Press Release

Report says more resources needed to conduct adequate waste management risk assessments

20 Thursday 2003

Monitoring systems for health and environmental effects of waste are deficient

A major report on the effects of various forms of waste disposal has concluded that Ireland has insufficient resources to carry out adequate risk assessments for proposed waste management facilities. The report, *Health and Environmental Effects of Landfilling and Incineration of Waste – A Literature Review*, was conducted by an interdisciplinary scientific team from University College Dublin, University College Cork and Dublin Institute of Technology, Kevin Street. It was commissioned by the Health Research Board (HRB) at the request of the Department of the Environment and Local Government.

In launching the report, Dr Ruth Barrington, CEO of the HRB, said that "the report is an important contribution to informing the public debate about the effects of two options for waste management" and she urged all those interested in the issues to read the report.

Dr Dominique Crowley, who coordinated the study team, pointed out that it was not within the scope of this report to make recommendations on waste management policy. The purpose of the report, Dr Crowley said, is to inform policy makers and the public of the technical aspects of both landfill and incineration practices in Ireland and the effects that these practices may have on the environment and human health. In this context, the report reviewed national and international literature as well as current practice and recent developments in landfill and incineration technologies.

"At present, Ireland has insufficient resources to carry out adequate risk assessments for proposed waste management facilities. Although the necessary skills are available, neither the personnel nor the dedicated resources have been made available for this purpose. In addition there are serious data gaps in relation to the environmental effects of these technologies. These problems should be rectified urgently.

"Irish health information systems cannot support routine monitoring of the health of people living near waste sites. There is an urgent need to develop the skills and resources required to undertake health and environmental risk assessments in Ireland. This should be considered as an important development to build capacity in Ireland to protect public health in relation to potential environmental hazards."

In relation to the detection and monitoring of the environmental impact of waste facilities, the report concludes that there is a serious deficiency of baseline environmental information in Ireland, which should be remedied.

"The lack of baseline data makes it very hard to interpret the results of local studies, for example around a waste management site. Existing research results should be collated and interpreted as a step toward building a baseline data bank. A strategically designed monitoring programme needs to be initiated that can correct deficiencies in current ambient environmental monitoring.

In addition, capacity needs to be built in environmental analysis. In particular, Irish facilities for measuring dioxins are required and should be developed as a priority."

Dr Crowley said that there is a paucity of literature relating to modern landfill and incineration sites, so that nearly all of the studies identified in this report relate to older technologies and that as emission controls improve, risks of adverse effects diminish. In this context, she then went on to highlight her team's findings in relation to the health effects of landfilling and incineration.

"Evidence of a causal relationship between specific health outcomes and landfill exposures is still inconclusive. There is insufficient evidence to demonstrate a link between cancer and exposure to landfill. There is modest evidence for an association between birth defects and residence near some landfill sites."

Dr Dominique Crowley said that there is some evidence that incinerator emissions may be associated with respiratory symptoms.

"The evidence for a link between cancer and proximity to an incinerator is not conclusive. Further research using reliable estimates of exposure over long periods of time, is required to determine whether living near landfill sites or incinerators increase the risk of developing cancer."

Turning to the environmental effects of landfill, Dr Crowley said that landfills are a potential threat to the quality of the environment, contributing 20 per cent of the total global anthropogenic methane emissions.

"Leachate management is also a major concern. For older unlined waste disposal sites, leachate can migrate to groundwater or even into surface waters. Contamination of groundwater by leachate has already occurred in Ireland, rendering the groundwater and the associated aquifer unreliable for domestic water supply and other beneficial uses. This is far more serious than river pollution because aquifers require extensive time periods for rehabilitation. The risks are considerably reduced for modern double-lined landfills."

In relation to the environmental effects of incineration, Dr Crowley said that her team concluded that the disposal of municipal solid waste through this method produces a range of volatile and gaseous emissions, which, if released to the atmosphere, can compromise environmental quality. The adoption by incinerator operators of environmental management plans has been helpful in minimising potential environmental impacts.

Re-emphasising the fact that this report is based on studies relating to older incineration technologies, Dr Crowley pointed out that new and planned incinerators will work to EU Directives which puts a greater emphasis on energy efficiency, residuals management and the reduction of natural resource consumption than was present heretofore.

The report has been printed using recycled paper and report is available in PDF format on the website of the HRB (www.hrb.ie)

For further information contact:

Sinead Duffy
Communications Manager
Health Research Board
73 Lower Baggot Street
Dublin 2
t +353 1 6761176 **ext** 103
m +353 868226560
e sduffy@hrb.ie

Dr Dominique Crowley
Research Co-ordinator
Department of Public Health and Epidemiology
Earlsfort Terrace
Dublin 2
t +353 1 7167345
m+353 868077900
e dominque.Crowley@ucd.ie

2

Mr. Hall
You may wish to see for info.
NC 8/4

Health Research Board study on risk assessment of landfill/thermal treatment

Runai Aire,

1. Mr. Casserly's note refers. Requests for proposals are issuing this week to 15 Irish and UK institutions. We have the option of issuing the proposed statement now, on our own initiative, or holding it for issue as a response to public or press queries, when and if they arise.

Timescale for study

2. Please note that in my note to the Minister dated 20 July 2001, I indicated that the HRB would invite proposals by early September and that the selected proposal could be identified and approved by end-September next. On foot of soundings within the research community, the HRB decided that with the holiday period involved, they would have to allow until 21 September for proposals, so that a study team may not be appointed until mid to end October. The HRB's RFP specifies that the proposed study must be completed by end-February 2002.

Implications of study

3. In discussion some weeks ago, the Minister asked for information on the legal position should the study conclude that a specific technology or type of waste facility posed an unacceptable risk to public health or the environment (e.g. whether a moratorium on development could be formally imposed).

4. As Mr. Casserly indicates, the Minister has powers of general policy direction in relation to –
   - waste management planning, or the granting of waste licences by the EPA (Waste Management Act, 1996), and
   - the planning functions of local authorities and an Bord Pleanala (Planning & Development Act, 2000).

However, in both cases, the Minister is precluded from exercising any power or control in relation to the performance by the bodies concerned of their functions in a particular case (planning) or particular circumstances (waste licensing). Accordingly, in a hypothetical situation where –
   - the conclusions of the proposed study seemed to warrant a policy direction against the adoption or authorisation of a particular waste management technology, but
   - in practice, any such direction impacted on a single development proposal or business concern,

the Minister could be constrained in the use of these powers.

If the Minister wishes, we can seek the views of the AG's Office in relation to such hypothetical circumstances.

5. In a more general context, under the EPA Act, 1992, the Agency is required in carrying out its functions, including licensing functions, to –

- keep itself informed of the policies and objectives of relevant public authorities (which includes a Minister of the Government), and
- have regard to the precautionary principle in relation to the potentially harmful effect of emissions from activities.

Accordingly, the EPA would have to take full account of –

- any revised policy position on the part of Government or the Minister, and
- the findings of a study such as that proposed,

but would not be specifically bound as to its position arising from either.

There is an equivalent provision is section 34 of the P&D Act, 2000, whereby a planning authority must have regard, among other things, to the policy of the Government or the Minister - however, this section has not yet been commenced.

6. The Minister is empowered under section 41 of the 1996 Act to require the EPA to –

- attach as conditions to a waste licence provisions requiring compliance with any specified standard or requirement, or
- take account of any other specified matter in attaching licence conditions.

However, these provisions clearly relate to conditioning of licences to be granted, rather than requiring the Agency to refuse to grant a licence in respect of specified activities or in specified circumstances.

Submitted please for approval/decision as to –

- content and timing of press statement, and
- request for advice from AG's Office as outlined at 4 above.

L. Whelan
7 August 2001

28 March 2003

Mr. Eamonn Corcoran
Department of Health and Children
Hawkins House
Dublin 2

2a

Dear Mr. Corcoran,

In the summer of 2001, the Health Research Board (HRB) agreed to a request from this Department that it commission a study to provide an objective and independent analysis of internationally available information regarding the likely effects of landfill and thermal treatment (especially incineration) activities on public health and the environment.

On 20 February 2002, the HRB published a report on this issue - *Health and Environmental Effects of Landfilling and Incineration of Waste: a literature review* - copy of which is accessible on the Board's website.

This report contains a number of findings and recommendations relevant to the Department of Health and Children (the Executive Summary and Chapter 6 refer). In particular, it concludes that Ireland presently has insufficient resources to carry out adequate risk assessments for proposed waste management facilities and that, in this regard, our health information systems cannot support routine health monitoring of communities near such facilities. The HRB goes on to recommend the urgent development of the necessary skills and resources to facilitate environmental and health risk assessments. With regard to the latter, the Board considers that the recommendations in the 1999 *Proposal for a National Environmental Health Action Plan,* especially concerning the establishment of a national centre for toxicology, could form a basis for future action.

I would welcome the views of your Department regarding these elements of the HRB report, and the scope for an appropriate response on the part of the relevant health services. A meeting, also involving the Environmental Protection Agency, would perhaps be useful.

Yours sincerely,

Liam Whelan
Principal

c.c. Dr. Jim Kiely, CMO

also
Mr John Purcell

Sent by hand 31/03/03

Per Cathal. Note. Sp? No reply as yet. WF 26/5

3

Mr Michael Kelly
Secretary General
Department of Health and Children
Hawkins House,
Hawkins Street,
Dublin 2,
Ireland.

25 March 2003 MK/cm

re: **Baseline Health Data**

Dear Mr Kelly

I write to you in respect of concerns expressed by the public regarding human health in the vicinity of waste facilities, including landfill sites and incinerators.

The Environmental Protection Agency has statutory obligations set out in the Environmental Protection Agency Act, 1992, the Waste Management Act, 1996 and other legislation. The brief of the Agency includes the following:

- Licensing and regulating activities specified in legislation with a potentially high risk of causing pollution, including industrial installations and waste facilities
- Enforcing environmental legislation in relation to specified activities in both private and public sectors
- Monitoring and reporting on the state of the environment

To date the Agency has licensed waste facilities such as existing landfills, new landfills and incinerators attached to particular industries. In granting licences for the operation of these facilities the Agency sets stringent emission limit values for pollutants and potential pollutants to meet the accepted EU standards and guidelines as a minimum requirement. In addition, the Agency evaluates the potential impact of the maximum licensed emission on the environment surrounding any facility to ensure that all EU standards for the environment and WHO guidelines will be met. If these cannot be met, then the Agency will reduce the level of emissions licensed accordingly. The Agency takes the view that if the licensed emission limit is complied with, then human health is adequately protected in line with best international practice. To ensure compliance, the Agency requires the operators of the facilities to monitor and report on specified substances, and in addition conducts its own monitoring and auditing of the facilities. The Agency is confident that this approach, coupled with the requirement on the part of the licensee, to implement environmental management plans and to operate according to Best Available Techniques minimises the risk to public health and the environment.

However, the public continues to have concerns regarding the health impacts of these facilities, and expresses these concerns to the Agency in written submissions and objections to the issue of licences, and in submissions at Oral Hearings of objections held by the Agency in the licensing of some facilities.

A recent report commissioned by the Department of the Environment and Local Government and carried out by the Health Research Board concluded, inter alia, that Irish health information systems cannot support routine monitoring of the health of people living near waste sites, and points to a lack of available information on the health status of residents residing near waste facilities, and a lack of baseline human health data at national, regional and county level.

The Report on the Investigations of Animal Health Problems at Askeaton, Co Limerick , carried out by Department of Agriculture, Food and Rural Development, Teagasc, EPA and the Mid Western Health Board, and published in 2001 also identified a number of issues in respect of human health data, which needed to be addressed so that proper expertise and baseline data are available in the State. Amongst other things, this report recommended a computerised system of monitoring congenital abnormalities based on the Eurocat model, a system of surveillance of morbidity in general practice, and the structuring of information systems within the health service to allow easy epidemiological investigation.

The issue of baseline health data and adequate health information systems is a matter appropriate to the Department of Health and Children and the Health Boards. The Agency would support the recommendations on these matters referred to in the above reports, the implementation of which should help to alleviate the legitimate public concerns about the health impacts of the very necessary infrastructural developments in a modern economy.

If you would like further clarification of any of the issues raised here I would be pleased to discuss them with you.

Yours sincerely,

Dr. Mary Kelly
Director General

North Eastern Health Board
Bord Sláinte an Oir Thuaiscirt

COMMUNITY CARE SERVICES,
Co. Clinic,
Navan, Co. Meath.

Tel: (046) 21595, Fax (046) 22818

4

Mr. M. Donnelly,
Principal Environmental Health Officer,
County Clinic,
Navan,
Co. Meath.

7th February 2002

Re:- Application by Indaver Ireland for a Waste Licence for a Waste Management Facility at Carranstown, Duleek, Co. Meath.
License Application Ref. :- 167-1

In order to properly assess this application request applicant to submit the following further information :-

1. The applicant shall restructure the proposal taking into account European and National Integrated Waste Management Policy i.e. Waste Management – Changing Our Ways, Department of the Environment and Local Government, 1998 and the European Directive on Incineration (2000/76/EC). The developer proposes to use the sorting bay only when a delivery of dry recyclable waste is received while unsorted waste shall be disposed of in the incineration process. This is contrary to the basic principles of the waste management hierarchy of prevention, minimisation, reuse and recycling.

2. The Environmental Impact Statement does not provide a breakdown of source and quantity of municipal, industrial and commercial waste. The applicant shall list explicitly the category and quantity of waste as required by the European Directive on Incineration (2000/76/EC).

X 3. Alternative sites for this development shall be fully assessed and examined in accordance with EIS requirements.

4. The Environmental Impact Statement referred to the World Health Organisation's criteria for Site Selection for New Hazardous Waste Management Facilities (1993). These criteria are not confined to landfill activities as stated in the applicant's submission and specifically exclude areas with limestone deposits. The applicant shall clarify this issue.

X X 5. The limestone bedrock constitutes a regionally important aquifer which is karst and fractured and is therefore susceptible to ground water pollution. This aquifer is the sole source of water for numerous houses in the vicinity. The impacts of this aquifer underneath the site shall be fully assessed and discussed.

6. The effects of the removal of overburden during preparation of the site were not discussed, nor were the impacts addressed in relation to the aquifer.

7. The effect of the development on the drawdown of local wells shall be addressed.

8. The impacts of the development on the gas line running directly underneath the site were ignored i.e. potential for gas leaks, fire, explosion. These impacts shall be fully addressed.

9. The applicant shall carry out a feasibility study on the sourcing of waste which would ensure the viability, sustainability and continued efficient operation of the incineration plant.

10. The applicant proposes to collect recyclable waste on the site. Applicant shall submit details as to how or where this waste shall be recycled.

11. The quantity, storage facilities and treatment of green waste were not discussed in the E.I.S. Request applicant to outline proposals for the location, treatment and final destination of waste.

12. Details on the stockpiling of waste – capacity and length of time waste will be stored on site – for both waste bunker and community recycling park.

13. The applicant failed to submit sufficient details of the processes involved in this development as follows :-

-Site layout was not adequately detailed.

-Processing areas and systems were not fully indicated and described. These areas shall be clarified on plan.

14. The Environmental Impact Statement states that boiler ash shall be sent to landfill whilst flue gas cleaning residues shall be removed to a hazardous waste landfill. Boiler ash is classed as a hazardous waste under the EC Council Directive on Hazardous Waste 91/689/EEC. However the applicant is not treating it as such. The applicant shall provide for the segregation of flue gas cleaning residues and boiler ash.

15. Provision shall be made for the visual inspection, weighing of each load, a storage tank inspection area for waste and quarantine area for waste which cannot be dealt with by the plant i.e. hazardous or clinical waste.

16. Details regarding the storage and treatment of overburden shall also be submitted.

17. The applicant failed to give sufficient detail with regard to volume of surface and rain water, site drainage layout, run off and run off controls. The direction and relative magnitude of flow of surface water movement shall be quantified.

18. Provision shall be made for the retention of firewater on site to avoid the potential threat of ground water pollution.

19. Details of the location of the puraflo waste water treatment system and percolation area shall be submitted. In addition, request applicant to submit details of water table and soil percolation tests.

20. The management policy and procedures of the plant shall be described i.e. operational, quality control and environmental management procedures.

21. Back- up or failsafe procedures which would effectively mitigate very severe impacts in the event of failure of the proposed measures shall be submitted.

22. A detailed description of the manner in which waste will be transported from the site i.e. enclosed waste containers or fully enclosed collection vehicles for the transport of waste to and from the site shall be submitted.

23. Detail proposed method and location of wheel washing facilities.

24. Measures taken to limit movement of heavy goods vehicles on and off site during unsociable hours shall be indicated.

25. A public complaints procedure shall be addressed.

26. The applicant shall submit a detailed rodent control programme for the site.

27. Submit proposals for the control and monitoring of dust and noise during the construction phase of the development.

28. Applicant stated in Section 2.7 of the E.I.S. that a decommissioning plan would be submitted as part of the license application. No such plan has been included. The applicant shall address this issue.

29. Clarify method and frequency of leachate tests which shall be carried out on flue gas cleaning residues and boiler ash. Request applicant to state parameters which shall be analysed in the above tests in order to determine the hazardous nature of the waste.

30. Applicant shall submit details on the transport and final destination of both boiler ash and flue gas cleaning residues. The weight and volume of the above solid wastes shall be quantified.

31. The disposal of bottom ash to landfill is not in keeping with the basic principles of waste management. The applicant stated that the ash can be treated in an ash recovery plant to render it suitable for road construction. Request applicant to provide full details of the ash recovery process. Indicate process method and location of the plant.

32. In section 2.4.2 of the E.I.S. the applicant states that in the case of both lines being shut down typically for 1-2 days per year fans will be kept on line as long as possible to maintain the bunker under negative pressure. Any odours will be discharged via the 40m stack. During these periods the waste in the bunker will be sprayed with odour suppressing chemicals to minimise odours.
Masking of odours is unacceptable - All odours shall undergo treatment prior to extraction. Please submit proposals for the treatment odours during this shutdown period.

33. Request applicant to clarify method that was employed to determine worst case air emission data and state where this information was sourced.

34. Section 5.5 states that an assessment shall be submitted to the EPA to ensure that noise emissions from the plant shall not exceed given limits at any sensitive noise receptor. No such assessment was included in the E.I.S. This issue shall be addressed.

35. Provide further details on the silt trap which shall be used during construction i.e. management and location of same.

Note: The Environmental impact statement claimed that the applicant consulted with the North Eastern Health Board during the pre-application process however no such consultation took place.

Elizabeth Byrne
Senior Environmental Health Officer

Carmel Lynch
Environmental Health Officer

RESEARCH REPORT

Adverse pregnancy outcomes around incinerators and crematoriums in Cumbria, north west England, 1956–93

T J B Dummer, H O Dickinson, L Parker

J Epidemiol Community Health 2003;57:456–461

See end of article for authors' affiliations

Correspondence to: Professor L Parker, School of Clinical Medical Sciences, Paediatric and Lifecourse Epidemiology Research Group, University of Newcastle, Sir James Spence Institute, Royal Victoria Infirmary, Newcastle NE1 4LP, UK; louise.parker@ncl.ac.uk

Accepted for publication 26 August 2002

Study objective: To investigate the risk of stillbirth, neonatal death, and lethal congenital anomaly among babies of mothers living close to incinerators and crematoriums in Cumbria, north west England, 1956–93.

Design: Retrospective cohort study. Logistic regression was used to investigate the risk of each outcome in relation to proximity at birth to incinerators and crematoriums, adjusting for social class, year of birth, birth order, and multiple births. Continuous odds ratios for trend with proximity to sites were estimated.

Setting: All 3234 stillbirths, 2663 neonatal deaths, and 1569 lethal congenital anomalies among the 244 758 births to mothers living in Cumbria, 1956–1993.

Main results: After adjustment for social class, year of birth, birth order, and multiple births, there was an increased risk of lethal congenital anomaly, in particular spina bifida (odds ratio 1.17, 95% CI: 1.07 to 1.28) and heart defects (odds ratio 1.12, 95% CI: 1.03 to 1.22) around incinerators and an increased risk of stillbirth (odds ratio 1.04, 95% CI: 1.01 to 1.07) and anencephalus (odds ratio 1.05, 95% CI: 1.00 to 1.10) around crematoriums.

Conclusions: The authors cannot infer a causal effect from the statistical associations reported in this study. However, as there are few published studies with which to compare our results, the risk of spina bifida, heart defects, stillbirth, and anencephalus in relation to proximity to incinerators and crematoriums should be investigated further, in particular because of the increased use of incineration as a method of waste disposal.

The incineration of domestic and industrial waste releases dioxins and other chemicals into the environment.[1 2] Crematoriums have been identified as sources of atmospheric mercury.[3 4] Such pollutants, many of which act as endocrine disruptors, are hazardous to human health.[5–8] However, very little is known about the public health impact of low dose, long term environmental exposure to these chemicals.[8 9 10] Epidemiological studies have identified an increased risk of congenital anomaly and low birth weight in children born close to landfill sites, which are potential sources of this complex family of chemical pollutants.[11–17] Higher levels of environmental pollutants—including dioxins, lead, and cadmium—have been found in the blood of children living near to waste incinerators in Belgium.[7] Reduced testicular volume and delayed sexual maturity among children living in areas with high exposure were also reported,[7] linking exposure to endocrine disruptors to components of the testicular dysgenesis syndrome.[18] Despite concern over the health effects of emissions from incinerators[6] and crematoriums,[7] there is little information concerning pregnancy outcomes for mothers living in their vicinity. Identification of possible health effects of incinerators is important given the growth of incineration as a method of waste disposal[19] and its widespread use for the disposal of animal carcasses during the 2001 outbreak of foot and mouth disease in the UK.[20]

This study investigated the risk of stillbirth, neonatal death, and lethal congenital anomaly among the offspring of mothers living close to incinerators and crematoriums in Cumbria, north west England, between 1956 and 1993.

METHODS

The Cumbrian Births Database

The study area was the county currently defined as Cumbria.[21] The Cumbrian Births Database has been described in detail elsewhere.[22 23] In summary, birth registration details of all 241 524 live births and 3234 stillbirths born to mothers usually resident in the study area, from the opening of the first crematorium in 1956 to 1993, were supplied from the Office for National Statistics and entered onto a computer database.[22 23] During this period a stillbirth was defined as a fetal death occurring after 28 weeks gestation (from 1 October 1992 fetal deaths occurring after 24 weeks gestation were included, consistent with current legal definitions).[24 25] Death registrations for the cohort, including those that occurred outside Cumbria, were supplied by the Office for National Statistics from the National Health Service Central Register (NHSCR), which was the primary source of ascertainment of deaths. NHSCR routinely records deaths of all residents of England and Wales who have ever registered with a general practitioner. However, hospital records within Cumbria and in regional referral centres outside Cumbria were searched to ascertain unregistered stillbirths and infant deaths.[26] All causes of stillbirth and death were coded to ICD-9. Causes of death and stillbirth were confirmed, where possible, through examination by a consultant neonatologist of details obtained from medical and/or postmortem records (the cause of about 50% of deaths were confirmed in this way). Thus, when postmortem and/or clinical records were available, causes of stillbirth and death were validated from a number of sources and derived using a more robust method than relying on death or stillbirth certificates. Neonatal death was defined as death within the first four weeks of life.

Several outcome groups were considered: stillbirth, neonatal death, stillbirth plus neonatal death, lethal congenital anomaly (overall and by cause category). Deaths from congenital anomaly (ICD740–759) were grouped by cause, using a standard classification of infant deaths,[27] into the following hierarchical and mutually exclusive categories: all neural tube defects (ICD740–742), congenital heart defects

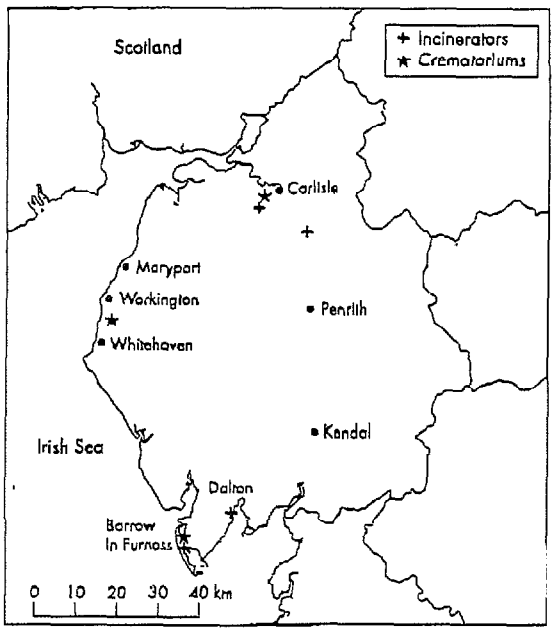

Figure 1 Location of incinerators and crematoriums in Cumbria, 1956–93.

(ICD745–747), other congenital anomalies. Neural tube defects were subdivided into: anencephalus (ICD740), spina bifida (ICD741), other central nervous system anomalies (ICD742). All other lethal congenital anomalies were grouped because of the small numbers within each ICD-9 cause category.

The mother's address on the child's birth certificate was postcoded and hence grid referenced.[18] The father's occupation, as recorded on the birth certificate, was assigned a social class.[19] Algorithms based on parents' names were used to assign birth order and identify multiple births.[20]

Geographical data (see table 1)

The grid references and dates of operation of incinerators in Cumbria were ascertained from Environment Agency records. No incinerators operated before 1977, and four operated between 1977–93. The locations of all crematoriums were ascertained from specialist digests and the dates of operation were obtained. During the period 1956–1993, three crematoriums operated. Details were captured in the geographical information system Arc/Info.[18] Mercury represents the main pollutant from crematoriums.[1 4] By contrast, emissions from incinerators incorporate a more complex mixture of dioxins, furans, particulates (such as chloride and sodium), heavy metals (including lead and chromium), and volatile organic compounds (such as chloroform).[1 21] Because of the differences in emissions, incinerators and crematoriums were analysed separately. Three of the four incinerators in Cumbria all dealt with materials defined as difficult by the Environment Agency,[22] the other (incinerator 1) processed only inert and biodegradable material.[22] Because of the historical nature of this study no detailed emissions data were available. Details of the material dealt with at each incinerator are presented in table 1. The location of all incinerators and crematoriums in Cumbria, 1956–93 is show in figure 1.

Analysis methods

A measure of exposure of each birth to incinerators and crematoriums was computed using the distance function $1/(D+0.1)^2$ where D was the distance in km from the site and the measure was summed over all sites that were in operation at the time of birth.

Stillbirth and neonatal death rates fell substantially over the study period.[21] The cause of stillbirth was recorded on the stillbirth registration only from 1961 onwards. Hence the analysis in relation to proximity to crematoriums was stratified by time period: 1956–60, 1961–71, 1972–82, 1983–93. As incinerators in Cumbria were in operation only between 1977 and 1993, this analysis was not stratified by time period.

Multivariate logistic regression[24] was used to model how the risk of each outcome varied in relation to proximity to incinerators and crematoriums, adjusting for the known demographic risk factors—year of birth, social class, birth order, and multiple births—using offsets from an analysis of the effects of demographic risk factors without the exposure function. Year of birth was modelled using both quadratic and linear terms. Social class, birth order, and multiple births were treated as categorical variables (social classes I, II, IIIn, IIIm, IV, V, armed forces, and unknown, father not recorded on the births certificate; birth order 1, 2, 3, and ≥4; multiple births, yes/no). A sensitivity analysis was carried out repeating the logistic regression, but excluding births with the greatest influence, as measured by Pregibon's influence statistic.[24] For incinerators the analysis was repeated for the period before any incinerators were open, 1956–76. Because multiple births may not be considered independent events, robust estimates of variance were used and significance assessed from the corresponding p value.[25]

RESULTS

Incinerators (see table 2)

The risk of stillbirth and neonatal death was not significantly increased closer to incinerators. However, the risk of lethal congenital anomaly was significantly higher ($p<0.01$). This significantly increased risk was restricted to heart defects and neural tube defects, specifically spina bifida. Sensitivity analysis demonstrated that these results remained significant when the most influential births were excluded. Replication of the

Table 1 Incinerators and crematoriums in Cumbria in operation during the study period, 1956–93

Site	Location	Material*	Time period of operation
Incinerator 1	Barrow in Furness	Inert, biodegradable	1977–1992
Incinerator 2	Ulverston	Hazardous, flammable, chemicals	1978–1994
Incinerator 3	Dalston	Filler material, treatment sludges, biodegradable	1979–1991
Incinerator 4	Arnoldwaite	Biodegradable, putrescible	1991–present
Crematorium 1	Carlisle	–	1956–present
Crematorium 2	Barrow in Furness	–	1963–present
Crematorium 3	Distington	–	1974–present

*Information from the Sitefile Digest[14] and Environment Agency records.

Table 2 Continuous odds ratios (OR)† for risk of stillbirth, neonatal death, and lethal congenital anomaly in relation to proximity to incinerators, 1956–76 (before incinerators opening)‡ and 1977–93, adjusted for social class, birth order, year of birth, and multiple births

Outcome	Number of cases	OR	95% CI	p
1956–76 (before incinerators opening)				
Stillbirth + neonatal death	4715	0.97	0.93 to 1.01	
Stillbirth	2622	1.00	0.96 to 1.03	
Neonatal death	2093	0.92	0.84 to 1.00	
Lethal congenital anomaly‡	1583	0.94	0.86 to 1.02	
All neural tube defects‡	602	0.95	0.85 to 1.06	
Anencephalus‡	262	0.96	0.82 to 1.13	
Spina bifida‡	244	0.86	0.67 to 1.10	
Other CNS anomaly‡	96	1.02	0.97 to 1.08	
Heart defects‡	247	1.01	0.91 to 1.12	
All other anomalies‡	303	0.94	0.81 to 1.09	
1977–93				
Stillbirth + neonatal death	1182	1.03	0.93 to 1.13	
Stillbirth	612	1.04	0.90 to 1.19	
Neonatal death	570	1.02	0.90 to 1.14	
Lethal congenital anomaly	417	1.10	1.03 to 1.19	**
All neural tube defects	132	1.13	1.04 to 1.23	**
Anencephalus	33	1.08	0.99 to 1.18	
Spina bifida	60	1.17	1.07 to 1.28	**
Other CNS anomaly	39	0.73	0.34 to 1.56	
Heart defects	104	1.12	1.03 to 1.22	**
All other anomalies	181	0.90	0.67 to 1.22	

*p<0.05, **p<0.01. †These ORs are continuous, for example, the odds of lethal congenital anomaly at a distance, D, from an incinerator compared with the odds at 3 km from incinerators is $1.10^{(1/10-0.1/3.1)} = 1/3.1$. Hence the odds ratio comparing risk at a distance of 0.5 km compared with that at 3 km (or further) is about 1.3. ‡Before incinerators opening lethal congenital anomalies were analysed only for the time period 1961–76.

analysis, using the location of incinerators for the time period *before* they were open, showed no increased risk for any outcome (table 2).

Crematoriums (see table 3)

During 1956–93 there was a significantly increased risk ($p<0.01$) of stillbirth closer to crematoriums, reflecting a consistently increased risk from 1961 onwards. The risk of anencephalus was also significantly increased during this period ($p<0.05$), due to a significantly increased risk in 1961–71. Although most (92%) cases of anencephalus were stillborn, the significantly increased risk of stillbirth remained after exclusion of anencephalus cases from the analysis. From 1972 onwards there was an increased risk of all other congenital anomalies, excluding neural tube defects and heart defects, with increasing proximity to crematoriums, which was significant ($p<0.01$) for the period 1983–1993. These findings remained significant after exclusion of the most influential births.

DISCUSSION

Summary

We found a significantly increased risk of lethal congenital anomaly (specifically spina bifida and heart defects) in relation to proximity to incinerators, but not of stillbirth or neonatal death. In contrast with Elliott *et al*,[12] who found an increased risk for certain congenital anomalies in areas where landfill sites were later opened, we found no increased risk for any outcome in areas where incinerators were subsequently opened. Hence, there was no evidence that these increased risks might be attributable to features of the environment where incinerators were located.

Around crematoriums, there was a consistently increased risk of stillbirth from 1961 onwards. There was also a significantly increased risk of anencephalus during 1961–1971, when case ascertainment was highest because this time period largely pre-dated antenatal screening for this outcome. In the later two time periods there were very few cases of anencephalus in term pregnancies and hence statistical power to detect an effect was greatly reduced. There was a significantly increased risk of all other lethal congenital anomalies around crematoriums from 1983 onwards. This increased risk was not observed in earlier time periods despite a greater number of cases, suggesting either that a small association was obscured in earlier time periods by cases due to causes that were eliminated or reduced during 1983–93, or that the significant association in 1983–93 was a chance finding.

The significant statistical associations are different for incinerators and crematoriums. While we cannot infer a causal effect from these statistical associations, the inconsistency may be attributable to the different pollutants emitted by crematoriums and incinerators,[14 13] or it may reflect confounding with other unmeasured risk factors, or it may be a chance finding. In addition, the time periods of operation of incinerators and crematoriums were different (1977–93 and 1956–93 respectively). Hence, while we observed a significantly increased risk of anencephalus with proximity to crematoriums during 1961–1971, we did not in the later time periods for either crematoriums or incinerators. It is unlikely that any association between proximity to incinerators or crematoriums and the risk of anencephalus would be detectable in later time periods when the number of cases was low because of prenatal screening and therapeutic termination.

Strengths and weaknesses of the study

Our study covered 38 years, allowing us to investigate a potential environmental hazard with a large cohort of 244 758 births. Changes in medical practices over time may have affected the results. Medical advances, such as improved antenatal care, which allows more fetuses to be carried to at least 28 weeks, and improved gestational dating, may have increased the number of deaths classified as stillbirths. However, other advances, such as better fetal monitoring and

Table 3 Continuous odds ratios (OR)‡ for risk of stillbirth, neonatal death, and lethal congenital anomaly in relation to proximity to crematoriums, 1956–93, by time period, adjusted for social class, birth order, year of birth, and multiple births

Outcome	Number of cases	OR	95% CI	P
1956–60				
Stillbirth + neonatal death	1508	0.95	0.74 to 1.22	
Stillbirth	887	0.85	0.60 to 1.20	
Neonatal death	621	1.08	0.77 to 1.52	
1961–71				
Stillbirth + neonatal death	2559	1.10	1.01 to 1.20	*†
Stillbirth	1413	1.19	1.09 to 1.31	**
Neonatal death	1146	0.93	0.75 to 1.15	
Congenital anomaly	906	1.10	0.95 to 1.27	
All neural tube defects	493	1.12	0.94 to 1.33	
Anencephalus	219	1.23	1.01 to 1.50	*
Spina bifida	1968	1.06	0.79 to 1.42	
Other central nervous system	76	0.65	0.33 to 1.26	
Heart defects	177	1.21	0.91 to 1.62	
All other anomalies	236	0.95	0.66 to 1.38	
1972–82				
Stillbirth + neonatal death	1212	0.98	0.87 to 1.09	
Stillbirth	602	1.04	0.93 to 1.16	
Neonatal death	610	0.89	0.72 to 1.11	
Congenital anomaly	462	0.80	0.59 to 1.09	
All neural tube defects	200	0.68	0.39 to 1.16	
Anencephalus	69	0.35	0.11 to 1.18	
Spina bifida	88	0.71	0.28 to 1.78	
Other central nervous system	43	0.97	0.64 to 1.47	
Heart defects	125	0.58	0.26 to 1.27	
All other anomalies	137	1.04	0.84 to 1.29	
1983–93				
Stillbirth + neonatal death	618	0.99	0.87 to 1.23	
Stillbirth	332	1.01	0.97 to 1.05	
Neonatal death	286	0.84	0.60 to 1.17	
Congenital anomaly	201	1.02	0.99 to 1.05	
All neural tube defects	41	0.76	0.37 to 1.58	
Anencephalus	7	0.65	0.13 to 3.19	
Spina bifida	18	1.02	0.97 to 1.08	
Other central nervous system	16	0.08	0.00 to 5.62	
Heart defects	49	0.50	0.15 to 1.62	
All other anomalies	111	1.03	1.01 to 1.06	**
1956–93				
Stillbirth + neonatal death	5897	1.02	0.99 to 1.05	
Stillbirth	3234	1.04	1.01 to 1.07	**
Neonatal death	2663	0.91	0.78 to 1.04	
Congenital anomaly (1961–93)	1569	1.02	0.96 to 1.08	
All neural tube defects	734	1.00	0.87 to 1.16	
Anencephalus	295	1.05	1.00 to 1.10	*
Spina bifida	304	0.99	0.77 to 1.27	
Other central nervous system	135	0.70	0.43 to 1.14	
Heart defects	351	1.00	0.77 to 1.31	
All other anomalies	484	1.04	1.00 to 1.07	*

*p<0.05, **p<0.01, †Became non-significant when most influential births were excluded. ‡These ORs are continuous, for example the odds of anencephalus at a distance, D, from crematoriums compared with the odds at 3 km from crematoriums in 1961–71 is $1.23^{(1/3-1/D)}$. Hence the odds ratio comparing risk at a distance of 0.5 km compared with that at 3 km in 1961–71 is about 1.77.

improved resuscitation, may have decreased the number of stillbirths either by shifting potential stillbirths into the category of neonatal deaths or by preventing infant death. The introduction of antenatal screening and elective termination reduced the number of stillbirths and deaths attributable to congenital anomalies in recent years.[26] Thus the clinical characteristics of the cases in the 1950s and 1960s may be intrinsically different from those in the 1990s. However, all analyses were adjusted for year of birth, such that the risk of stillbirth, lethal congenital anomaly or neonatal death to mothers living close to incinerators or crematoriums was, in effect, compared with that of other mothers giving birth around the same time. Hence, the objectives of our study were not affected by changes in the nature of cases over time.

Because the Cumbrian Births Database recorded all birth registrations in Cumbria during the study period by date of birth and postcode of mother's residence, we had precise data on the population at risk and the location of each birth. Consequently we were able to estimate exposure and risk within a continuous model unconstrained by the availability of population statistics from other sources and we did not have to restrict our analysis to traditional geographical areal units. However, a limitation of our study was the unavailability of data on pregnancies less than 28 weeks gestation (24 weeks since 1 October 1992), which will affect the population at risk because some serious congenital anomalies might not continue to this stage of maturity, either through spontaneous abortion or termination. The inability to include such cases in

Key points

- Incinerators and crematoriums are sources of harmful chemicals (including dioxins), although little is known about the effects of long term low dose exposure.
- We investigated the effects of proximity to incinerators and crematoriums on stillbirth, neonatal death, and lethal congenital anomaly.
- We used precise details of the population at risk and the distance of each birth from all sites.
- We found an increased risk of spina bifida and heart defects in relation to proximity to incinerators and an increased risk of stillbirth, anencephalus, and other congenital anomalies in relation to proximity to crematoriums.

Recommendations

- Further work is needed to establish whether this statistical association is causal or not.

our study is likely to have resulted in a conservative estimate of the effects of proximity to sources of pollution. A further limitation of our study was the exclusion of non-lethal congenital anomalies, although we were rigorous in our ascertainment of deaths, stillbirths, and lethal congenital anomalies.[24] Because no data were available for non-lethal congenital anomalies these cases could not be excluded from the live birth control group. However, as the control group comprised all live births that survived over 28 days non-lethal congenital anomalies would have comprised a very low proportion of the comparison group.

We were able to incorporate exposures of each birth to putative pollution from several sites. In addition, we had demographic information for each birth and hence were able to take account of individual risk factors, such as social class, which we have shown previously to be a better predictor of stillbirth rates than community based deprivation measures such as the Townsend score.[41] Grid references for incinerators and crematoriums were supplied to an accuracy of 100 metres.

We assumed that the mother's residence during pregnancy was the same as that recorded on the birth registration. Hence migration of mothers during pregnancy may have resulted in misclassification of exposure, which would have tended to obscure any association between risk of adverse pregnancy outcome and proximity to crematoriums or incinerators.

A further limitation was that, as actual pollution levels around each site were unknown and would be impossible to ascertain retrospectively over such a long time period, we relied on a function of distance as a surrogate for potential exposure. The form of the exposure function, $1/(D+0.1)^2$, assumed that exposure increased rapidly with proximity to the sites. A potential mechanism for absorption of toxic pollutants from incinerators or crematoriums by pregnant women might involve direct inhalation of pollutants or contact through food, soil, or water contamination. We assume higher pollution levels closer to the point source and thus the distance function is a reasonable surrogate indicator that has been used in many similar studies investigating health risks around pollution sources.[11–13 19] Although we could not consider any changes in pollution levels over time all analyses were adjusted for year of birth, so the risk of adverse pregnancy outcomes for mothers living close to crematoriums/incinerators was compared with that of mothers giving birth in the same year.

The facilities in Barrow in Furness and Dalton in Furness are located near to industrial sites defined as hazardous by the Environment Agency. Hence, there is some potential for confounding between proximity to incinerators/crematoriums and proximity to hazardous industrial sites.

There is potential for confounding between distance from incinerators and crematoriums and unmeasured risk factors, such as diet, lifestyle, or occupational exposures. However, we adjusted for individual social class, which is likely to be related to such lifestyle factors. Hence, this study can only identify a potential statistical association between exposure to incinerators or crematoriums (modelled by a function of distance) and adverse pregnancy outcomes. We cannot establish the biological plausibility of these findings given the lack of detailed emissions data. Further studies are now required using actual pollution levels around crematoriums and incinerators to investigate the biological plausibility of our findings.

We undertook a large number of comparisons and hence it is possible that some of the significant results may be chance findings, arising through multiple significance testing. However, our results of raised risk of stillbirth, congenital heart defects, and neural tube defects were generally consistent between time periods and sensitivity analysis showed they were robust, which lessens the probability of them being chance findings. As with all geographically based studies, there was potential for confounding with lifestyle and sociodemographic risk factors that were not included in the analysis, although we were able to adjust for individual level socioeconomic status, which has not been possible in many other studies.

Comparison with other studies

Although several studies have considered pregnancy outcomes for mothers living close to hazardous waste and municipal landfill sites,[11–13 17 33 34] there is a paucity of epidemiological data concerning pregnancy outcomes around incinerators and crematoriums with which to compare our study. Our finding of an increased risk of lethal congenital anomalies, in particular neural tube defects and congenital heart defects, in babies born close to incinerators is consistent with the results of some studies of congenital anomalies around hazardous waste and municipal landfill sites[11–13] but not with others.[17 18] Nevertheless, our findings need to be interpreted cautiously, as both the pollutants and exposure pathways associated with these sources differ. While incinerators are sources of a range of chemicals, including some also emitted by hazardous waste and municipal landfill sites, they also emit dioxins, heavy metals, and particulates.[31] Furthermore, the exposure pathways from incinerators and landfill sites are different[32 33 35]: exposure of humans to landfill pollution results from water supply contamination, groundwater run off, and atmospheric contamination from landfill gases,[12 13] whereas pollutants from incinerators are primarily dispersed atmospherically.

Although incinerators and crematoriums in Cumbria were located in urban areas, there were so few in operation that only 10% of the Cumbrian birth cohort were born within 2 km of an incinerator or crematorium, in contrast with the finding by Elliott *et al*[12] that 80% of the population in England and Wales live within 2 km of a landfill site.

Conclusions

We found an increased risk of lethal congenital anomaly (specifically spina bifida and heart defects) in relation to proximity to incinerators and an increased risk of stillbirth and anencephalus in relation to proximity to crematoriums. In view of the scarcity of published data and our use of a distance function to represent potential exposure it is difficult to assess whether these statistical associations reflect a causal effect. Further investigations using actual pollution levels and high quality data, including lethal and non-lethal outcomes in term pregnancies and elective terminations, are required. Sufficient investment must be made in national registration systems to ensure these issues can be investigated adequately. The UK system for registration of congenital anomalies is known to be incomplete and this severely restricts its credibility.[36]

ACKNOWLEDGEMENTS

We thank Mr Julian Smith and Mrs Jane Saloth for continuing maintenance of the Cumbrian Births Database and Mrs Katharine Kirton

for secretarial assistance. We thank Dr Martin Ward-Platt for advice on the categorisation of deaths.

....

Authors' affiliations

T J B Dummer, H O Dickinson, L Parker, School of Clinical Medical Sciences, Paediatric and Lifecourse Epidemiology Research Group, Department of Child Health, University of Newcastle, Sir James Spence Institute, Royal Victoria Infirmary, Newcastle upon Tyne, UK

Funding: the authors are grateful to Newcastle Hospitals Special Trustees for funding the project and to the North of England Children's Cancer Research Fund for ongoing support.

Conflicts of interest: none.

REFERENCES

1 **Schuhmacher M, Domingo JL, Xifro A,** *et al*. Presence of dioxins and furans in vegetation samples collected in the neighbourhood of a municipal solid waste incinerator. *J Environ Sci Health A* 1998;33:195–212.
2 **Sakai SI, Hayakawa K, Takatsuki H,** *et al*. Dioxin-like PCBs released from waste incineration and their deposition flux. *Environ Sci Technol* 2001;35:3601–7.
3 **Mills A.** Mercury and crematorium chimneys. *Nature* 1990;346:615.
4 **Maloney SR, Phillips CA, Mills A.** Mercury in the hair of crematoria workers. *Lancet* 1998;352:1602.
5 **Mocarelli P, Gerthoux PM, Ferrari E,** *et al*. Paternal concentrations of dioxin and the sex ratio of offspring. *Lancet* 2000;355:1858–63.
6 **Mukerjee D.** Health impacts of polychlorinated dibenzo-p-dioxins: a critical review. *J Air Waste Manag Assoc* 1998;48:157–65.
7 **Staessen JA, Nawrot T, Den Hond E,** *et al*. Renal function, cytogenetic measurements, and sexual development in adolescents in relation to environmental pollutants: a feasibility study of biomarkers. *Lancet* 2001;357:1660–9.
8 **Crews D, Willingham E, Skipper JK.** Endocrine disruptors: present issues, future directions. *Q R Biol* 2000;75:243–60.
9 **Larkin M.** Public-health message about dioxins remains unclear. *Lancet* 1999;353:1681.
10 **Watanabe S, Kitamura K, Nagahashi M.** Effects of dioxins on human health: a review. *J Epidemiol* 1999;9:1–13.
11 **Vrijheid M, Dolk H, Armstrong B,** *et al*. Chromosomal congenital anomalies and residence near hazardous landfill sites. *Lancet* 2002;359:320–2.
12 **Elliott P, Briggs D, Morris S, de Hoogh C,** *et al*. Risk of adverse birth outcomes in populations living near landfill sites. *BMJ* 2001;323:363–8.
13 **Dolk H, Vrijheid M, Armstrong B,** *et al*. Risk of congenital anomalies near hazardous-waste landfill sites in Europe: the EUROHAZCON study. *Lancet* 1998;352:423–7.
14 **Goldman LR, Paigen B, Magnant MM,** *et al*. Low birthweight, prematurity and birth defects in children living near the hazardous waste site, Love Canal. *Haz Waste Haz Mat* 1985;2:209–23.
15 **Geschwind SA, Stolwijk JAJ, Bracken M,** *et al*. Risk of congenital malformations associated with proximity to hazardous waste sites. *Am J Epidemiol* 1992;135:1197–207.
16 **Berry M, Bove F.** Birthweight reduction associated with residence near a hazardous waste landfill. *Environ Health Perspect* 1997;105:856–61.
17 **Croen LA, Shaw GA, Sanbonmatsu L,** *et al*. Maternal residential proximity to hazardous waste sites and risk for selected congenital malformations. *Epidemiology* 1997;8:347–54.
18 **Skakkebaek NE, Rajpert-De Meyts E, Main KM.** Testicular dysgenesis syndrome: an increasingly common developmental disorder with environmental aspects. *Hum Reprod* 2001;16:972–8.
19 **Hu SW, Shy SM.** Health effects of waste incineration: a review of epidemiologic studies. *J Air Waste Manag Assoc* 2001;51:1100–9.
20 **Hunter M.** Public health concerns grow over foot and mouth outbreak. *BMJ* 2001;322:881.
21 *Local Government Act 1972*, Schedule 1 page 236. London: HMSO, 1972.
22 **Parker L, Smith J, Dickinson HO,** *et al*. The creation of a database of workers at a nuclear facility - an exercise in record linkage. *Appl Occup Environ Hyg* 1997;12:40–5.
23 **Dummer TJB, Dickinson HO, Pearce MS,** *et al*. Stillbirth risk with social class and deprivation: no evidence for increasing inequality. *J Clin Epidemiol* 2000;53:147–55.
24 *Births and Deaths Registration Act 1953*. London: HMSO, 1953.
25 *Stillbirth (Definition) Act 1992*. London: HMSO, 1992.
26 **Dickinson HO, Parker L, Harris D,** *et al*. Audit of ascertainment of deaths to children born in Cumbria, UK, 1950–89 through the NHS Central Register. *J Epidemiol Community Health* 1997;51:436–42.
27 **Alberman E, Botting B, Blatchly N,** *et al*. A new hierarchical classification of causes of infant deaths in England and Wales. *Arch Dis Child* 1994;70:403–9.
28 **Royal Mail Postcode Services.** *Postzon*. Portsmouth: National Postcode Centre, 1992.
29 **Office of Population Censuses and Surveys.** *Standard Occupational Classification Volumes 1, 2, 3*. London: HMSO, 1990.
30 **Environmental Systems Research Institute.** *Arc/Info version 7.0.3*. California: Environmental Systems Research Institute, 1995.
31 **Hinshaw GD, Trenholm AR.** Hazardous waste incineration emissions in perspective. *Waste Management* 2001;21:471–5.
32 **Aspinwall and Company.** *The Sitefile Digest: a digest of authorised waste treatment and disposal sites in Great Britain*. Shrewsbury: Aspinwall and Company, 1991.
33 **Botting B,** ed. *The health of our children*. OPCS Decennial supplement. London: HMSO, 1995.
34 **Hosmer DW,** Lemeshow S. *Applied logistic regression*. New York: Wiley, 1989.
35 **Royall RM.** Model robust confidence intervals using maximum likelihood estimators. *International Statistical Review* 1986;54:221–6.
36 **Northern Region Health Authority.** *Regional fetal abnormality and perinatal mortality surveys. Collaborative survey of perinatal, late neonatal and infant death in the Northern Region*. Newcastle upon Tyne: Northern Region Health Authority, 1989.
37 **Shaw GM, Chulmon PH, Frisch JD,** *et al*. Congenital malformations and birthweight reduction in areas with potential environmental contamination. *Arch Environ Health* 1992;47:147–53.
38 **Marshal EG, Gensburg LJ, Deres DA,** *et al*. Maternal residential exposure to hazardous wastes and risk of central nervous system and musculoskeletal birth defects. *Arch Environ Health* 1994;49:416–25.
39 **Working Group of the Registrar General's Medical Advisory Committee.** *The OPCS monitoring system for congenital malformations*. London: Office of Population Censuses and Surveys, 1995. (Occasional paper 43)

SECOND SCHEDULE

1. The development shall be carried out in accordance with the plans and particulars lodged with the application as amended by the particulars received by the planning authority on the 7th and 27th days of June, 2001 and the 23rd day of July, 2001, and in accordance with the provisions of the Environmental Impact Statement as amended, except as may otherwise be required in order to comply with the following conditions.

   Reason: In the interest of clarity.

2. Appropriate arrangements for the connection of the proposed waste to energy facility to the E.S.B. National Grid transmission lines and the diversion of the 110 kV overhead power lines traversing the application site, to the satisfaction of the planning authority, shall be in place prior to commencement of development.

   Reason: In the interest of orderly development.

3. **The proposed community recycling park shall be omitted and the area shall be landscaped in accordance with the requirements of the planning authority.**

   Reason: It is considered that this aspect of the proposed development, which is to serve a local need only and would attract unnecessary car-borne traffic, would more appropriately be located in the local population centre of Duleek.

4. Waste for acceptance at the waste management facility for incineration and recycling/treatment shall be strictly limited and confined to waste generated and produced in the North East Region area of counties Meath, Louth, Cavan and Monaghan. The annual tonnage for thermal treatment/recycling shall not exceed the quantities as identified in the Environmental Impact Statement on an annual basis, that is, 170,000 tonnes per annum.

   Each and every consignment of waste, howsoever arriving at the waste management facility, shall be accompanied by a waste certificate, which shall identify the following –

   - Waste origin, source and area in which it was produced/generated.
   - Waste collection schedules.
   - Weight of each consignment.
   - Waste collection contractor name and address.
   - Composition and nature of waste.

   The developer shall submit to the planning authority, on a monthly basis, records of all waste delivered to the site on a daily, weekly and monthly basis, in accordance with the aforesaid waste certificate.

   Reason: In the interest of development control and to ensure that the principles of regional waste management as set out in the Regional Plan are adhered to.

7

epa Environmental Protection Agency	OFFICE OF LICENSING & GUIDANCE
TO:	Directors
FROM:	Patrick Nolan, Programme Manager - **LICENSING UNIT**
DATE:	28 September 2004
RE:	Indaver Ireland waste licence application. Reg. No. 167-1

1 Please see attached draft report that was prepared by Mr. Peter Carey prior to leaving the Agency. The recommendation attached to his report is included in the documentation before the Board along with the application and all submissions and correspondence associated with the application. He has also attached a copy of An Bord Pleanala decision for information purposes.

2 It should be noted that Mr. Carey considered all the documentation in relation to this application received by the Agency at that date. In carrying out his examination of the application he found it to be in compliance with the requirements of the Licensing Regulations. He also assessed the Environmental Impact Statement (EIS) submitted with the application and found it to be in compliance with the EIA and Licensing Regulations. The Agency confirmed that the application and EIS was in compliance with the licensing regulations by notice dated 1st August 2003.

3 I have read Mr. Carey's report and recommendations and in my role as manager of the licensing unit I have reviewed them in accordance with existing procedures for submissions to the Board. I also discussed his report and recommendation with Mr. Carey before he left the Agency.

4 I attach a Recommended Decision that I have prepared in consultation with senior licensing personnel within the licensing unit. This RD incorporates most of the conditions set out in Mr. Carey's recommendation. The Recommended Decision is in a revised format and Annex 1 gives a general overview of its structure.

5 I also wish to confirm that the recommendation has been drafted in compliance with National and European legislation having particular regard to the Waste Management Acts, Waste Licensing and EIA Regulations and Directive 2000/76/EC [WID] of the European Parliament and of the Council of 4th December 2000 on the incineration of waste.

6 The following comments relate to matters raised in Mr. Carey's report.

Waste Types and Quantities

The overall capacity limit for the incineration plant is set at 150,000tpa. Having regard to the limited information available and requirements of the WID in relation to the classification and coding of waste I am of the view that this should be confined to Municipal waste.

Residues from the Waste to Energy/ Incineration Plant
The monitoring of waste residues at the plant is essential in order to establish the physical and chemical characteristics and polluting potential of the different waste residues. Having regard to the activity involved I recommend that the frequency of monitoring be revised as set out in the following schedule.

Waste Description	Parameters to be measured	Frequency Note 1
Bottom ash, Boiler ash	TOC, metals (Ba, Cd, Mo, Sb, Se, Zn, Tl, Hg, Pb, Cr, Cu, Mn, Ni, As, Co, V, Sn) and their compounds, chloride, fluoride, sulphate, dioxins/furans and dioxin-like PCBs.	Quarterly
Flue gas, Gypsum	TOC, metals (Ba, Cd, Mo, Sb, Se, Zn, Tl, Hg, Pb, Cr, Cu, Mn, Ni, As, Co, V, Sn) and their compounds, chloride, fluoride, sulphate, dioxins/furans and dioxin-like PCBs.	Biannually

Note 1. The monitoring frequency may be adjusted once the waste composition has been determined and is consistent over a reasonable period.

I think it is a misreading of the application to suggest that the applicant proposed a weekly frequency to the above monitoring.

Facility Development and operation.
The provision of a wheel wash should not be necessary given that the working areas of the facility will primarily be of impervious hardstand type. While this licence does not seek to control the construction phase of this facility there are a limited number of conditions which specify design factors that must be taken into account during the construction phase of the development.
The incineration plant will be run on a continuous basis while waste acceptance hours will be restricted. The waste acceptance hours should be adequate to provide for a sufficient quantity of waste to be accepted at the facility in order to allow the plant operate during periods when waste cannot be accepted. The receiving bunkers have been sized accordingly.

Emissions to Air.
The necessary procedures have been followed with regard to increasing the stack height. The emission limit values specified in Directive 2000/76/EC of the European Parliament and of the Council of 4th December 2000 on the incineration of waste are set in the licence. As pointed out by Mr. Carey the abatement system proposed should ensure that typical emissions will be considerably less than the proposed limits.
The emissions from incineration of waste are made up of a number of different parameters. The WID seeks to identify those parameters that must be limited and monitored. It should be noted that it does not seek to set ELVs for each parameter specified in the group but rather sets a limit for the combined emissions of all in the group. It is the combined effect of these parameters that the Directive is seeking to control. For that reason I do not think it necessary to specify an ELV for one particular parameter of the group, in this instance arsenic, as it is already built into the group ELV limit.
As pointed out in Mr. Careys report air-dispersion modelling of the predicted emissions indicates that they will not breach the air quality standard set by Directive

1999/30/EC. That being the case and having regard to the fact that there is no European or WHO standards or guidelines for $PM_{2.5}$. There does not appear to be any justification for the requirement to monitor for $PM_{2.5}$ or to determine the particulate distribution.

Emissions Monitoring

Mr. Carey recommends that the following condition be included in the licence

> *8.19 Prior to commencement of waste activities, the licensee shall consult with the Food Safety Authority of Ireland regarding monitoring of the food chain and submit to the Agency for its agreement, recommended monitoring of the food chain to take place prior to commencement of waste activities or/and during operation of the facility.*

The purpose of this condition is to seek to establish if there will be any impact on the quality of the food chain from emissions from the facility. It is generally accepted that the principal mechanism of environmental release of dioxins in this country is by low-level emission from multiple sources to the atmosphere. It is reasonable to assume, therefore, that the primary mechanism for entering the food chain is through atmospheric deposition. Cow's milk is considered to be a particularly suitable matrix for assessing the presence of dioxins in the environment as cows tend to graze over relatively large areas and these compounds will, if present, concentrate in the fat content of the milk. In this context it should be noted that the Agency has already put in place a monitoring regime for measuring the background levels of dioxins in milk and that the Carranstown area has been included in this programme. The approach adopted is to take samples from the region as well as samples from tankers serving the potential impact area. Sampling is by EPA personnel while analysis is by a reputable and certified laboratory. The monitoring of milk is considered to be one of the best means of assessing the impact of dioxins in the food chain and has, I understand, been adopted as a monitoring tool by other EU member states. In these circumstances I do not consider it necessary to provide for additional monitoring. The milk survey or limited elements of it in this area should be repeated annually.

Groundwater

There is no discharge to ground authorised in the licence other than the emission from the septic tank treating sanitary waste only. All material and waste held on site will be on impermeable surfaces or specially engineered concrete structures that will eliminate the possibility of any discharge to ground. The provision of monitoring wells and monitoring of groundwater as recommended should be more than adequate to evaluate the impact, if any, the activity is having on groundwater quality. The activity will involve the abstraction of $470m^3$/day and the RD provides for the provision of alternative supplies if anyone is adversely affected by the abstraction.

Ash Handling and monitoring

The storage of waste from the incineration process is specifically addressed by the conditions in the RD. Its removal off site is subjected to strict criteria and verification as to its classification and associated coding in the Waste Catalogue. Only permitted contractors will be allowed to transport waste off site and it will only be sent to a facility that is authorised to accept such waste.

Legal status of application
The application and EIS has been evaluated and found to be in compliance with the national legislation. The transposition of EU Directives is primarily a matter for the Government. The reasoned opinion referred to in Mr. Carey's report is not accepted by the sponsoring Department.

Recommendation
I consider that the requirements of section 40 (4) of the Waste Management Acts 1996 to 2003 have been satisfied and recommend that the Board approve the attached Recommended Decision.

Programme Manager
Licensing Unit

Annex 1

The structure of attached recommended decision is as follows

Condition 1 Scope: -

This condition identifies and prescribes the site boundary, limits and restricts the type and tonnage of waste that can be accepted and processed at the facility.

Condition 2 Management of the Facility: -

This condition provides for management of the facility and the putting in place of Environmental Management Systems that includes a communication programme with the public.

Condition 3 Infrastructure and operation: -

This condition ensures that the appropriate infrastructure is in place, specified hours of operation, requires the putting in place of measures and procedures for the operation and control of the incineration plant.

Condition 4 Interpretation: -

This condition provides the interpretation as to the monitoring to be carried out and the standardisation of certain measurement results.

Condition 5 Emissions: -

This condition specifies the limitation on emissions from the facility.

Condition 6 Control and Monitoring: -

This condition specifies monitoring parameters, frequencies, equipment, analysis methods and locations together with the establishment of certain monitoring procedures.

Condition 7 Resource Use and Energy Efficiency: -

This condition requires the identification of opportunities to increase the overall energy efficiency of the facility and the reduction in use of water and other raw materials.

Condition 8 Materials Handling: -

This condition requires the procedures for the acceptance, removal and handling of waste together with the segregation and storage of certain wastes from the incineration process.

Condition 9 Accident Prevention and Emergency Response :-

This condition puts in place policies and procedures for dealing with accidents and emergencies on site and

Condition 10 Remediation, Decommissioning, Restoration and Aftercare.

This condition requires the putting place of a decommissioning and aftercare plan and for the site to be rendered safe with the removal of any waste that may cause environmental pollution.

Condition 11 Notification, Records and Reports :-

This condition provides for the keeping of certain records on site, the notification of the Agency of monitoring results or accidents on site and the submission of specified reports at various intervals.

Condition 12 Financial Charges and Provisions

This condition specifies the annual charge to be paid to the Agency, the carrying out of an environmental liabilities risk assessment and the putting in place of financial provisions to deal with accidents and emergencies. A community support and development fund is also to be provided for the benefit of the local community.

Schedule A ***Limitations***

This sets out the waste types and tonnage limits to be accepted at the facility.

Schedule B ***Emission Limits***

This sets the emissions limit values for specified parameters.

Schedule C ***Control and Monitoring***

This specifies the process control parameters to be monitored and associated equipment. It also lists the emission parameters to be monitored, the frequency of same and the analysis method to be used.

Schedule D ***Annual Environmental Report***

This details the contents of the Annual Environmental Report.

8

INCINERATION OF HOUSEHOLD WASTE

- ***Possible increase in waste incineration***
- ***Concerns over pollution***

Recent national waste strategies have led to the suggestion that the numbers of waste incinerators may increase significantly. This raises concerns over the health effects of pollution and the role of incineration in waste management.

POST 149
Post Note December 2000

BACKGROUND

Each year UK households generate around 30 million tonnes of municipal solid waste (MSW)[1] (Table 1). The Department of the Environment, Transport and the Regions (DETR) reports that this figure appears to be growing at about 3% per year. Management of MSW in the UK is dominated (83%) by landfill disposal (Table 1), with less than one tenth either incinerated or recycled[2].

There are 13 MSW incinerators (MSWIs) operating in Britain (there are none in Northern Ireland), burning around 2 million tonnes of MSW each year (8% of the total). All MSWIs recover some of the energy from combustion as electricity or in district heating. As such, these facilities are known as 'energy from waste' (EfW) or 'waste to energy' plants. Current facilities range in size from a plant in Lerwick, handling 26,000 tonnes per year (26kt/yr) and producing heat for a local district heating system to a 600kt/yr facility at Edmonton, generating 30 megawatts (MW) of electricity. Over half of all current incinerators handle more than 200kt/yr, and 40% between 100 and 200kt/yr.

MSWIs operate by feeding wastes onto a moving grate where they are burned. The heat generated raises steam, driving turbines to generate electricity. The burning of the waste gives rise to:

- solid **incinerator bottom ash** (up to 25% of the weight of the MSW) - which falls to the bottom of the grate for collection. This is either disposed of to landfill or reused in construction.
- a very much finer **fly ash**, caught up in the **flue gases** (air and gaseous combustion products).

Box 1 outlines the current technology for waste incineration, and the main developing technologies. Information provided by the Energy from Waste Association (EWA) shows that additional incinerator capacity of ~4 million tonnes/yr is currently being considered - more than doubling existing capacity (**Table 2**).

[1] The total for municipal, industrial and commercial wastes is ~70 million tonnes
[2] many countries recycle and incinerate a larger proportion of waste than the UK.

TABLE 1 WASTE TREATMENT IN THE UK

Region	MSW (million tonnes/yr)	Landfill	Recycling and reuse	Incineration
England & Wales	28	82%	10%	8%
Scotland	3	90%	5%	5%
N. Ireland	1	95%	5%	0%
Total	**32**	**83%**	**9%**	**8%**

Sources: DETR, Scottish Environment Protection Agency, Environment and Heritage Service Northern Ireland

BOX 1 WASTE INCINERATOR TECHNOLOGY

There are four main technologies for the incineration of waste.

Mass Burn – This is currently the simplest and most common form of incineration. Mixed wastes are fed into a hopper and then fall onto a sloping grate which agitates and moves the waste through the combustion chamber. Energy is recovered from the hot combustion gases, which is used to generate around 7MW of electricity per 100,000 tonnes of waste (enough electricity to serve around 10,000 homes).

Fluidised Bed Combustion (FBC) – Before the waste is incinerated, non-combustible components are removed and the waste shredded to produce coarse Refuse Derived Fuel (cRDF) which has a higher calorific value than the untreated waste. The cRDF is fed into a bed made up of a mixture of sand and dolomite mineral. Air is pumped through the base so that the solid waste and minerals resemble a bubbling liquid. This 'fluidisation' improves the combustion efficiency, hence reducing pollution and generating more energy per tonne of waste. However, the process is between 25% and 35% slower than mass-burn. To date there has been limited experience with using FBC for municipal waste incineration, and the performance of this technology has not been proven on a commercial scale. In Berlin, a new FBC waste incinerator has been closed down because of reliability problems.

Pyrolysis and Gasification – These novel technologies have had limited experience in treating municipal waste. Wastes do not need sorting, but must be crushed, and this pre-treatment leads to higher costs and uses more energy.

- **Pyrolysis** involves heating waste in the absence of oxygen at temperatures of 400-800°C. The heat alone breaks down complex molecules and the resultant gases are then passed into a combustion chamber where they are burned (in the presence of oxygen) at temperatures around 1250°C.
- **Gasification** involves heating wastes in a low-oxygen atmosphere to produce a gas with a low energy content. This gas can then be burned in a turbine or engine.

There are only a few pilot pyrolysis and gasification plants worldwide - in Japan and Germany – but the technology has not yet been proven to be commercially viable. A pilot scale gasifier is being built in Bristol with a capacity to burn 9kt/yr of MSW.

POLLUTANTS FROM INCINERATION

The main pollutants of concern are dioxins, acid gases, nitrogen oxides, heavy metals and particulates (**Box 2**). These are present in bottom ash, fly ash and combustion gases[3], although flue gas cleaning reduces pollutant emissions to the air to a large extent. Fly ash can contain sufficient dioxins and metals to require it to be treated as a

[3] There are also pollutants present in liquid effluents arising from gas cleaning and ash cooling equipment.

the classification of energy from waste as a form of renewable energy – this is highly contentious, but is beyond the scope of this briefing.

Regulatory Issues

The role of the environmental regulator

The potential impacts of pollutant releases on health raise concerns, most often related to whether there is a 'safe' dose of dioxins. While the International Agency on Cancer Research (IARC) classifies dioxin as carcinogenic to humans, uncertainty remains over how dioxin causes cancer, and at what level it may be carcinogenic or have other effects. Recognising this uncertainty, the EU adopted a precautionary approach in setting the dioxin emission limit value. But, this level has not been set on the basis of an assessment of what might be considered a 'safe' dose – i.e. it is not related to any specific TDI (Box 3). Instead, the limit was set so that reliable measurements can be made by available detection equipment.

This means that regulating emissions relative to the emission limit does not guarantee that emissions are at a safe level. Rather, regulation to protect health has to rely on mathematical models of the dispersion, deposition and uptake of dioxins, and the consequent levels of exposure in relation to the TDI. Each element in the model relies on assumptions and can introduce large uncertainties. This raises concerns over whether the setting and enforcement of standards, and process authorisation fulfil the Agencies' requirement to protect human health. However, modelling worst-case situations helps to take account of many uncertainties.

Critics of incineration have suggested that more than 500 deaths would be brought forward over the operating life of an incinerator. However, this figure has now been shown to be erroneously too high[14]. Even so, such an analysis, based on extrapolation of the COMEAP report would not produce an accurate figure for any specific incinerator, as it does not take account of local conditions, such as the:

- location of pollutant sources and those receiving the pollution.
- the pathways of exposure (e.g. the transport of dioxins through the food chain).
- how susceptible people are to particular pollutants (e.g. the old, young or infirm).

[14] following recalculation by consultants of the cost-benefit analysis in the DETR's Regulatory and Environmental Impact Assessment on the Proposed Waste Incineration Directive.

BOX 4 INCINERATOR PLANNING AND THE PUBLIC

Examples of including the public in decision-making include:

- **Dundee Energy Recycling Ltd** has signed the UK's first 'Good Neighbour Charter' committing the company to adopting environmental standards stricter than currently required by law.
- the **SELCHP** incinerator in southeast London, involved local people working with the developers and planners, and a member of the local community sits on the management board.
- Following a previously failed plan, **Hampshire County Council** set up a number of citizens' panels to examine issues related to waste in the county and has worked with them to develop a mix of options that includes composting, recycling and small-scale incineration. This plan has met with wider public acceptance.

The role of local authorities

Local authorities produce statutory 'waste local plans', act as waste collection authorities, waste disposal authorities, and as local planning authorities. The Local Government Association (LGA) and the Planning Officers Society have expressed concerns that there is very poor coordination between these functions. This can be particularly acute where these responsibilities are split between counties (waste planning) and districts (collection, disposal and land use control).

Public Concerns and Acceptability

Local opposition to incinerators is often strong. Concerns arise over whether an incinerator is:

- justified in relation to reduction, reuse and recycling of wastes.
- sited and sized appropriately – e.g. if it deals only with wastes originating locally, and if it is located in a deprived area (raising issues of environmental justice).
- regulated to sufficient environmental standards, and that these standards are enforced adequately – i.e. whether the regulator can be trusted as independent and competent.

Such concerns are frequently characterised as NIMBYism (Not in My Back Yard). However, research shows that people's concerns often stem from the way that MSWIs are planned and consultation conducted. In particular, opposition arises when people feel excluded from decision-making and have decisions imposed upon them. Acceptability is increased if local people are involved early in planning (Box 4), including in the regional and waste local planning process. The DETR makes this point in recent guidance, and is fully supported by the LGA and the EWA, who now regard this process as the 'norm'.

Copy

All Correspondence to:

No.10 Boyne Shopping Centre
Patrick Street
Drogheda
Co. Louth

Tel: (041) 9842275
Fax: (041) 9870282

Dr Mary Kelly, Director General
EPA Headquarters
PO Box 3000
Johnstown Castle Estate
Co. Wexford

10/01/2005

Dear Dr Kelly,

I am writing to you concerning your decision to hold oral hearings into the planned incinerators at Carronstown, Duleek County Meath and in County Cork.

The key concern I have is regarding the Health Effects of Incineration. I refer to the report of the Health Research Board "Effects on Public Health and the Environment of Landfill and Thermal Treatment of Waste" which found that Irish health information systems cannot support routine monitoring of the health of people living near waste sites and points to a lack of baseline human health data at national regional and county level. In the absence of such systems I believe that the decision to grant this license is certainly premature.

I believe that it is now absolutely essential to hold your oral hearing into all health aspects of this application in the presence of the most eminently qualified International experts on the Health and Environmental Effects of Incineration.

I understand that The Environmental Protection Agency has no qualified Health Professional on its staff and did not commission an independent professional report from suitable qualified Health Specialists in relation to this specific proposal notwithstanding the great public concern locally about this matter.

I note form the report of Mr Patrick Nolan Programme Manager EPA that he changed in two material respects the recommendation of the EPA Inspector Mr Peter Carey.

Mr Carey notes on page 12 of his report The Food Safety Authority of Ireland paper on Waste Incineration and possible contamination of the food supply with dioxins which states "that it is vital however that rigorous monitoring programmes be maintained and that consideration be given to expanding environmental monitoring around any incineration facitities."

Mr. Carey then recommends that the following condition be included in the licence *8.19 Prior to commencement of waste activities, the licensee shall consult with the Food Safety Authority of Ireland regarding monitoring of the food chain and submit to the Agency for its agreement, recommended monitoring of the food chain to take*

Dáil Éireann
Leinster House
Kildare Street
Dublin 2

Dáil Éireann
Teach Laighean
Sráid Chill Dara
Baile Átha Cliath 2

All Correspondence to:

No.10 Boyne Shopping Centre
Patrick Street
Drogheda
Co. Louth

Tel: (041) 9842275
Fax: (041) 9870282

place prior to commencement of waste activities or/and during operation of the facility

This recommendation was overruled by the Programme Manager.

The Inspector's recommended monitoring frequency of Bottom Ash, and Boiler Ash of some waste residues at the plant was changed from a weekly frequency to Quarterly and the monitoring of the Flue Gas and Gypsum was changed from weekly monitoring to Biannually monitoring.

I am very concerned also about the fact that County Louth and Drogheda in particular (which is very close to Carronstown) presently has the highest rate of Cancer in the Country.Accordingly I believe that it is in the public interest that the EPA exercise their option to have present at this hearing expert witnesses and advisors from the World Health Organisation and also to have present experts from the Food Safety Authority of Ireland.

Yours Sincerely

Fergus O'Dowd TD

Dáil Éireann
Leinster House
Kildare Street
Dublin 2

Dáil Éireann
Teach Laighean
Sráid Chill Dara
Baile Átha Cliath 2