THE ROYAL SOCIETY

Policy document 10/04

Royal Society's review of DEFRA's report on the environmental and health effects of waste management

November 2003

Summary

This study addresses important issues that have significant implications for the complex subject of waste policy. The authors of the report and our review group have done a considerable amount of work to bring this information together and produce this report in the short time available. In our view, the research has been comprehensive and the results are presented objectively. The collation of the data in this report is valuable but as detailed below will require further analysis before it can become the basis for making policy.

We believe that the report has significant limitations that restrict its usefulness to those making policy decisions. These limitations concern what is missing from the report and, in some places, the use made of the data reported. In particular:

- A lack of life cycle framing in this study means that any comparison of the waste management options is incomplete. No consideration is made in the results of the effects of activities displaced by recovering materials or from generating energy from the waste.
- In view of the large uncertainties associated with some of the data examined, particularly in the epidemiological studies, it would have been more appropriate to adopt a cautious approach, rather than use inadequate data in a quantitative framework. The latter may give a misleading impression of the robustness of the results.
- Caveats associated with the uncertainties in the results are not presented adequately, particularly in the quantification of the health effects, which could mislead the reader.
- The report's relevance to waste management decision-making by Local Authorities is limited, as several important issues are not addressed. These include the effect of local environmental and health sensitivity to pollutants and the impact on emissions of specific waste management activities operating under non-standard conditions.
- Bias in the availability of good quality information means the report concentrates mainly on the effects of air pollution. Consideration of the potential effects of exposure to pollutants through other pathways is not consistent throughout the report and therefore prevents adequate comparison of the options.
- Little discussion is presented as to how technological, legislative and scientific advances have affected, are affecting and will affect the management of waste in the future.

Given our concerns listed here and discussed in detail below, we recommend that this report should only be used for information and in conjunction with other reports and decision making tools that adopt a life cycle approach, such as the Environment Agency's software package WISARD (Waste integrated systems for recovery and disposal).

The Royal Society's involvement

In response to an approach from DEFRA to provide an independent peer review of this report, the Royal Society put together a working group comprising Professor Richard Perham FRS, Professor Nigel Bell, Professor Roland Clift OBE FREng, Professor Peter Guthrie OBE FREng, Professor Virginia Murray, Professor Lewis Roberts CBE FRS and Dr Lesley Rushton. The group were asked to comment on the report's

comprehensiveness, familiarity with new science, objectivity and general robustness. We were not consulted regarding the study's terms of reference. This document has been approved on behalf of the Royal Society Council by Professor Sir John Enderby CBE FRS, Vice President and Physical Secretary. We welcome the fact that the Department for Environment and Rural Affairs is opening up the science information it receives to independent peer review.

Readership of the report

We recognise that this report is potentially a fundamental piece of work that has important implications for waste policy. The subject matter is complex and is hindered, as the authors recognise, by the lack of good quality studies. It is vital that the issues are addressed properly. The authors of the report suggest that it will be suitable for supporting waste management decisions at both a local and national level. However several omissions in the report (detailed below) mean it offers incomplete guidance to those making policy decisions on waste management strategies and is potentially misleading both for national policy and for local authorities. With regard to local concerns, and in addition to the misgivings detailed below, the report contains little discussion of the effect of emissions under non-standard conditions, which may be different from national averages, but are of vital local concern. Nor does it discuss the effect of local health and environmental sensitivity to the emissions.

We therefore recommend that this report should only be used for general information and be read alongside other relevant reports that take a broader life cycle approach, and which include the benefits that the various management options could provide, for example by offsetting emissions from other sources. The information in the report would be particularly useful to the Environment Agency's software package WISARD (Waste integrated systems for recovery and disposal), which enables life cycle evaluation of integrated waste management systems and is currently being updated, as the authors of the report themselves say.

Framing of the report

A major limitation to the report is the lack of a life-cycle approach to the various waste management options. We are surprised that the report has not been framed in the context of sustainable development using a life cycle approach when the *Waste Strategy 2000 for England and Wales* (DEFRA 2000) recognises the importance of such an approach in finding an overall, optimal, environmental solution for managing waste, without the risk that a decision will result in a worsening of the overall impact. Had the terms of reference, which were established before our involvement in the project, taken a life cycle approach, this report would have produced different results and allowed a better comparison of the options.

Without considering the wider issues of material and energy flows that a life-cycle approach would include, it is not possible to weigh up the full environmental and health impacts of the waste management options. For example, in Chapter 5 the results could be very different if the analysis had considered the particulates and arsenic emissions offset by incinerating Municipal Solid Waste (MSW) to generate electricity instead of burning coal. Similarly, restricting recycling to only the activities within the Material Recycling Facilities (MRF) fails to include the emissions from the reprocessing of the recyclable material and from transporting it to the recycling plant, which can be a considerable distance from the MRF. Excluding these wider considerations, and their implications on the environmental and health impacts, could lead the reader to a very skewed conclusion.

Bias of available information to air pollution

The report is mainly based on the health and environmental impacts of emissions to air, which might give the impression that impacts from alternative pathways, such as water, soil and food, are small when in fact there

is a lack of good quality information. The authors recognise this and recommend several new studies to address this deficit. It is crucial that these impacts are considered if an adequate comparison of the options is to be carried out and we feel that there is not enough discussion, throughout the report, of the potential health and environmental effects.

Uncertainties

The report is inconsistent in how it presents the many uncertainties inherent in the emission data and in the use of epidemiology. In several key areas, particularly with regard to the epidemiology, the uncertainties are frequently represented inadequately and appropriate caveats regarding their assumptions and limitations are lacking or not carried through to the rest of the report. The overall effect is that the report gives an apparently reassuring estimate of the impact of different waste management options, when in fact it does not present a complete or sufficiently critical summary of the evidence. In view of the large uncertainties associated with some of the data examined, it would have been more appropriate to adopt a cautious approach, rather than use inadequate data in a quantitative framework. These concerns are addressed in more detail below under Health impacts.

The effects on the data of using studies that include industrial, commercial and MSW, which contain substantially different quantities of degradable waste, are not discussed. For example, as the report acknowledges, MSW tends to be landfilled with other wastes including construction, demolition, commercial and industrial wastes, and sometimes with dredged material. As a significant part of these other wastes is inert and will not degrade, their presence may distort and potentially underplay the effect of MSW in these studies. This is important because if the true impacts were significant, MSW could conceivably be segregated, generating much smaller quantities that could then be dealt with using more specialist and effective techniques. Without consideration of these uncertainties and limitations in the data, the report fails to present a convincing summary of the evidence.

Although the report recognises that emissions from landfills will continue over a considerable time period and require long-term management, it makes little recognition of the changes in composition of the emitted landfill gases over time. The report does not make it clear how these changes are represented in the data or in the analysis.

Health impacts

We are particularly concerned about how uncertainties have been expressed in the quantification of the health impacts. The uncertainties in the data have been inadequately expressed in the results of the quantification and, more worryingly, data have been extrapolated to quantify the health impacts when the uncertainties demonstrate that this is inappropriate.

In particular we are concerned that in Chapter 4 the authors have extrapolated the results of the Elliott 2001 study to quantify the health outcomes when the Department of Health's Committee on Toxicity (COT 2001) concluded that it was inappropriate to draw firm conclusions on the health effects of landfill sites from this study, and that the results merited further investigation. Given the fact that the authors of this report reference the COT review of the Elliott 2001 research, we are surprised that they do not include COT's key concern that, because a study of this kind assumes that the population being measured is exposed to emissions from the landfill sites, it cannot demonstrate that the effects might be caused by other factors. Low and very low birth weights, in particular, could be related to inequalities or ethnicity, factors that have not been considered. In Chapter 3, the report provides several caveats regarding the quality of the data that Elliott uses, although the caveats are not comprehensive. For example, they do not mention that the congenital malformation register is recognised as being incomplete. Given that the authors are aware that a

causal link to landfill has not been demonstrated, it would have been better if they had not attempted the notional extrapolation to produce a national figure as it could be misinterpreted. In addition the caveats are not prominent where the quantification is undertaken in Chapter 4.

The report includes the results of a comparative modelling study of the health effects of emissions from different waste technologies, using a methodology that had been developed for incineration. The health impacts are calculated using dose-response coefficients derived from the work of COMEAP. (Committee on the Medical Effects of Air Pollutants). We are concerned that the uncertainties inherent in the data in Chapter 3 and in the methodology are inadequately expressed in the results and graphs in chapter 4 and in the authors' conclusions in Chapter 7. The authors ascribe an uncertainty factor of 30 to their estimates, but attempting to compare different options when the uncertainties are so large may be misleading. In addition the results include no consideration of the effects of activities displaced by recovering materials and/or energy from the waste. This makes Figures 4.1 to 4.6 particularly susceptible to misinterpretation, as the net effects in some cases will be reduced, while in others the uncertainties will range from negative to positive incremental effects. Appropriate caveats are particularly important when dealing with sensitive issues such as deaths brought forward. We also have reservations about whether the COMEAP methodology is applicable for this kind of analysis. The limitations to this methodology are expressed in COMEAP's own report in 1998 (COMEAP 1998).

The discussion of the epidemiological evidence in Chapter 3 (3.2.1) is also limited. Confounding factors and cancer latency are important but full comprehension of the potential health effects of the different options for waste management requires discussion of the susceptibility of populations to a particular health outcome and sensitivity to certain emissions, cumulative effects, timelines for exposure, effect of mixtures and synergies of emissions and the additive effects, for example, when combined with other environmental and occupational exposures. The latter is particularly important for workers involved in composting and material recycling facilities. Without consideration of these factors the report fails to recognise the limitations in the data.

Environmental Impact

The report makes a reasonable assessment of the uncertainties in the emission data and in the environmental effects. Recognition is made of the lack of information although the limited quantification of the impacts in Chapter 5 could give the impression that, in comparison with health, the impacts on the environment are small. Overall this may be true but as with the health impacts no mention is made of the synergistic and cumulative effects of emissions and the sensitivity of local areas for example Sites of Special Scientific Interest (SSSI). These are important considerations when considering the siting of a waste management facility.

Comparison of impacts and interpretation of the data are also made harder as the methodology is not always consistent and inclusive. For example, offset burdens of incineration and energy recovery are included only in consideration of impact on climate and not on air quality. Similarly, transport is included inconsistently and generally refers to movements of Heavy Goods Vehicles (HGV) with no reference to the movement of waste by rail and boat.

Future information needs

The report concentrates on current and historical waste management practices, at a time when the industry is changing. As the report acknowledges, changes in the legislation will mean a considerable increase in the amount of recycling and composting; however, those most affected by emissions from these processes are likely to be local residents as well as the workforce. The latter do not appear to be adequately considered in the report. Technological changes will also affect the waste management industry and may lead to

substantial changes in how current practices are regarded; for example, standards may become more stringent, as history would suggest. Improvements in landfill engineering and the segregation and handling of degradable wastes could have significant effect on the emissions produced.

Whilst we agree with the authors that more research is required, particularly to improve understanding of the causal links, we believe that all analysis of waste management must be framed in a life cycle context with more consideration of the implications of legislative, technological and scientific changes that have affected and will affect the waste management industry in the future.

We believe that there will be a continuing need to update work in this area. For example we would be pleased to see a research programme set alongside national and internationally published peer review data that recognises the need to reduce uncertainties. In our view it is essential to share this evolving information with decision makers and the public.

We have not reviewed the extended summary of this report on the environmental and health effects of waste management.

This review and our involvement in the study can also be found on the Royal Society web site: www.royalsoc.ac.uk. For further information please contact Richard Heap in the Science Advice Section, Royal Society, 6-9 Carlton House Terrace, London SW1Y 5AG. Email: science.advice@royalsoc.ac.uk.

References

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The revisions made by the authors of this report in response to the Royal Society's review of the previous version in November 2003 have been considered on behalf of the Royal Society by the chair of the Society's working group, Professor Richard Perham FRS, and by the chair of the Society's review panel and Vice-President, Professor Sir John Enderby CBE FRS. It has not been practicable to reconvene the full review panel to comment on the revisions.

The Royal Society is satisfied that a significant number of its concerns have been addressed.

Throughout our review we have stressed the need to clarify the uncertainties inherent in the data in this report and consider the implications this uncertainty has when evaluating the environmental and health effects of waste management. Although the uncertainties have been acknowledged in this report, it is important that anyone using these data takes adequate consideration of its inherent uncertainty.

In Section 1.1 the authors refer to a separate report prepared by Eftec and Enviros Consulting Limited for DEFRA on the economic costs and benefits of health and environmental effects of waste management. We have not seen or been asked to review this separate report. However we have been assured by DEFRA that it will give adequate consideration to the uncertainties inherent in the data on the health and environment effects.

We have not reviewed the extended summary of this report on the environmental and health effects of waste management.

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