08	19.0	0.929	1.62
55	320	100	2.75	0.179	0.111	0.446	0.217	5.19	95.1	0.532	1.85	6.97	2.00	0.930	0.319	1.40	8.41	0.841	14.6
56	740	100	0.261	0.258	0.410	1.16	0.832	13.1	54.2	1.21	1.85	2.46	3.34	2.82	0.469	2.49	21.7	0.586	26.3
57	0	500	0.531	1.50	1.80	3.18	2.18	20.6	78.8	5.33	6.05	5.35	11.8	7.62	2.13	5.83	43.3	3.20	86.5
57.1	0	500	0.435	1.27	1.66	2.37	1.87	21.5	71.6	3.66	4.68	5.00	7.72	4.27	1.79	5.69	37.1	4.72	79.9
58	20	500	1.80	7.63	9.47	10.8	4.80	108	397	15.5	19.8	18.6	36.4	23.5	9.23	24.6	165	15.9	463
59	40	500	0.308	1.43	1.34	2.76	2.84	23.7	77.8	3.18	5.09	4.82	9.98	4.08	2.38	5.92	49.6	1.58	79.9
60	80	500	0.360	0.708	0.902	1.29	1.62	9.94	49.1	1.28	1.64	2.27	3.61	1.92	0.769	2.36	14.3	1.75	23.3
61	160	500	0.0530	0.404	1.31	2.23	1.65	13.8	55.6	1.83	2.84	2.13	5.91	1.89	1.34	3.53	18.3	2.97	20.1
62	320	500	0.342	1.12	1.72	1.29	2.18	14.5	102	3.33	4.61	4.07	7.33	4.46	1.82	3.90	34.0	6.58	84.9
63	740	500	0.0990	0.354	0.391	1.15	2.06	18.1	66.8	1.28	1.89	1.82	4.61	2.75	0.709	2.69	21.4	2.19	50.8
64	0	1000	0.470	1.43	1.16	1.81	1.04	16.4	62.2	2.11	2.11	2.16	4.88	3.62	1.56	3.07	22.7	3.15	36.1
65	20	1000	0.483	0.958	1.00	0.430	0.994	12.1	59.4	2.17	3.18	4.00	4.68	1.04	3.29	2.90	24.4	0.736	36.0
66	40	1000	0.381	0.700	1.25	0.583	0.281	2.85	3.75	0.108	0.229	0.226	0.267	0.305	0.919	0.483	0.813	0.442	0.102
67	80	1000	1.09	1.61	23.5	4.35	9.17	7.60	179	2.83	8.09	18.1	9.36	0.667	0.831	1.58	24.3	3.77	70.9
68	160	1000	0.353	0.863	1.65	2.74	2.57	24.0	105	6.53	4.91	12.2	12.4	10.3	4.77	3.76	69.0	7.64	64.6
69	320	1000	0.117	0.828	1.17	1.43	5.41	5.24	38.1	3.62	0.978	1.28	6.16	1.81	1.43	1.30	3.21	3.05	10.8
70	740	1000	0.793	1.29	1.46	1.23	3.54	5.70	49.7	6.39	9.29	1.44	9.41	1.96	2.01	6.66	53.6	10.1	34.3

a) Dioxins (ng/kg) (cont'd)

Sample No	X	Y	Total tetrachlorodibenzo-p-dioxin	Total pentachlorodibenzo-p-dioxin	Total hexachlorodibenzo-p-dioxin	Total heptachlorodibenzo-p-dioxin	Total tetrachlorodibenzofuran	Total pentachlorodibenzofuran	Total hexachlorodibenzofuran	Total heptachlorodibenzofuran	ITEQ upper	ITEQ lower	WHO-TEQ upper	WHO-TEQ lower
36	0	10	3.10	22.3	29.8	41.8	12.2	9.63	19.0	15.6	4.61	3.75	5.05	3.68
37	20	10	6.01	27.4	23.9	24.3	24.5	39.2	38.6	23.0	9.94	5.48	11.3	6.82
38	40	10	12.2	29.7	60.2	74.6	48.1	61.1	63.8	69.3	10.4	10.4	11.3	11.3
39	80	10	5.65	7.62	16.5	47.8	18.8	14.6	38.9	58.0	6.40	6.40	6.77	6.77
40	160	10	4.61	11.1	15.2	11.9	23.1	24.6	27.1	30.4	3.91	2.40	4.09	2.58
41	320	10						4.87			8.94	0.0534	11.4	0.00534
42	740	10	4.90	4.65		34.3		4.91		22.3	2.32	0.700	2.42	0.685
43	0	50	2.02	4.79	15.6	31.4	11.5	12.6	11.1	20.8	4.35	4.35	4.75	4.75
44	20	50	11.6	22.1	49.7	55.6	27.5	28.7	54.7	7.53	9.84	8.67	10.7	9.49
45	40	50	32.7	53.5	52.9	140	77.0	63.3	76.5	72.4	15.1	13.9	17.0	15.8
46	80	50	3.19	10.6	23.1	12.8	16.7	25.0	24.8	25.2	4.78	3.73	5.09	3.65
47	160	50	5.26	13.6	31.8	47.0	15.4	23.3	28.3	28.4	4.60	4.07	5.01	4.48
48	320	50		2.59							1.96	0.203	2.21	0.155
49	740	50		5.30	13.6	33.4	6.93	10.7	9.85	22.4	2.62	1.57	2.84	1.80
50	0	100	3.27	10.5	31.7	16.6	17.0	27.1	24.8	31.2	5.11	4.98	5.58	5.44
51	20	100	1.46	10.2	32.4	19.7	15.3	24.8	28.0	31.7	5.62	5.30	5.80	5.20
52	40	100	8.17	13.2	30.2	14.9	23.3	32.7	39.1	40.3	6.19	5.31	6.58	5.20
53	80	100	3.57		17.0		11.1	7.33	10.8	13.8	2.04	0.927	2.27	0.888
54	160	100	5.94	8.11	31.1	19.6	15.7	8.64	19.2	24.3	3.84	3.07	4.33	3.56
55	320	100								29.0	7.27	0.194	7.26	0.0951
56	740	100	5.39	8.71	9.96	37.4	6.46	17.9	8.74	22.7	3.42	2.87	3.48	2.79
57	0	500	7.34	23.5	54.7	53.5	45.2	37.6	64.5	55.9	9.08	7.37	9.68	7.22
57.1	0	500	10.7	22.0	42.8	20.1	37.8	47.6	50.2	51.7	7.49	7.49	7.99	7.99
58	20	500	27.7	64.5	177	245	85.4	106	122	173	33.1	33.1	36.1	36.1
59	40	500	7.87	20.7	49.1	55.9	35.8	45.5	47.5	73.4	7.84	7.53	8.42	8.11
60	80	500	3.44	9.66	21.6	10.6	12.7	16.1	20.2	20.4	3.64	3.64	3.93	3.93
61	160	500	2.58	3.10	8.18	29.4					3.86	3.36	3.99	3.50
62	320	500		8.98		33.0	11.4	6.54	28.2	36.8	6.51	5.47	6.90	5.86
63	740	500	2.07	2.28	21.7	38.0	7.56	7.23	24.9	25.5	3.38	3.20	3.45	3.10
64	0	1000	8.69	13.2	38.2	35.2	11.4	10.7	16.6	24.2	4.82	2.92	5.44	2.83
65	20	1000	2.55	8.83	29.0	33.0	10.3	14.4	25.4	29.5	5.24	3.59	5.63	3.51
66	40	1000									1.32		1.67	
67	80	1000				24.7	6.78	12.6		16.9	17.2	10.3	17.8	10.0
68	160	1000		5.79	7.49	37.1	33.5	25.3	29.2	75.6	12.8	5.65	13.1	5.50
69	320	1000					3.42			20.4	3.62	0.517	3.99	0.483
70	740	1000	7.78		37.9		39.4	26.6	70.8	71.5	6.67	5.12	7.24	5.69

b) PAHs (µg/kg)

Sample No	X	Y	Acenaphthylene	Acenaphthene	Fluorene	Anthracene	Phenanthrene	1-Methylphenanthrene	2-Methylphenanthrene	Fluoroanthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Benzo(e)pyrene	Perylene	Benzo(ghi)perylene	Indeno(1,2,3-cd)pyrene	Dibenzo(ac)anthracene & Dibenzo(ah)anthracene	Coronene	total
1	0	0	3.28	5.27	7.80	5.64	68.7	7.85	12.0	84.6	60.9	46.6	74.7	82.3	82.3	59.1	58.8	58.8	14.1	55.1	60.1	10.7	12.9	872
2	20	0	12.6	12.0	13.5	26.4	116	28.1	34.4	360	320	151	197	390	390	200	244	176	62.0	268	185	68.8	36.1	3290
3	40	0	12.7	14.3	15.6	43.2	169	30.5	40.8	425	364	158	231	519	519	201	285	236	72.1	311	228	88.4	19.3	3980
4	80	0	9.14	12.8	14.0	19.3	174	22.9	34.0	192	152	84.9	131	138	138	101	96.9	93.4	23.3	84.6	95.9	17.5	22.1	1660
5	160	0	1.10	2.12	2.55	5.61	40.9	6.40	8.36	108	104	31.8	40.6	66.1	66.1	19.0	57.3	35.9	15.0	31.7	34.0	5.54	17.0	699
6	320	0	2.50	3.13	3.28	6.01	37.8	6.11	7.89	88.7	79.5	31.7	40.7	70.4	70.4	22.4	46.0	34.9	10.9	44.7	51.1	9.74	21.3	689
7	740	0	3.36	6.70	7.95	5.08	49.5	6.76	10.4	78.1	61.2	43.6	60.9	62.8	62.8	47.9	53.4	45.5	12.4	44.7	51.0	8.86	8.37	731
8	0	0.1	2.93	4.19	5.47	7.59	71.3	8.81	13.6	105	77.9	47.9	75.3	77.9	77.9	59.0	55.4	56.7	13.0	51.3	56.9	10.1	11.6	890
9	20	0.1	15.0	14.1	14.1	23.5	156	16.7	24.1	260	229	154	214	474	474	152	264	194	66.1	316	223	82.0	22.0	3390
10	40	0.1	17.9	14.0	14.3	43.0	181	36.7	51.8	425	401	159	264	870	870	188	258	423	72.5	437	233	52.3	1.48	5010
11	80	0.1	7.49	11.8	6.03	13.1	90.0	16.0	20.9	185	157	65.7	110	108	108	84.7	79.0	76.5	19.6	75.8	81.5	14.7	106	1440
12	160	0.1	1.21	2.64	2.88	6.31	45.7	6.31	8.36	103	99.5	29.3	40.3	64.0	64.0	18.2	51.3	32.2	13.6	26.3	28.6	4.59	13.5	662
13	320	0.1	4.13	6.56	6.58	7.14	72.2	9.92	14.5	108	84.8	58.9	89.1	88.6	88.6	70.7	73.4	67.7	18.7	60.8	65.2	11.1	10.9	1020
14	740	0.1	3.07	4.12	5.02	5.72	56.0	7.86	11.5	85.1	64.3	49.8	76.9	76.3	76.3	53.8	58.5	58.1	14.0	50.5	51.8	8.14	11.3	828
15	0	0.5	5.61	8.33	11.8	8.84	78.2	8.93	13.4	89.7	65.7	44.0	66.3	72.8	72.8	48.0	54.2	49.5	13.8	48.1	54.3	9.63	11.3	835
16	20	0.5	6.08	9.86	10.3	16.3	139	19.3	29.3	232	192	118	172	176	176	147	154	139	40.3	144	154	28.6	37.2	2140
17	40	0.5	4.97	4.53	5.06	10.0	72.8	12.8	15.8	162	138	60.1	83.7	161	161	48.5	102	80.2	23.6	103	116	20.9	64.8	1450
18	80	0.5	4.88	6.63	4.31	9.28	73.6	13.7	16.0	146	124	55.9	90.0	87.6	87.6	67.2	65.8	62.1	15.9	61.7	65.0	12.2	88.9	1160
19	160	0.5	3.63	4.52	5.04	14.6	66.1	12.4	16.1	134	111	57.7	92.0	233	233	70.6	90.7	76.1	25.7	94.9	69.0	25.3	10.4	1450
20	320	0.5	3.34	2.19	1.82	4.09	26.8	5.50	13.8	64.2	61.2	25.4	38.7	41.7	41.7	26.9	30.5	30.3	9.96	32.8	22.4	7.73	17.3	508
21	740	0.5	2.94	3.34	5.36	2.98	63.0	3.40	4.69	48.1	43.8	41.6	61.7	61.9	61.9	51.4	50.3	47.8	12.4	43.9	46.9	7.97	11.2	677
22	0	1	8.82	9.81	14.8	6.10	59.0	8.68	12.6	108	94.0	39.0	65.2	69.9	69.9	57.6	53.8	54.7	13.7	49.9	50.4	10.6	18.8	875
23	20	1	12.2	11.2	13.1	41.1	176	39.3	64.0	416	362	156	222	342	342	300	255	195	62.2	328	219	80.9	106	3740
24	40	1	11.9	16.4	21.5	28.1	204	25.8	37.9	318	263	166	250	264	264	210	224	202	59.7	213	227	42.4	51.0	3100
25	80	1	6.03	7.12	6.06	12.7	97.5	18.9	22.8	188	166	67.7	113	117	117	82.0	81.6	78.6	19.9	79.5	84.5	15.8	107	1490
26	160	1	3.95	4.57	2.95	16.1	74.9	14.1	20.2	158	134	69.0	118	342	342	81.0	124	106	31.2	165	111	38.4	49.8	2010
27	320	1	2.60	2.21	2.96	3.10	28.3	4.92	5.09	67.0	61.4	24.5	41.7	41.4	41.4	33.5	30.4	31.2	10.2	34.7	24.0	8.03	21.0	520
28	740	1	6.60	14.9	14.3	10.5	167	5.74	9.13	119	108	80.5	102	96.6	96.6	90.7	95.6	76.6	24.6	72.7	78.3	13.0	22.3	1300
29	0	5	7.02	10.1	11.8	9.52	79.6	10.4	15.5	154	136	55.2	85.6	93.2	93.2	74.1	71.8	70.0	18.6	63.9	67.3	12.5	23.8	1160
30	20	5	19.4	14.1	16.1	35.1	164	39.6	50.0	392	339	124	188	492	492	333	192	146	48.1	310	185	72.0	0.650	3650
31	40	5	4.96	8.01	9.38	14.0	130	21.7	30.9	228	185	99.0	161	166	166	125	125	129	32.1	120	125	22.7	38.9	1940
32	80	5	2.27	4.90	6.66	6.84	68.2	9.00	13.8	106	81.5	51.4	80.7	81.9	81.9	59.0	63.3	57.9	15.8	53.6	59.2	10.1	13.9	928
33	160	5	0.699	1.66	2.01	3.83	35.0	5.52	7.23	80.5	75.6	23.7	34.2	55.6	55.6	15.6	42.9	31.0	10.9	25.0	24.9	3.98	13.5	549
34	320	5	3.75	2.22	2.78	3.24	23.6	4.60	9.39	51.4	48.3	19.7	32.9	36.5	36.5	24.8	23.6	25.3	7.71	27.4	18.6	6.53	14.9	424
35	740	5	1.34	3.93	4.47	4.88	51.2	6.88	10.1	75.4	56.6	43.2	66.2	67.1	67.1	50.8	54.5	53.2	13.8	48.8	51.1	8.19	9.95	749

b) PAHs (µg/kg) (cont'd)

Sample No	X	Y	Acenaphthylene	Acenaphthene	Fluorene	Anthracene	Phenanthrene	1-Methylphenanthrene	2-Methylphenanthrene	Fluoroanthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Benzo(e)pyrene	Perylene	Benzo(ghi)perylene	Indeno(1,2,3-cd)pyrene	Dibenzo(ac)anthracene & Dibenzo(ah)anthracene	Coronene	total
36	0	10	3.22	7.47	7.60	6.71	65.0	9.09	13.4	117	99.4	45.6	78.7	81.8	81.8	66.6	58.4	61.5	14.5	55.0	58.1	10.2	21.0	962
37	20	10	20.9	15.7	13.8	46.7	184	40.0	49.7	503	443	187	281	429	429	458	340	262	88.5	238	312	115	46.2	4500
38	40	10	11.7	13.1	9.48	40.7	189	34.4	45.7	331	303	162	259	650	650	152	270	246	81.6	318	199	80.8	5.70	4050
39	80	10	6.76	7.39	6.08	7.45	57.0	8.81	10.8	123	109	43.7	68.6	67.6	67.6	54.1	52.3	47.4	12.4	49.2	52.8	10.1	66.8	929
40	160	10	5.93	10.5	7.29	22.8	107	16.9	19.5	308	259	126	159	122	122	117	125	94.8	30.9	88.8	92.0	17.5	63.7	1920
41	320	10	1.52	2.54	3.71	3.18	30.0	4.16	4.71	50.9	45.6	26.1	36.2	36.1	36.1	24.6	24.5	46.5	6.15	20.2	14.8	5.54	10.5	434
42	740	10	1.33	3.71	4.10	4.18	48.6	7.38	10.7	86.5	68.9	40.8	63.1	62.4	62.4	49.1	50.2	48.1	12.4	42.9	44.9	6.97	9.34	728
43	0	50	1.69	7.62	6.40	23.7	94.1	13.2	19.1	210	191	90.4	122	265	265	95.0	149	97.3	39.7	120	92.3	38.3	1.16	1940
44	20	50	9.93	23.3	22.5	41.9	292	39.4	57.7	446	384	252	355	359	359	313	342	290	88.5	299	320	59.0	55.6	4410
45	40	50	23.9	230	127	778	1800	151	242	4570	4230	2250	2380	5840	5840	1630	3910	2140	979	3720	2790	1030	694	45400
46	80	50	3.60	34.4	16.0	64.3	275	20.8	29.6	599	546	309	360	303	303	310	363	244	91.8	235	259	51.6	152	4570
47	160	50	2.24	3.58	3.69	10.9	53.3	10.7	13.5	105	90.2	47.0	72.7	135	135	57.8	76.1	63.9	20.6	81.0	56.6	20.2	4.21	1060
48	320	50	4.02	2.56	2.07	5.42	37.6	7.13	12.5	88.3	82.4	35.1	55.8	60.7	60.7	33.9	42.3	42.7	13.9	45.1	31.7	10.7	20.0	695
49	740	50	3.11	3.31	7.23	3.67	48.7	6.19	9.08	69.5	65.0	36.8	55.1	58.2	58.2	41.6	42.7	43.1	9.39	43.8	42.9	6.89	10.2	665
50	0	100	3.37	4.22	3.57	8.11	61.1	22.3	10.7	113	96.5	38.7	65.1	59.8	59.8	44.8	43.0	43.4	10.1	41.1	41.8	7.90	62.8	841
51	20	100	3.23	8.08	3.88	6.88	48.1	7.36	9.46	99.5	87.3	37.1	59.2	54.0	54.0	44.0	45.8	41.3	11.4	40.4	40.9	7.82	50.7	760
52	40	100	6.87	14.9	7.56	8.93	68.9	11.8	13.7	131	113	42.6	66.1	54.7	54.7	48.5	50.3	45.5	12.3	45.8	46.0	8.64	67.8	920
53	80	100	5.86	7.79	9.61	4.29	38.5	5.28	7.49	76.1	68.2	57.9	92.2	93.6	93.6	76.4	75.1	69.5	18.7	67.4	71.5	13.1	28.3	980
54	160	100	2.89	3.86	4.21	9.26	52.0	9.37	12.8	128	112	46.7	70.6	126	126	63.4	68.5	64.6	18.9	83.3	56.5	22.3	4.74	1090
55	320	100	2.36	3.35	4.30	4.71	38.5	5.89	7.49	76.8	67.8	28.2	41.2	73.6	73.6	22.7	43.9	36.6	10.0	45.0	52.7	8.06	25.2	672
56	740	100	2.51	3.81	5.16	5.33	53.6	8.17	12.1	86.0	71.9	49.9	78.2	86.6	86.6	60.5	65.6	65.0	16.4	65.2	68.8	11.2	13.4	916
57	0	500	5.05	5.54	4.51	12.1	83.3	14.5	14.7	185	177	107	157	203	203	153	156	135	44.9	131	197	21.5	73.7	2080
57.1	0	500	8.04	7.79	5.93	17.4	125	19.3	24.4	308	267	132	198	200	200	164	152	140	40.0	138	157	29.7	143	2480
58	20	500	14.2	15.9	27.1	25.9	193	29.1	42.0	428	381	251	357	369	369	320	318	268	88.5	273	300	54.2	48.9	4170
59	40	500	55.2	20.1	21.6	32.0	192	31.6	46.8	636	558	286	426	475	475	463	365	382	94.5	334	369	74.1	103	5440
60	80	500	2.41	8.19	3.78	4.58	35.2	4.61	6.47	57.8	51.6	20.8	34.1	39.1	39.1	25.9	25.2	23.1	6.31	24.7	26.3	4.89	33.7	478
61	160	500	55.3	4.41	40.8	3.49	79.6	5.55	7.42	78.8	71.3	46.9	67.5	70.2	70.2	66.1	58.2	54.3	14.4	50.9	52.8	9.72	14.8	923
62	320	500	25.5	13.0	13.8	49.3	201	12.9	18.5	231	222	162	227	235	235	219	204	186	51.2	173	178	34.9	64.4	2760
63	740	500	3.91	4.40	7.04	4.64	49.5	7.56	10.8	91.4	70.5	49.6	73.9	69.5	69.5	61.7	62.3	58.7	15.5	52.7	56.8	9.66	11.2	841
64	0	1000	3.72	6.01	5.48	3.76	74.8	4.82	7.03	69.3	61.1	62.5	103	99.8	99.8	84.4	76.2	70.5	18.9	69.5	74.7	14.7	26.7	1040
65	20	1000	4.73	4.82	4.79	3.22	70.0	3.73	4.59	45.3	41.0	52.3	76.0	90.2	90.2	68.0	67.7	61.9	16.8	61.7	67.1	11.3	29.1	874
66	40	1000	16.3	16.4	18.2	23.6	227	11.4	17.1	196	170	137	202	209	209	185	178	155	45.6	153	153	27.6	62.0	2410
67	80	1000	30.7	4.28	42.9	11.1	82.7	14.5	34.2	174	161	67.4	98.1	101	101	59.9	69.1	75.2	20.6	52.3	36.5	6.24	23.8	1270
68	160	1000	21.3	8.02	26.3	12.2	80.9	12.2	29.8	182	163	75.9	106	123	123	67.0	79.7	78.6	15.5	55.8	42.1	6.16	29.9	1340
69	320	1000	16.0	1.63	21.5	9.07	61.9	9.63	22.9	127	114	45.9	74.3	71.4	71.4	48.0	55.7	61.2	17.0	37.3	28.5	10.3	18.7	923
70	740	1000	30.4	2.84	37.1	15.2	107	16.8	40.9	187	165	81.4	130	120	120	80.0	84.9	90.2	22.7	61.3	46.1	7.99	34.1	1480

c) PCBs (ng/kg)

Sample No	X	Y	PCB 18	PCB 28	PCB 31	PCB 47	PCB 49	PCB 51	PCB 52	PCB 77	PCB 81	PCB 99	PCB 101	PCB 105	PCB 114	PCB 118	PCB 123
1	0	0	99.6	107	123	20.2	17.7	3.29	26.9	6.26	0.272	34.0	71.6	31.8	0.965	92.2	12.3
2	20	0	96.2	77.3	39.0	10.8	23.3	0.860	27.4	17.1	1.11	74.4	157	85.0	3.76	214	21.6
3	40	0	165	341	249	49.3	98.1	4.59	181	76.9	8.25	162	346	206	9.72	505	7.87
4	80	0	10.6	38.0	38.8	1.56	2.93	0.560	1.79	0.276	0.345	1.30	2.38	1.42	0.174	2.92	0.343
5	160	0	184	94.4	75.1	20.5	10.5	4.01	10.2	6.72	1.74	24.5	26.9	24.3	0.917	55.2	1.95
6	320	0	57.6	80.8	83.6	8.50	16.2	2.85	20.7	7.06	1.13	25.1	35.8	28.5	0.578	38.2	0.627
7	740	0	58.0	57.6	56.9	13.7	12.2	2.26	21.2	2.35	0.318	19.4	40.3	18.6	1.21	53.0	1.70
8	0	0.1	63.2	35.7	45.9	10.5	13.2	1.30	19.6	4.25	0.183	31.7	50.0	26.4	0.459	75.2	3.02
9	20	0.1	86.4	38.2	47.8	39.4	33.9	4.64	37.3	15.3	0.735	103	210	94.4	4.37	223	4.71
10	40	0.1	72.1	53.9	36.7	22.0	18.1	3.02	28.9	15.8	1.24	78.3	135	57.7	4.80	150	4.15
11	80	0.1	184	90.4	76.7	29.5	22.5	6.97	19.7	22.2	5.19	68.1	60.9	47.1	6.50	81.9	13.2
12	160	0.1	6.84	104	241	22.1	12.0	5.34	12.8	7.21	1.61	19.2	28.8	25.3	1.03	33.0	2.60
13	320	0.1	50.8	92.2	83.1	15.9	10.2	1.82	14.5	4.03	0.445	23.3	26.6	20.3	0.934	39.6	1.40
14	740	0.1	45.0	49.6	52.4	7.10	7.35	0.192	7.36	2.05	0.129	14.8	28.4	15.3	1.01	43.3	0.735
15	0	0.5	42.8	61.9	56.8	15.1	14.6	2.84	18.2	5.65	0.439	26.4	43.0	26.6	1.67	73.8	2.61
16	20	0.5	103	67.0	47.3	15.1	21.5	2.28	29.8	11.9	1.17	79.6	133	88.1	3.93	199	3.16
17	40	0.5	64.9	263	77.1	8.89	19.1	0.957	26.4	26.8	0.701	92.5	163	87.2	3.95	198	28.0
18	80	0.5	0.333	90.0	72.8	26.6	13.1	4.86	13.0	11.2	1.49	38.0	65.4	38.0	2.51	97.9	7.19
19	160	0.5	98.5	42.5	62.9	235	23.1	26.6	27.0	5.48	0.153	63.4	89.8	40.4	52.8	97.7	22.2
20	320	0.5	39.4	54.2	50.5	15.2	6.53	1.71	16.2	4.30	0.326	19.7	25.4	16.2	1.04	33.2	1.40
21	740	0.5	43.4	25.2	44.1	18.0	13.4	5.94	22.7	4.38	0.228	20.4	36.2	23.0	0.956	45.7	1.73
22	0	1	51.3	29.5	25.1	18.4	11.1	2.51	21.1	6.33	0.419	27.7	43.9	28.8	4.79	68.4	2.72
23	20	1	103	83.6	92.1	19.3	32.5	2.43	42.8	20.3	2.02	110	208	127	5.35	245	6.54
24	40	1	68.6	138	71.3	17.5	23.2	1.35	21.9	21.6	1.29	77.1	153	101	3.39	217	4.09
25	80	1	8.59	126	159	30.2	14.5	3.65	12.5	13.4	2.12	41.8	57.8	41.1	2.05	85.0	5.00
26	160	1	42.2	71.7	55.4	2.48	8.31	0.682	11.6	6.21	0.345	22.8	31.2	26.5	0.737	65.1	1.11
27	320	1	50.1	55.7	53.7	18.5	7.61	3.62	15.3	3.39	0.486	20.0	27.8	19.3	0.323	40.0	0.144
28	740	1	35.0	23.6	29.4	4.36	6.99	1.62	8.89	3.76	0.499	17.0	29.7	14.1	0.629	44.2	1.20
29	0	5	52.3	23.1	31.6	19.8	17.1	2.81	25.2	12.5	1.28	50.7	79.6	40.7	2.09	102	1.95
30	20	5	97.5	59.9	45.0	33.1	35.1	5.04	50.2	13.0	1.41	106	204	94.0	4.27	209	5.36
31	40	5	67.4	82.5	54.0	10.6	20.2	0.894	30.2	8.40	0.688	63.1	134	59.6	2.14	148	19.0
32	80	5	66.3	50.9	39.5	20.4	11.1	3.32	22.8	4.76	0.337	33.9	38.7	29.1	0.731	75.8	0.836
33	160	5	184	71.1	114	31.4	14.3	6.25	10.6	7.43	14.4	23.8	39.5	20.1	4.77	56.7	4.54
34	320	5	46.0	42.1	40.9	20.5	9.54	3.94	17.6	3.66	0.0420	23.9	31.8	15.1	0.0200	44.9	1.20
35	740	5	32.9	74.9	96.2	22.3	13.9	4.54	25.9	2.96	0.0400	13.9	30.3	11.1	0.589	39.8	0.450

c) PCBs (ng/kg) (cont'd)

Sample No	X	Y	PCB 126	PCB 128	PCB 138	PCB 153	PCB 156	PCB 157	PCB 167	PCB 169	PCB 170	PCB 180	PCB 189	∑6	∑7	total	WHO-TEQ upper	WHO-TEQ lower
1	0	0	2.49	26.0	183	249	14.5	3.95	8.50	0.781	72.9	137	3.43	775	867	1350	0.281	0.281
2	20	0	6.60	56.5	352	411	32.7	8.92	17.8	0.501	107	185	4.69	1210	1420	2030	0.722	0.722
3	40	0	19.7	117	672	753	72.3	19.9	31.4	4.94	213	419	12.2	2710	3220	4740	2.15	2.15
4	80	0	0.223	0.484	3.08	3.10	0.504	0.275	0.199	0.113	0.179	1.67	0.0900	50.0	52.9	113	0.0244	0.0232
5	160	0	4.42	16.0	39.9	111	10.2	4.48	6.20	1.19	42.8	59.6	4.47	342	397	841	0.471	0.0165
6	320	0	1.94	21.6	123	160	9.56	3.20	7.44	0.802	58.1	74.4	2.56	495	533	870	0.217	0.208
7	740	0	1.65	14.4	95.7	116	9.42	2.77	4.22	0.314	41.8	66.8	1.61	398	451	713	0.183	0.182
8	0	0.1	5.21	23.7	163	229	18.4	3.42	6.76	3.03	56.7	87.7	3.93	585	660	981	0.574	0.574
9	20	0.1	3.79	76.9	450	543	45.7	9.76	21.0	0.558	142	265	5.09	1540	1770	2510	0.449	0.449
10	40	0.1	6.09	58.0	361	440	36.6	7.99	14.6	1.17	167	254	7.10	1270	1420	2040	0.669	0.657
11	80	0.1	12.2	61.9	73.6	247	18.7	7.44	12.7	5.75	91.3	146	37.8	638	720	1450	1.31	0.0321
12	160	0.1	2.11	13.7	42.5	118	9.90	3.51	3.62	1.21	41.2	65.8	5.31	372	405	830	0.238	0.0105
13	320	0.1	1.78	17.0	110	136	11.5	2.56	5.13	0.785	51.9	68.3	1.65	448	487	792	0.200	0.200
14	740	0.1	1.39	13.1	89.1	102	8.68	2.22	4.44	0.812	23.5	44.1	1.27	321	364	565	0.159	0.159
15	0	0.5	5.10	26.4	164	240	12.9	3.42	7.16	0.244	53.2	87.2	2.09	614	688	994	0.533	0.0215
16	20	0.5	6.07	60.9	371	457	39.5	11.9	14.3	2.11	96.7	163	6.60	1220	1420	2030	0.687	0.687
17	40	0.5	11.0	67.7	422	467	37.4	10.5	15.8	1.64	138	241	6.16	1580	1780	2480	1.18	1.18
18	80	0.5	3.15	24.2	77.9	211	21.0	16.5	12.8	6.21	77.3	108	22.7	565	663	1060	0.415	0.0359
19	160	0.5	24.2	28.9	91.1	134	8.79	2.38	3.11	2.10	19.0	50.6	6.76	435	533	1260	2.49	2.44
20	320	0.5	1.14	12.9	79.9	113	6.50	1.79	2.55	0.158	39.0	57.4	1.06	346	379	601	0.126	0.124
21	740	0.5	2.04	17.1	108	130	8.06	1.92	5.50	0.530	35.0	61.3	2.01	383	429	677	0.223	0.223
22	0	1	1.95	18.2	135	177	9.57	2.65	5.98	0.693	55.7	84.3	2.53	491	559	836	0.221	0.221
23	20	1	9.07	83.6	483	548	46.3	10.8	20.3	2.61	141	258	5.85	1620	1870	2710	1.01	1.01
24	40	1	6.01	65.9	388	434	38.3	10.4	17.8	1.76	111	198	5.11	1330	1550	2200	0.680	0.680
25	80	1	6.36	39.8	125	428	24.2	10.9	11.0	5.42	88.9	123	12.2	872	957	1480	0.725	0.664
26	160	1	3.71	24.1	124	135	11.3	3.21	5.82	0.729	38.4	59.3	2.63	433	498	755	0.396	0.396
27	320	1	1.90	15.7	94.6	107	7.42	2.92	4.16	0.895	47.1	60.5	2.26	361	401	660	0.211	0.211
28	740	1	1.85	11.2	34.1	88.1	9.24	1.77	3.68	0.286	30.8	53.2	1.48	238	282	457	0.200	0.200
29	0	5	3.04	31.1	88.6	246	19.1	5.17	8.68	1.44	79.3	138	4.17	601	703	1090	0.348	0.348
30	20	5	4.10	63.6	418	490	38.4	7.63	12.1	1.14	134	241	7.08	1460	1670	2380	0.480	0.480
31	40	5	4.77	43.2	259	315	24.6	7.92	11.2	1.68	82.9	143	4.41	964	1110	1600	0.535	0.535
32	80	5	2.94	18.2	139	171	8.60	2.43	6.13	0.443	50.1	76.5	1.60	499	575	875	0.316	0.0166
33	160	5	1.92	13.9	37.9	116	12.0	2.09	4.00	3.42	44.3	57.6	4.75	333	389	901	0.246	0.00419
34	320	5	2.87	18.2	107	116	7.82	2.32	4.03	0.424	51.5	60.9	2.33	375	420	675	0.303	0.299
35	740	5	1.50	9.27	69.6	96.2	4.42	2.44	2.72	1.49	26.1	41.4	0.535	338	378	625	0.174	0.159

c) PCBs (ng/kg) (cont'd)

Sample No	X	Y	PCB 18	PCB 28	PCB 31	PCB 47	PCB 49	PCB 51	PCB 52	PCB 77	PCB 81	PCB 99	PCB 101	PCB 105	PCB 114	PCB 118	PCB 123
36	0	10	65.5	20.8	56.3	15.0	21.2	2.68	28.3	14.9	1.53	63.2	117	59.3	2.04	145	3.01
37	20	10	97.6	90.9	40.3	28.2	18.9	3.64	41.0	11.0	1.86	82.0	173	78.4	3.96	210	4.08
38	40	10	80.4	88.0	73.5	13.9	25.2	2.55	29.2	17.8	1.42	84.7	156	101	1.68	192	5.34
39	80	10	13.8	67.5	63.4	24.3	10.2	6.30	14.7	6.97	1.13	32.1	45.4	28.5	3.55	56.4	2.27
40	160	10	7.26	60.6	175	11.2	7.29	5.31	5.19	8.32	0.518	10.3	16.1	26.5	9.78	52.0	1.11
41	320	10	56.1	69.8	50.1	8.70	11.1	2.98	17.6	4.58	0.328	19.9	30.9	19.5	1.13	38.7	0.947
42	740	10	54.2	38.4	37.0	14.6	11.0	2.48	12.5	1.93	0.259	18.2	29.7	13.1	1.32	32.8	1.37
43	0	50	56.1	88.8	47.2	8.71	15.2	0.633	22.3	11.2	0.507	43.2	63.3	38.9	3.06	95.4	2.43
44	20	50	65.9	57.4	34.1	23.4	27.3	2.93	28.4	21.4	1.59	75.8	151	64.4	1.54	200	1.43
45	40	50	78.7	52.5	39.1	20.5	27.1	1.75	39.5	20.1	1.35	86.6	205	79.9	2.08	222	5.54
46	80	50	184	54.9	17.9	20.6	15.7	6.45	14.1	7.30	2.37	39.4	36.0	32.2	5.96	76.9	6.47
47	160	50	59.4	41.3	43.3	3.37	11.0	0.585	16.2	4.02	0.897	21.7	36.5	22.0	1.18	52.3	1.76
48	320	50	46.4	36.9	39.5	19.4	10.6	4.70	18.5	3.74	0.239	20.2	23.7	13.5	1.56	31.7	1.55
49	740	50	38.4	37.2	31.3	13.2	8.09	2.80	12.5	1.88	0.0600	18.4	23.6	11.5	0.247	34.5	0.729
50	0	100	11.7	76.3	101	33.3	31.7	5.29	34.9	17.3	3.10	67.0	112	31.9	1.47	69.5	2.90
51	20	100	184	93.1	118	25.6	16.4	7.32	10.9	11.0	3.71	40.4	51.7	40.5	10.3	73.2	4.68
52	40	100	184	25.2	68.7	12.6	14.1	10.8	11.1	7.30	3.77	44.8	69.4	27.7	4.04	66.9	6.28
53	80	100	40.0	34.1	26.0	8.48	12.5	1.92	13.5	8.18	0.644	25.2	38.4	25.3	0.396	58.0	0.570
54	160	100	41.3	49.9	59.7	2.88	9.65	1.08	10.2	6.00	0.354	18.7	25.9	27.9	1.66	52.2	0.908
55	320	100	63.6	77.8	84.2	15.9	15.4	3.81	18.3	2.63	0.0620	19.8	29.0	21.1	1.68	48.0	1.12
56	740	100	61.0	75.1	84.7	13.7	16.9	2.52	25.6	5.06	0.0890	16.9	46.5	15.6	0.233	47.1	3.18
57	0	500	58.3	24.4	24.0	16.9	16.5	2.96	25.7	13.0	1.30	45.0	79.1	30.7	1.64	125	13.1
57.1	0	500	2.68	1.94	3.64	8.84	7.18	2.92	15.6	8.46	0.373	32.2	70.2	23.1	0.899	92.7	8.71
58	20	500	54.8	39.3	21.1	11.4	14.2	0.729	19.4	14.8	0.711	43.3	76.3	42.7	4.28	161	4.55
59	40	500	60.4	33.8	22.9	23.2	28.2	3.56	38.6	13.9	1.36	62.9	111	37.6	3.94	185	26.7
60	80	500	15.6	2.35	8.07	6.91	8.44	2.47	19.3	5.03	0.747	24.1	25.1	19.7	0.690	49.2	3.68
61	160	500	36.3	24.3	19.4	2.12	6.60	1.38	10.6	5.29	0.157	18.1	27.2	14.8	1.83	38.6	1.42
62	320	500	46.1	48.5	54.4	8.58	15.3	2.60	18.2	17.0	0.665	52.4	98.4	45.2	4.35	107	16.5
63	740	500	68.5	73.5	54.6	7.14	14.1	1.50	21.1	5.16	0.492	27.8	51.2	26.0	1.99	70.7	2.53
64	0	1000	37.7	78.1	39.1	8.48	11.1	2.24	16.4	8.90	0.553	28.9	54.1	21.9	1.98	57.1	4.39
65	20	1000	49.0	41.5	29.8	10.6	8.63	2.24	13.5	6.82	0.295	31.1	40.4	15.9	0.779	53.3	1.30
66	40	1000	43.6	121	32.3	13.0	13.3	2.95	19.9	9.80	0.547	43.5	81.0	28.3	3.28	109	16.5
67	80	1000	94.0	103	145	14.2	29.0	4.70	30.0	4.39	0.462	61.7	113	16.4	0.229	45.7	5.11
68	160	1000	91.5	68.3	50.7	8.59	27.1	2.87	33.6	5.62	0.486	72.4	162	27.9	0.380	72.3	5.69
69	320	1000	101	84.5	77.1	15.2	22.4	4.36	37.4	6.32	1.40	38.0	94.3	15.6	0.874	56.6	2.89
70	740	1000	105	64.7	39.8	11.9	35.9	2.28	48.1	21.5	0.994	72.7	112	71.6	1.42	186	3.09

c) PCBs (ng/kg) (cont'd)

Sample No	X	Y	PCB 126	PCB 128	PCB 138	PCB 153	PCB 156	PCB 157	PCB 167	PCB 169	PCB 170	PCB 180	PCB 189	∑6	∑7	total	WHO-TEQ upper	WHO-TEQ lower
36	0	10	4.59	49.5	109	285	24.0	5.97	10.9	0.843	93.3	146	3.07	706	851	1350	0.506	0.506
37	20	10	3.31	43.8	340	398	31.5	5.57	18.0	0.539	116	206	5.14	1250	1460	2050	0.388	0.383
38	40	10	5.86	73.9	364	338	30.6	10.3	15.7	3.09	107	174	5.59	1150	1340	2000	0.671	0.671
39	80	10	2.59	20.6	59.4	179	17.5	3.84	7.52	2.93	62.3	95.4	8.90	461	518	837	0.311	0.0208
40	160	10	2.85	16.2	34.1	121	9.84	3.70	4.59	0.704	39.4	50.8	2.04	288	340	682	0.313	0.0206
41	320	10	2.05	14.3	43.4	126	11.8	2.62	4.68	0.751	41.3	63.0	1.75	351	389	644	0.227	0.226
42	740	10	1.28	8.68	64.5	79.8	7.14	1.47	3.04	0.633	32.5	43.4	1.10	268	301	512	0.144	0.137
43	0	50	3.59	25.2	198	219	16.4	3.99	7.22	0.369	54.5	115	3.21	706	802	1140	0.390	0.390
44	20	50	3.87	51.0	356	478	32.0	6.44	11.7	1.37	132	206	4.35	1280	1480	2040	0.450	0.450
45	40	50	7.23	66.1	355	487	33.6	10.4	12.5	2.32	140	194	4.51	1330	1560	2190	0.803	0.779
46	80	50	3.45	15.3	100	121	21.2	8.48	9.78	1.65	42.0	60.8	8.27	387	464	912	0.393	0.0222
47	160	50	2.61	15.4	101	139	10.4	3.19	5.51	0.678	35.1	59.8	2.16	394	446	690	0.284	0.284
48	320	50	1.30	16.8	99.2	128	9.19	2.33	5.24	0.662	48.2	56.9	3.29	363	395	643	0.149	0.149
49	740	50	1.17	10.3	82.6	99.4	5.78	1.75	2.54	0.461	19.9	35.3	1.36	291	325	495	0.131	0.131
50	0	100	3.14	22.8	50.1	177	12.2	5.62	7.34	4.46	79.5	97.1	7.20	547	617	1070	0.382	0.0209
51	20	100	4.47	25.8	141	219	19.2	9.05	13.4	2.73	96.5	104	6.74	620	693	1330	0.508	0.0267
52	40	100	5.19	22.6	154	166	22.0	6.91	5.41	2.61	75.0	83.5	9.94	509	576	1110	0.574	0.0246
53	80	100	2.34	24.0	58.1	169	12.5	2.91	6.88	0.756	56.6	67.5	2.50	381	439	696	0.259	0.259
54	160	100	2.16	17.5	102	109	10.8	2.89	4.03	0.188	29.2	53.6	2.83	351	403	643	0.235	0.233
55	320	100	1.96	16.3	103	147	11.0	2.69	5.82	0.369	58.6	74.6	1.75	450	498	825	0.215	0.211
56	740	100	0.733	12.1	77.2	77.7	6.08	0.770	1.75	1.60	36.5	52.3	0.257	354	402	681	0.1000	0.0831
57	0	500	5.48	19.7	88.5	242	22.4	5.60	7.90	1.33	87.0	151	5.57	611	736	1110	0.595	0.595
57.1	0	500	8.00	19.3	187	227	21.5	4.19	8.47	0.901	79.2	128	4.74	630	722	968	0.836	0.0257
58	20	500	6.95	40.8	315	266	33.1	6.85	15.9	2.23	102	134	5.33	850	1010	1440	0.762	0.762
59	40	500	7.99	39.0	162	377	32.6	8.54	17.6	1.38	120	189	5.01	911	1100	1610	0.862	0.862
60	80	500	5.26	11.2	92.0	114	7.68	2.92	6.22	0.933	38.2	61.1	4.73	314	363	536	0.549	0.0128
61	160	500	3.42	17.1	112	130	16.9	3.63	6.63	2.64	47.6	64.8	3.20	369	408	616	0.386	0.382
62	320	500	6.44	34.0	92.2	251	22.5	5.19	8.52	1.77	90.3	147	6.28	655	762	1200	0.697	0.697
63	740	500	2.54	17.9	115	120	12.0	4.13	5.05	0.995	37.4	65.2	3.28	446	517	810	0.284	0.274
64	0	1000	3.77	17.7	66.3	179	14.9	4.17	6.24	1.44	60.0	84.6	2.11	479	536	811	0.411	0.411
65	20	1000	2.90	21.9	145	167	13.8	2.51	5.76	0.508	60.0	87.9	2.56	495	549	815	0.312	0.312
66	40	1000	4.67	31.9	96.7	263	19.8	4.73	10.5	1.34	82.3	134	4.61	716	825	1190	0.511	0.511
67	80	1000	3.95	42.3	270	314	19.1	7.40	12.7	1.07	92.6	127	4.85	957	1000	1560	0.427	0.416
68	160	1000	7.57	59.9	168	454	28.5	9.09	15.1	1.98	142	203	6.63	1090	1160	1730	0.808	0.808
69	320	1000	4.09	28.8	64.9	225	16.0	5.15	7.52	1.14	68.7	116	3.21	622	679	1100	0.440	0.440
70	740	1000	5.36	60.2	299	315	26.8	11.0	11.9	1.04	150	218	5.99	1060	1240	1880	0.595	0.584

We are The Environment Agency. It's our job to look after your environment and make it **a better place** – for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

Published by:

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