

FOOT AND MOUTH DISEASE: Disposal of carcasses

Third Report on Results of Monitoring Public Health

SUMMARY

Introduction

This is the third report of the monitoring programme that was established for the protection of public health during the foot and mouth disease epidemic. It describes the results of routine monitoring and surveillance as well as specific monitoring activities set up as a result of the outbreak. The programme was announced by the Department of Health at the end of May (www.doh.gov.uk/fmdguidance/) and by the Public Health Laboratory Service (PHLS) in the Communicable Disease Report of 1 June (www.phls.co.uk/publications/CDR%20Weekly/archive/news2201.html#fmd)

What has been monitored?

The PHLS Communicable Disease Surveillance Centre (CDSC) has co-ordinated a nation-wide search for cases of diseases that might affect people as a result of activities associated with the handling and culling of animals and the disposal of carcasses.

The Department for Environment, Food and Rural Affairs (DEFRA), Department of Health (DH), Environment Agency (EA), Drinking Water Inspectorate (DWI), Ministry of Defence (MoD), Food Standards Agency (FSA), Health and Safety Executive (HSE) and local authorities have carried out monitoring of air pollution from pyres and incinerators, foods, soil and herbage, public and private water supplies, rivers and streams and occupational health.

Individual agencies will be publicising the detailed results of their monitoring on their own websites.

www.defra.gov.uk/footandmouth/

www.doh.gov.uk/fmdguidance/

www.environment-agency.gov.uk/yourenv/footandmouth/

www.foodstandards.gov.uk

www.hse.gov.uk/hthdir/noframes/footmouth.htm

www.phls.co.uk

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Background

At the end of May the Department of Health published the 'Programme of Monitoring for the Protection of Public Health'. The key aspects being monitored are human health, air quality, water supplies and the food chain.

The basis for the monitoring was set out in earlier Department of Health risk assessment and guidance documents and these can be found on the web at: www.doh.gov.uk/fmdguidance/

1. Human health

What have we found?

- None of the 39 suspected human cases of foot and mouth disease has tested positive for the disease. There is no evidence that there has been any transmission of the foot and mouth virus to humans during this outbreak.
- 4 cases of Q fever have been identified amongst those who have been involved in animal disposal operations.
- No gastrointestinal disease linked to animal disposals due to Foot and Mouth disease (FMD) has been reported from any of the areas affected by the FMD outbreak..
- A study¹ in the North West of England shows a dramatic decline in the incidence of Cryptosporidiosis in that region since the onset of the Foot and Mouth epidemic.
- A health impact assessment² in North and East Devon Health Authority found that pyres did not have any effect upon consultations or prescriptions for asthma or respiratory distress.

Cryptosporidiosis is a serious diarrhoeal disease caused by the protozoan parasite *Cryptosporidium parvum*. The study¹ compared routine reports sent to the Communicable Disease Surveillance Centre-North West and submissions of patient isolates to the Public Health Laboratory Service (PHLS) Cryptosporidium Reference Unit from the NHS and PHLS laboratories in the region during 2001 with each of the previous four years.

The results showed that for the first 31 weeks of 2001 there was an 80% decline in cases of Cryptosporidiosis in the region compared to the same period in the previous year (769

cases in 2000 to 154 in 2001). Overall there have been 77% fewer cases in 2001 than for similar periods in each of the preceding 4 years. Strain typing was undertaken at the Cryptosporidium Reference Unit and results showed that there had been a significant decline in the relative importance of *C. parvum* Genotype 2, the strain found in cattle and sheep, from 86% in 2000 to 62% in 2001.

It is not known whether the reduction in cases resulted from the removal of animals due to slaughter, changes in animal husbandry or lack of access by people to the rural environment – probably a combination of all three. There have also been some new control measures brought in by the local Water Company in response to previous outbreaks of the disease, but these new controls could not explain the decline across the whole region. The findings of this study suggest that zoonotic transmission of this disease is the major route of infection in the North West. The results also suggest that the risks of Cryptosporidium infection associated with the presence of live animals in the North West region are greater than those from the contamination of ground water from mass burial sites.

Q fever

As a result of the investigation of a case of Q fever in a Bradford resident who had worked on a farm in Cumbria, a further 14 persons were identified as having worked on the farm in question at the same time. Of these, 4 reported relevant symptoms and were screened for Q fever and psittacosis. All laboratory investigations are negative.

A further 4 cases of Q fever have been reported to CDSC by laboratories in England and Wales. None are known to have any links with the FMD cull.

Enhanced surveillance of human gastro-intestinal infection

Consultants in Communicable Disease Control (CCDCs) established increased surveillance for gastrointestinal disease in areas affected by FMD and were asked to make a return to CDSC indicating the presence of animal disposal sites within their Health District, the presence of private water supplies within the vicinity of the burial sites, and of cases of gastrointestinal infection that may have been associated with consumption of water from such private water supplies.

No cases of gastro-enteritis associated with consumption of water from private water supplies in the vicinity of burial sites have been reported.

Specific enhanced surveillance of gastrointestinal (GI) illness was introduced by GPs and CCDCs in those areas where animal disposals were taking place. For example, the County Durham and Darlington Health Authority area has shown no GI illness associated with private water supplies and no increase in GI illness in the Tow Law area, Derwentside or Wear Valley areas which had a total of 43 burial sites.

Some local GP practices reported an increased number of consultations with patients complaining of symptoms- nausea, sore throat, sore eyes and cough –that the individuals

felt were due to the burial site. However, on the basis of tests carried out, the practices concluded that there was no “*obvious evidence of definable pathological disease*”.

North and East Devon Health Authority (NEDHA) has undertaken a rapid health impact assessment of the health effects thought to be attributable to the pyres used for the disposal of carcasses from FMD². As part of this health assessment, a preliminary examination was made of readily available data to see if pyres had a measurable effect upon respiratory health. The NEDHA undertook analysis of primary care data gathered from GPs, NHS Direct and TARKA DOC (the out of hours medical service for North Devon, Torridge and part of West Devon.) Eight general practices in the most heavily affected areas and one control practice provided weekly data about consultations and prescriptions for asthma. These data were cross-referenced with the locations of pyres. A breakdown of age effects was performed and a time series graph was drawn of total consultations and prescriptions by week. Post coded data was obtained from NHS Direct about telephone calls from people with respiratory distress (asthma attacks, breathing difficulties, cough and wheezing) for April and May of 2000 and 2001. Clustering of calls to GPs around pyres was then investigated by mapping the data using a Geographical Information System. By mapping health data against the pyre sites it was possible to see if there was any clustering of calls close to pyre sites.

The results showed that calls were dispersed and did not cluster around pyre sites. Overall the results of the assessment showed that pyres did not appear to have any effect on consultations or prescriptions for asthma. This study would not have captured data about people whose asthma might have worsened but who did not consult their GP or NHS Direct or who were admitted directly to hospital.

Occupational health related illness

DEFRA have reported from their occupational health safety study that since the last report there has been no occupational ill health reported which could be linked to working on FMD infected sites. They are continuing to identify staff who have been undertaking fieldwork to ensure that they are included in the forthcoming health questionnaire / surveillance round. The in-house health surveillance questionnaire has been made available to both the HSE and the Environment Agency.

Mental Health and Stress in the community.

Concerns have been expressed about whether the impact on health of the stress caused by the effects of Foot and Mouth disease in the community could be significant. Deaths of farmers by suicide have received media attention and indicated the severe stress suffered by some individuals which could be a marker for wider problems. A health impact assessment by the Institute of Rural Health has looked at the impact of the FMD outbreak upon people’s mental health, drawing on information from ‘front-line’ support providers. The purpose of this initial study was to provide a better base of understanding. The Report of the study is available on the Institute’s website at www.rural-health.ac.uk Following this a more detailed assessment is being done to increase understanding and, if possible, quantify the impacts. This study is due for completion in March 2002. It is

taking place in two areas in Wales affected by FMD and will use data from primary care and people in the communities. The target groups for primary collection of information are: farmers and their families; farm workers and workers in agricultural businesses or other businesses affected by FMD restrictions and individuals managing or handling the FMD situation.

References:

¹ “Possible impact of the Foot and Mouth Epidemic on the epidemiology of Cryptosporidiosis in the North West of England”. Submitted for publication
P R Hunter, R M Chalmers, Q Syed, S Hughes and S Woodhouse. September 2001

² North Devon Health Authority (2001). “Rapid Health Impact Assessment of Foot and Mouth Disease in Devon.” Submitted for publication.

2 Monitoring of Water Supplies

What have we found?

- No water sources used for public supply are affected by FMD disposals and none have been identified as likely to be affected.
- No private water supplies have been found to have been affected by contamination from disposal sites.
- As a result of liaison between water companies and the Environment Agency, precautionary enhanced monitoring is taking place at four sources:

Northumbrian Water - **Lumley water treatment works** on the River Wear in Northumberland (which supplies the Sunderland area) is being monitored because the Environment Agency (EA) expressed some concern about small scale disposals in the catchment, and particularly localised pollution at Tow Law where a water course eventually feeds into the River Wear. No evidence of contamination has been found.. Enhancements have been made to raw water monitoring at two groundwater sites at **Murton** and **Elrington** but the EA has confirmed that they have no concerns and the action is purely precautionary.

Thames Water has enhanced monitoring at **Ramsbury borehole** which is close to an ash disposal site. The precautionary monitoring has shown no adverse effects and the Water Company is confident that this will continue to be the case.

Throughout the FMD crisis the protection of public water supplies has been a major concern to all the agencies involved. The Environment Agency (EA) has been at pains to protect groundwater sources against the risk of pollution and has undertaken risk assessments for sites proposed for animal disposal. In the early stages some sites were inadvertently missed out of this assessment process in the rush to dispose of animals

quickly to prevent the spread of disease. These sites have been retrospectively assessed and where the site has been found to be unsuitable for the disposal carried out the remains have been removed and monitoring put in place for any possible pollution.

Carcasses have been disposed of on the basis of a hierarchy of disposal agreed with the Environment Agency and the Department of Health to minimise the risks to human health and the environment. This hierarchy was, in order of preference:

- Rendering
- Incineration for cattle born before 1.8.96
- Licensed landfill site for sheep, pigs. Cattle born after 1.8.96
- Burning on pyre
- Burial in engineered mass burial sites or on farm.

Since late July almost all the FMD disposals have been dealt with by rendering. However at the height of the crisis, because rendering capacity is limited, the other methods had to be used to keep pace with the demand for rapid disposal.

Monitoring to check for pollution of water supplies around mass disposal sites, pyres, and licensed landfill sites has been put in place by the Environment Agency. Local Authorities have responsibility for monitoring private water supplies that might have been affected by any disposal, including on farm burial or burning. As public drinking water is subjected to treatment to make it safe prior to consumption, the emphasis has been on private supplies.

Within the North Yorkshire region, which covers County Durham, there are three local authorities with private water supplies potentially at risk from 43 burial sites. Investigations established that 24 private supplies were potentially “at risk” and all of these have been tested and found to be satisfactory. In some areas local Environmental Health Officers have occasionally had difficulty obtaining information about which burial sites exist in their area and in assessing which private water supplies are potentially at risk from these sites.

Information on the location and monitoring of animal disposal sites

The Environment Agency has collated information it holds on disposal sites and is transferring these into a standard format. Each record contains: the name of the site; site location; the type of disposal; whether a risk assessment was carried out; whether a ground water authorisation was granted, is pending, or was refused.

This information will shortly be posted on the Environment Agency website under the draft heading “Disposal sites receiving ground water authorisations from the Environment Agency”.

Monitoring for the mass disposal sites continues and the EA will shortly be posting the monitoring data on the Environment Agency website under the draft heading “Environmental Monitoring of Mass Disposal Sites”.

Sites of mass disposal

For these sites, monitoring is being done by both the operators of the sites and the Environment Agency as part of the compliance with the Groundwater Authorisation. In some cases additional monitoring is being done on a precautionary basis. Dual purpose boreholes are being used for groundwater/leachate sampling and landfill gas is also being monitored. Surface waters, ground waters and leachates are tested for biological oxygen demand, ammonia and suspended solids as well as chloride and potassium levels.

Around the Tow Law and Widdrington burial sites, a microbiological programme of testing was co-ordinated by the Newcastle Public Health Laboratory Service to specifically look at environmental waters around the burial sites i.e. private water supplies, streams and becks. Results showed that there had not been any deterioration in microbiological quality in any of the private water supplies nor in waters around the sites.

Sennybridge (Eppynt)(SN935395)

Monitoring of groundwater is being done at six boreholes and of surface water at nine sites. Ammonia is being used here as the key marker for pollution together with potassium. There has been no rise in potassium levels in the boreholes adjacent to the burn site but ammonia contamination has been detected in one borehole. The ammonia level is now falling.

Great Orton (NY311538)

The EA has put in place an extensive monitoring programme for surface water at twenty points sampled twice a week. Ground water and leachate are being monitored by the operator for both chemical and biological parameters. Borehole methane and carbon monoxide levels are also checked. Results are audited by the EA. There is also occasional sheep dip testing though none has been detected to date.

Widdrington (NZ233214)

Groundwaters and leachate in test boreholes are being monitored for chloride, ammonia and potassium levels as markers for possible contamination.

Tow Law (NZ1240 4010)

At this site monitoring commenced prior to its use for disposals to obtain background information. Eight locations around the site are sampled for surface water quality. Elevated potassium levels are an historical issue and are due to the natural geology of the site and the presence of minewater in the River Wear catchment area. There are thirty boreholes around the site being tested for groundwater quality. Visible checks for evidence of pollution are also done. Gas from the site is extracted from the disposal trenches and passed through a thermal oxidiser and activated charcoal filters. The only methane detected so far has been in one borehole and this is due to the coal measures in the area and not the burial operations.

Hydrogen sulphide monitoring has been done by Wear Valley Council in response to complaints about odour. None has been detected although odour problems have been reported.

Throckmorton (SO974492)

At this site standard monitoring is being done of surface waters, ground water and leachate using the determinands described above. Landfill gas is also being monitored. There has been some impact upon the groundwater in the test boreholes nearest to the site which is expected. There has also been some contamination of surface waters in the immediate vicinity but downstream sampling has shown no impact from this.

The Environment Agency has reported that overall the results from monitoring of the mass disposal sites do not give rise to any cause for concern.

Disposal in landfill sites

A total of 111 licensed landfill sites have been given permission to receive animal carcasses and ash. However only a handful have to date been used for this purpose. Approximately 50,000 tonnes of FMD carcasses have been disposed of in landfill sites. Licensed landfill sites are still being used for the disposal of carcasses of animals slaughtered for welfare purposes and about 60,000 tonnes of these have been disposed of in landfill sites.

It is estimated that approximately 120,000 tonnes of ash and associated material e.g. soil and rubble needed to be removed from pyre sites. To date about 103,000 tonnes have been transported to licensed landfill sites, including ash from the large pyre sites at Hemscott Hill in Northumbria and Sennybridge (Eppynt) in Wales. Wherever possible, ash from pyres has been buried on site. Where this has not been possible, due to risks of contamination of the groundwater, the ash has been collected and disposed of in licensed landfill sites. The Environment Agency had advised that where cattle born before 1 August 1996 had been burnt the ash should be removed and re-incinerated if the site was not suitable to allow ash to be buried on site. This was found to be causing delays in ash disposal and greater risks were considered to occur from ash being left waiting for disposal. A risk management system was drawn up to identify the best option for disposal of ash to protect human health and the environment. Disposal to landfill was identified as the best option to minimise the time that ash would be left lying on the fields.

This follows advice given by the Spongiform Encephalopathy Advisory Committee's (SEAC) Working Group in May this year. SEAC advised that where over five year old cattle had been burnt, ash containing the remains of over five-year-old cattle could be buried without significant risk to public health. Where over five year old cattle had been buried further risk assessments would need to be carried out for individual sites and the risks of exhuming the material would need to be considered against the risk of leaving the material in place.

The SEAC Working Group conclusions on 24 May are set out in the Group's report available at: www.defra.gov.uk/animalh/bse/bse-science/seac0601a.html.

These conclusions were endorsed by the full meeting of SEAC on 27 June 2001.

In order to minimise any potential risks to health, removal and handling of the ash is carried out in accordance with detailed protocols. Road transport has utilised steel containers with integral liners carrying 20 tonnes at a time. In Cumbria, where the distances from site to landfill are shorter, 20 tonne tipper lorries have been used, with full wrap containment of the ash and further cover sheets. Ash removal in Cumbria has almost been completed with only a few further sites remaining to be dealt with.

- Ash from Devon, the West Midlands and Wales has been delivered to the Grundon Bishop's Cleave site in Gloucestershire.
- Ash from the North East and Yorkshire has been delivered by rail through Cleveland Freightliner Depot to the Shank's Calvert site in Buckinghamshire.
- Ash from South Cumbria has gone to the Alco Waste site at Workington.
- Ash from North Cumbria has gone to the Cumbria Waste Management site at Hespian Wood.

Results from the analysis of protein and amino acid profiles in ash from the pyre sites appear to support the assumptions made in the initial risk assessment that 90% destruction of prion infectivity takes place during the pyre burn. In many cases the results show this to have been a cautious estimate of destruction of infectivity but the data is not yet complete. However the analysis done does not provide precise information of the biological infectivity of any remaining protein.

Results from ash analysis also showed raised levels for some metals such as lead, arsenic, copper, zinc and nickel in some samples compared with guideline values for these metals in agricultural soils. The levels are however within the permissible levels in sewage sludge recycled to agricultural land. The levels present do not pose any problem for traces of ash remaining on the ground nor for any translocation of metals into the soil below. Since ash is either buried deep enough on site or removed to landfill sites, the Food Standards Agency considers metals in the ash should not present a risk to the safety of food crops subsequently grown on the pyre site.

3. Air Pollution Monitoring

What have we found?

- Levels of pollutants were either lower than air quality standards or within the range of urban background levels.
- Measurements for particles, sulphur dioxide and nitrogen dioxide remained in the DH/DEFRA LOW air pollution band.
- Dioxin levels in soil, herbage and food were mostly within the expected range and/or similar to levels found at control farms.
- The modelling and predictions based upon it have been validated by the results actually obtained.
- The advice given in April on minimising the health effects of pyres remains valid.
- Pyres should not be lit under certain unusually still weather conditions that can, but rarely, occur in Autumn and Winter.

Air Quality monitoring has been undertaken by AEA Technology on behalf of the Department for Environment, Food and Rural Affairs (DEFRA), and by the Environment Agency. The primary aim of the monitoring done for DEFRA was to determine the concentration of pollutants in communities close to pyres. The Environment Agency covered both monitoring in communities and in areas closer to pyres in order to assess the impact of pyres on air quality.

Results of air monitoring are available on the following websites:

www.aeat.co.uk/netcen/airqual/welcome.html

www.powys.gov.uk/footandmouth/english/airquality.php3

Brief summaries of the results have been provided in previous DH monitoring reports. A summary of the results of the monitoring is given in Table 1. The table also gives the date and location of the site, size of pyre, distance from the monitoring site and weather conditions at the time. The results show that all of the measurements of particles, sulphur dioxide and nitrogen dioxide remained in the DH DEFRA LOW air pollution band which is reassuring.

Further monitoring data on dioxins, PCBs and polycyclic aromatic hydrocarbons in air is also available and is described in the report referred to below and will be published shortly on the same website.

Since the last monitoring report, further work has been done to re-examine the advice given on the health effects of emissions from pyres in the Department of Health's report 'Foot and Mouth-Effects on Health of Emissions from Pyres Used for Disposal of Animals' issued in April 2001 at www.doh.gov.uk/fmdguidance

The advice given was based upon modelling predicted pollution levels around pyres. At the time of the first report no results from direct monitoring of pollutants around pyres were available. However, results of monitoring actual levels of pollutants are now available from both small and large pyres and these results can be compared with the predicted levels. It must however be borne in mind that monitoring will not necessarily detect the potential maximum concentrations downwind of pyres.

The results show that levels of pollutants were either lower than air quality standards or within the range of urban background standards.

Levels of dioxins in soil, herbage and food were mostly within the expected range and /or similar to levels found at control farms. The dioxin levels predicted were overestimated, though even these overestimated levels were not considered to be of major concern.

The Food Standards Agency has now withdrawn its precautionary advice regarding the monitoring of dioxins around large pyres prior to the re-introduction of cattle.

The Environment Agency (EA) has undertaken a validation exercise of the modelling by comparing the monitored concentrations with the modelled predictions for maximum downwind concentrations using the data from the Sennybride site.

The validation exercise tested the following assumptions:

- the estimate of total emissions of pollutants from pyres
- the assumptions that pyres can be modelled as a line source of emissions
- the assumption that emissions are uniform over time and along the length of the pyre
- the prediction of meteorological variables such as heights of emissions
- the modelling of dispersion of emissions from line sources

The comparisons have shown good agreement between the monitored concentrations and the predicted levels though there were more uncertainties regarding the polycyclic aromatic hydrocarbons (PAHs).

As the modelling has been validated for most of the pollutants the predictions concerning health effects and the recommendations made to protect health also remain valid.

The recommendations were that populations downwind of pyres should be:

more than 2km from small pyres;

3km from large pyres;

4km from very large pyres

These recommendations still stand.

Further modelling has now been done to take account of worst case Autumn/Winter weather conditions. This shows that in very unusually still weather conditions, of the sort

that only occur perhaps once in every ten years, increased risks to health could occur even as far away as 4 km if large pyres were lit. It is recommended therefore that in such weather conditions, which can be predicted by consulting the Meteorological Office, pyres should **not** be lit.

Air Curtain Incinerators

There is limited data from monitoring Air Curtain Incinerators. These have considerably better air circulation than pyres and could be expected to give rise to lower pollution levels than conventional pyres. However the evidence is not yet sufficient to come to any firm conclusions about recommended distances from populations for these to be sited. Until more evidence is available the recommendations for pyres should apply to the use of Air Curtain Incinerators.

Detailed air pollution information is available at:

<http://www.defra.gov.uk/environment/airquality/airpoll/index.htm>

<http://www.aeat.co.uk/netcen/airqual/foot-and-mouth/>

Monitoring results are available for: Okehampton, Devon

http://www.aeat.co.uk/netcen/airqual/foot-and-mouth/oakh_all.html

Holsworthy, Devon

http://www.aeat.co.uk/netcen/airqual/foot-and-mouth/hols_all.html

Mynydd Epynt, Wales

<http://www.powys.gov.uk/footandmouth/english/airquality.php3>

4. Monitoring the Food Chain

What have we found?

- Concentrations of dioxins in soil samples from farms close to the pyres were within the range previously found in the rural environment.
- Concentrations of dioxins in herbage samples were similar to those at a control farm.
- Concentrations of dioxins and dioxin-like polychlorinated biphenyls (PCBs) in samples of milk are all within the expected range for these foods.
- The monitoring results on dioxin in milk has led the Food Standards Agency to conclude that the advice previously issued -that people who consume whole milk and whole milk products only from animals within 2 km of pyres may wish to vary their diet to include milk and milk products from other sources - is no longer necessary.

- Concentrations of dioxin-like polychlorinated biphenyls (PCBs) (but not of dioxins) in milk from two farms in Anglesey have shown a small rise in the second round samples but the pyres are not thought to have caused this increase.

The Food Standards Agency has monitored food and other samples from areas where there were large pyres or continuous pyres to ensure that there are no long term effects on food safety. The testing programme comprises 120 results from foods including eggs, milk, lamb and chickens. The FSA considers that the available results show that the pyres have posed no additional risks to health through the food supply and, although a few results remain to be reported, it is not expected that these results will alter this conclusion. In the light of these results the FSA considers that its earlier precautionary advice about the consumption of milk from animals close to pyres is no longer necessary. Results from 48 remaining samples are awaited and these will be reported in a further final report. No further samples are to be taken.

Decisions on whether to graze animals or restock land close to pyre should be based on advice on preventing the spread of FMD. The FSA has advised that where heavy contamination of land was found, restocking or grazing of land should not take place. The FSA has not to date found any evidence of such contamination.

A summary of results received to 31 August is given in the Annex hereto taken from the FSA's third monitoring report.

The Report of the results of the monitoring undertaken by the FSA 'Dioxins and dioxin-like polychlorinated biphenyls in foods from farms close to pyres. *Third Report*' is available on the FSA website at: <http://www.foodstandards.gov.uk>

Annex

Concentrations of dioxins and dioxin-like PCBs in food and environmental samples collected from the vicinity of FMD pyres – summary of all results received to 31 August 2001

			Concentrations (ng WHO-TEQ/kg fat)		
Sample	Region	Number of samples ^a	Dioxins	Dioxin-like PCBs	Dioxins and PCBs Total
i) Milk					
First round	Cornwall	4	0.4 (all)	0.5 (all)	0.8 to 0.9
First round	Devon	11	0.4 to 0.8	0.3 to 1.8	0.8 to 2.4
Second round	Devon	10	0.4 to 0.7	0.4 to 1.5	0.8 to 2.2
First round	Cumbria	11	0.4 to 0.8	0.4 to 0.9	0.8 to 1.7
Second round	Cumbria	7	0.5 to 0.8	0.4 to 1.5	1.0 to 2.2
First round	Anglesey	3	0.5, 0.7, 1.4	0.4, 0.5, 1.2	0.9, 1.2, 2.5
Second round	Anglesey	3	0.4, 0.6, 1.6	0.5, 2.9, 3.0	0.9, 3.5, 4.6
Control – first round	Gwynedd(for Anglesey)	1	0.5	0.4	0.9
Control – second round	Gwynedd(for Anglesey)	1	0.6	0.6	1.1
First round	Dumfries and Galloway	4	0.4 to 0.5	0.4 to 3.3	0.9 to 3.8
Second round	Dumfries and Galloway	3	0.4, 0.5, 0.8	0.4, 0.5, 0.6	0.9, 1.0, 1.4
Third round	Dumfries and Galloway	3	0.4, 0.7, 0.4	0.7, 0.5, 0.5	1.0, 1.2, 0.9
Fourth round	Dumfries and Galloway	1	0.4	1.2	1.6
Control	Dumfries and Galloway	1	0.7	0.3	1.0
First round	County Down	4	0.4 to 0.8	0.5 to 0.9	0.9 to 1.7
Goats' – first round	Dumfries and Galloway	1	0.5	0.4	0.8
Goats' – second round	Dumfries and Galloway	1	0.6	0.9	1.5
Goats' – third round	Dumfries and Galloway	1	0.5	0.8	1.3
ii) Eggs					
Hen – first round	Anglesey	1	4.3	29	34
Hen – second round	Anglesey	1	10	82	92
Hen – controls	Anglesey	2	6.7, 5.8	1.4, 2.4	8.1, 8.2
Hen	Carmarthenshire	1	3.8	1.7	5.5
Hen	Devon	2	0.6, 1.5	0.4, 1.3	1.0, 2.8

Hen	Dumfries and Galloway	5	1.6 to 5.4	1.3 to 8.5	2.8 to 14
Duck – first round	Anglesey	1	6.1	9.7	16
Duck – second round	Anglesey	1	4.1	11	15
Duck –control	Carmarthenshire	1	1.7	1.13	2.9

Concentrations (ng WHO-TEQ/kg fat)					
Sample	Region	Number of samples ^a	Dioxins	Dioxin-like PCBs	Dioxins and PCBs Total
iii) Meat					
Chicken	Dumfries and Galloway	4	2.4, 3.2, 39 ^b , 40 ^b	2.7, 12, 3.1 ^b , 1.6 ^b	5.1, 15, 42 ^b , 42 ^b
Chicken (control)	Dumfries and Galloway	1	0.4	0.6	1.0
Lamb kidney (control)	Gwynedd (control for Anglesey)	1 ^c	0.7	0.6	1.3
Lamb liver (control)	Gwynedd (control for Anglesey)	1 ^c	13.5	3	16.5
Lamb kidney	Anglesey	1 ^c	0.7	0.7	1.3
Lamb liver	Anglesey	1 ^c	19	3.7	23
Lamb meat	Anglesey	2 ^c	1.1, 1.4	0.6, 0.7	1.7, 2.1
Lamb meat (control)	Carmarthenshire	2 ^c	8.2, 3.4	3.3, 1.4	11.5, 4.8
Lamb meat	Carmarthenshire	2 ^c	3.5, 2.7	1.8, 1.3	5.3, 4.0
Lamb kidney	Devon	1 ^c	0.4	0.4	0.9
Lamb meat	Devon	2 ^c	0.8, 1.0	0.6, 0.6.	1.4, 1.6
iv) Other foods					
Clotted cream	Cornwall	1	0.3	0.5	0.8
Cheese	Dumfries and Galloway	4	0.4 to 0.5	0.3 to 0.5	0.8 to 0.9
Cheese (control)	Dumfries and Galloway	1	0.4	0.4	0.8
Butter	Dumfries and Galloway	1	0.6	0.5	1.1
Ice cream	Dumfries and Galloway	2	0.3, 0.3	0.6, 0.5	0.8, 0.7
Trout	Dumfries and Galloway	2 ^d	4.7, 6.6	13, 16	18, 22
Trout fillets	Dumfries and Galloway	2 ^d	5.9, 15	17, 34	22, 49
Concentrations (ng WHO-TEQ/kg fresh weight)					
Sample	Region	Number of samples	Dioxins	Dioxin-like PCBs	Dioxins and PCBs Total
Rhubarb	Dumfries and Galloway	1	0.03	0.02	0.05
Poultry feed – Grain	Anglesey	1	0.1	<0.1	0.1
Poultry feed – Grain	Dumfries and Galloway	1*	<0.1	<0.1	0.1

Poultry feed - Layer pellets	Dumfries Galloway	and	1*	<0.1	<0.1	0.2
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Concentrations (ng WHO-TEQ/kg dry weight)					
Sample	Region	Number of samples	Dioxins	Dioxin-like PCBs	Dioxins and PCBs Total
vi) Soil (5 cm depth)	Anglesey	7	1.1 to 2.0	[0.2 (all)]	[1.2 to 2.2]
	Carmarthenshire	2	1.5,1.6	0.1,0.2	1.6,1.7
Control	Gwynedd	1	4.4	0.2	4.6
	Devon	9	0.8 to 1.5	0.1 to 0.2	0.9 to 1.7
vii) Herbage	Anglesey	6	0.2 to 1.4	[0.1 to 0.3]	[0.3 to 1.8]
	Control	Gwynedd	1	0.6	0.1
	Carmarthenshire	2	0.9,1.0	0.1,0.2	1.1,1.1
	Devon	9	[0.2 to 0.8]	[<0.1 to 0.2]	[0.3-1.0]
Silage	Anglesey	1	0.4	n/a	n/a
Silage	Devon	3	0.2 to 0.3	<0.1 to 0.1	0.3 (all)

Notes:

Total concentrations of dioxins and dioxin-like PCBs may not equal the sum of individual dioxins and dioxin-like PCBs values due to rounding, and because the highest and lowest concentrations of dioxins and dioxin-like PCBs were not always found in the same samples.

For eggs, fish and meat all concentrations refer to the edible portion.

Ranges of concentrations in square brackets are based on incomplete data sets for some of the samples.

n/a Results not yet available.

^a Number of samples refers to a composite of samples taken from a single site *e.g.* 1 egg sample will be a composite of up to 12 eggs from one site. The ranges shown for soil, herbage, and silage are generally those of the average concentrations in three samples from each farm.

^b 2 birds from the same flock.

^c Results from an area are different cuts of a single lamb

^d One trout and trout fillet each from 2 separate farms.

^e Feed samples from same farm.

Table 1 Monitoring data for levels of nitrogen dioxide, sulphur dioxide and particles around pyres

Site and population	Period	Pollutant	Max pollutant concentration	Distance from pyre	Size of pyre
Holsworthy 1,892	24/04/2001 to 28/04/2001	NO ₂	69 ppb (low)	~ 1.4 km	5 Pyres each of 1000 cattle equivalent, 100 m x 5 m
		SO ₂	12 ppb (low)		
		PM ₁₀	20 µg/m ³ (low)		
Okehampton 4,841	28/04/2001 to 06/05/2001	NO ₂	29 ppb (low)	Various pyres	
		SO ₂	23 ppb (low)		
		PM ₁₀	27 µg/m ³ (low)		
Chulmleigh < 1000	30/04/2001 to 06/05/2001	NO ₂	12 ppb (low)	~ 850 m	Approx 800 cattle equivalents*, 10 m x 150 m
		SO ₂	17 ppb (low)		
		PM ₁₀	42 µg/m ³ (low)		
Longtown 2,548	10/04/2001 to 23/04/2001	NO ₂	16 ppb (low)	~ 1 km	Main pyre not lit
		SO ₂	37 ppb (low)		
		PM ₁₀	39 µg/m ³ (low)		
Sennybridge (EA site) (small isolated community)	02/04/2001 to 07/05/2001	NO ₂	35 ppb (low)	~ 2.1 km	5/4 to 11/4 1613 cattle and 2021 sheep (1723 cattle equivalents)
		SO ₂	21 ppb (low)		
		PM ₁₀	40 µg/m ³ (low)		

Footnotes

All population data from 1991 Urban Population Census

Concentrations are given for the averaging time relevant to the air quality standard. Air quality standards are

NO₂ 1 hr average 150 ppb

SO₂ 15 min average 100 ppb

PM₁₀ 24 hr average 50 µg/m³

Low indicates concentrations below the air quality standard

*Information from different sources 613 or 650 Cattle, 3280 or 4000 sheep (790 or 867 cattle equivalents)

ANNEX 5 COMPOSITE ASH ANALYSIS (based on Environment Agency sampling programme)

Determinant	EU Sewage Sludge Directive 86/278/EEC Limit values in sludge for recycling to land (mg/kg dm)	Soil Limit pH <5.5	Number samples analysed	Composite Average mg/kg (unless stated)
(mg/kg unless stated)				
Metals and potentially toxic elements				
Na	N/A	N/A	26	9633.38
K	N/A	N/A	26	17798.63
Cu	1,000 - 1,750	80	27	153.55
Mg	N/A	N/A	26	6443.21
Ca	N/A	N/A	26	92088.58
Cd	20 - 40	3	27	0.56
Si	N/A	N/A	19	224444.05
Al	N/A	N/A	26	35101.50
Pb	750 - 1,200	300	27	167.20
As	N/A	50	27	58.06
Cr	1,000 (proposed)	400	27	118.78
Fe	N/A	N/A	26	49792.83
Ni	300 - 400	50	27	78.67
Zn	2,500 - 4,000	200	1	538.00
Dioxins and Furans (ng/kg)				(ng/kg)
Dioxins (ng/kg (nd=0))			18	418.65
Dioxins I-TEQ (ng/kg (nd=0))			18	6.08
Dioxins I-TEQ (ng/kg (nd=ld))			16	9.13
Dioxins WHO -TEQ (ng/kg (nd=0))			16	7.33
Dioxins WHO -TEQ (ng/kg (nd=ld))			16	9.78
PAH Determinants				
naphthalene (ug/kg)			6	436.50
acenaphthylene (ug/kg)			6	16.00
acenaphthene (ug/kg)			6	7.00
fluorene (ug/kg)			6	7.30
phenanthrene (ug/kg)			6	124.25
anthracene (ug/kg)			6	18.65
fluoranthene (ug/kg)			6	56.65
pyrene (ug/kg)			6	32.10
c1 naphthalene (ug/kg)			6	330.50
c2 naphthalene (ug/kg)			6	479.75
c3 naphthalene (ug/kg)			6	402.25
Total C1 phenanthrene / anthracene (ug/kg)			6	95.70

chrysene (ug/kg)	6	24.85
benzo(a)anthracene (ug/kg)	6	14.28
benzo(b)fluoranthene (ug/kg)	6	12.03
sum of benzo(k)fluoranthene and benzo(j)fluoranthene (ug/kg)	6	10.25
benzo(e)pyrene (ug/kg)	6	11.88
benzo(a)pyrene (ug/kg)	6	12.25
perylene (ug/kg)	6	7.00
indeno(123cd)pyrene (ug/kg)	6	10.10
dibenzo(ah)anthracene (ug/kg)	6	7.00
benzo(ghi)perylene (ug/kg)	6	11.28
benzo(b)anthracene (2,3 benzanthracene) (ug/kg)	6	7.00
Total PAH (ug/kg (nd=ld))	6	2134.55
Total PAH (ug/kg (nd=0))	6	2066.05

NOTES: Less than limit of detection figures recorded as the higher figure (I.e. <1 recorded as 1 and not zero)

ADVICE: Figures in red (pale text colour) indicate that the ash results for that determinant are greater than the maximum soil limits in the Code of Practice for Agricultural Use of Sewage Sludge (I.e assuming no dilution with the soil). These are the sa