Institution: Cardiff Metropolitan University
Unit of Assessment: A3 Allied Health Professions, Dentistry, Nursing and Pharmacy
Title of case study: The impact on the organic waste industry from research on workers' exposure to bioaerosols: Adoption of technical guidance
1. Summary of the impact (indicative maximum 100 words)

This case study is an illustrative example of the immediate and interim impact of our research with and for the organic waste industry. Specifically, it deals with effective management of the risk to the health of workers from exposure to bioaerosols. Led by Sykes, since 2006 a portfolio of research (both publicly available academic studies and confidential industrial reports) has been developed which led the Association for Organics Recycling (AfOR) to commission a technical guidance document for the composting industry in 2012. High-risk work activities and potential for harm to workers' health were identified, and recommendations on risk reduction strategies and good practice were made which have been endorsed by the Health and Safety Executive.

[Throughout this Impact Case Study, references to the underpinning research are numbered 1 to 6; sources to corroborate the impact are numbered 7 to 16.]

2. Underpinning research (indicative maximum 500 words)

The programme of research that underpins this Impact Case Study has been delivered by the Centre for Health, Safety and Environment at the Cardiff School of Health Sciences, Cardiff Metropolitan University. Led by **Sykes** (appointed in 1997 as a Lecturer – now the School's Director of Enterprise), the team of researchers includes **Jones K** (appointed in 1993 as a Senior Lecturer – now a Professor), **Karani** (appointed in 1994 as a Reader – now a Professor), **Belcher** (appointed in 1986 as a Senior Lecturer - now the Director of Learning and Teaching), **Allen** (appointed in 2007 as a Consultancy Assistant), **Morris** (appointed in 1995 as a Senior Lecturer – now a Reader), and **Wildsmith** (appointed in 1986 as a Senior Lecturer) who left the University in 2010.

The diversion of biodegradable waste from landfill is a major imperative in developing a sustainable waste strategy, yet there are potential occupational and public health risks from exposure to bioaerosols in the vicinity of commercial composting activities. Preliminary research (by Jones K) on inhalation of environmental dusts and airborne particles began in the early 1990s and predates the timeframe for this case study. It led, however, to an important study (also by Jones K, 3) on the cellular events linked to exposure to a bronchial inhalation challenge amongst pigeon breeders – an allergic pulmonary disease associated with exposure to inhaled organic agents. With an experimental design using an established protocol, the work showed empirically the hazardous nature of exposure to aetiological agents on a chronic basis. It also acted as a springboard for other empirical studies on allergenicity and respiratory conditions that also inform this Impact Case Study about bioaerosols.

Building on other research concerned with the effects on respiratory health of vehicle exhaust emissions (by Karani, 2), the occupational health effects of air pollution in working environments linked directly to the waste industry were advanced using real-time monitoring of volatile organic compounds. Data-capture techniques were replicated later in research with the composting industry that were able to accommodate variable levels of airborne pollutants at different sampling locations for different work-related functions.

Occupational health and safety research intended specifically for industrial and professional end-users has resulted in a major contribution to *Clay's Handbook of Environmental Health* (by Belcher and Wildsmith). Now in its twentieth edition, it is considered the definitive reference work for the environmental health practitioner. In the eighteenth edition the chapters on 'protection of persons', 'plant and systems' and 'toxic and dangerous substances' (1) provide an applied focus that has also informed the work of the Centre for Health, Safety and Environment, and specifically the research with the composting sector.

Together, these studies provided the platform for the sustained engagement with the composting industry upon which this Impact Case Study is predicated. An initial scoping study led to a scientific position statement by Sykes *et al*. (5) and identified knowledge gaps that existed in technical understanding and regulatory arrangements – which in turn compromised risk assessment and management of the potential risks arising from the dispersal of bioaerosols. A clear programme of work was set out for more focussed research into hazard characterisation, exposure assessment techniques and an evaluation of the existing risk control and mitigation measures.

The most significant contribution to the enhancement of occupational health of waste management workers is the research that reports exposure to dust, endotoxin and β(1-3) glucan at four different composting sites whilst fulfilling different work-related functions (4, 6). Endotoxin is a potent respiratory irritant but is both difficult and expensive to measure. The findings of this year-long research showed how concentration of airborne dust particles, which is much easier and less costly to measure, can be used as an indirect or proxy measure of endotoxin concentration. This work also made explicit the high-risk activities (e.g., manual sorting and screening of waste), seasonal variation in airborne pollutants, and the efficacy of vehicle filtration and air-handling systems.

3. References to the research (indicative maximum of six references)

The underpinning research for this Impact Case Study has been published in international peer-reviewed journals (2, 3, 5 and 6) characterised by being esteemed outlets for the publication of leading-edge research, peer-reviewed conference proceedings (4), and the leading industry practitioner handbook (1). For specific journals, the impact factor (IF) on 31st October 2013 is indicated, and, where known, the number of citations by the same date is also included.

1. Belcher, P. and Wildsmith, J.D. (1999). Chapters 25-32. In S. Battersby and W.H. Bassett (eds.) *Clay's Handbook of Environmental Health* (18th ed., pp. 462-530). London: Routledge.
2. Burr, M., Karani, G., Davies, B., Holmes, B.A. and Williams K.L. (2004). Effects on respiratory health of a reduction in air pollution from vehicle exhaust emissions. *Occupational and Environmental Medicine*, *61*, 212-218. DOI: 10.1136/oem.2002.003244 [IF: 3.215; Scopus citations: 21]
3. Reynolds, S.P., Jones, K.P., Edwards, J.H. and Davies, B.H. (1993). Inhalation challenge in pigeon breeder's disease: BAL fluid changes after 6 hours. *European Respiratory Journal*, *6*, 467-476. [IF : 6.355; Scopus citations: 15]
4. Sykes, P., Allen, J.A., Wildsmith, J.D. and Jones, K.P. (2009). An analysis of employee exposure to organic dust at large scale composting facilities. Journal of Physics: Conference Series 151, 012064. DOI: 10.1088/1742-6596/151/1/012064 Available from http://iopscience.iop.org/1742-6596/151/1/012064 [Google Scholar citations: 3]
5. Sykes, P., Jones, K.P. and Wildsmith, J.D. (2007). Managing the potential public health risks from bioaerosol liberation at commercial composting sites in the UK: An analysis of the evidence base. *Resources, Conservation and Recycling*, *52*, 410-424. DOI: 10.1016/j.resconrec.2007.05.005 [5-Year IF: 2.889; Scopus citations: 15]
6. Sykes, P., Morris, R.H.K., Allen, J.A., Wildsmith, J.D. and Jones, K.P. (2011). Worker exposure to dust, endotoxin and β-(1-3) glucan at four large-scale composting facilities in the UK. *Waste Management*, *31*, 423-430. DOI: 10.1016/j.wasman.2010.10.016 [5-Year IF: 2.926; Scopus citations: 6]

4. Details of the impact (indicative maximum 750 words)

This case study is an example of 'immediate impact' of our research that has informed policy and services linked to the health and well-being of composting workers. Specifically, the benefits to the industry are a reduction of the risk of harm, improved working conditions and control measures, enhanced prevention of illness and disease, and reduced criminal and civil litigation. There has also been a heightened awareness of related health risks. As a result, the medium and longer-term

social and economic impact will be fewer incidences of absence from work, gains in productivity through more effective working arrangements, and reduced statutory sick pay.

Composting is the recycling of organic waste such as vegetation and foodstuffs. It is a sector that has experienced rapid recent growth in order to reduce the amount of waste going to landfill. According to the Waste and Resources Action Programme, in 2012 there were 23 mechanical biological treatment facilities in the UK and over 300 composting sites. It is also known that there are a further 3000 sites that have exemptions under environmental permitting rules. The Health and Safety Executive have estimated that in 2006 across the UK there were more than 175,000 workers employed in the waste and recycling services industry.

As a large-scale commercial activity composting is carried out either in open windrows or enclosed systems and to encourage efficient composting effective aeration is required. In open windrows this is achieved by regular turning of the material which creates bioaerosols including human allergens and pathogens which affect respiratory health and may cause headaches, nausea and fatigue. In chronic cases bioaerosols can lead to asthma, alveolitis, bronchitis, gastro-intestinal and skin disorders.

The trade body, the Renewable Energy Association, was formed in 2013 by the merger of the AfOR and the Renewable Energy Association. It describes itself as a “modern proactive not for profit organisation within the wider waste industry” (http://www.organics-recycling.org.uk) and has a membership of approximately 1,100 companies, organisations and individuals. In 2012 AfOR published a guidance document for the sector, *The Health and Safety at Composting Sites: A Guide for Site Managers* (7). Based on his research (4, 5 and 6), Sykes was commissioned to write chapters on composting and bioaerosols, control of substances hazardous to health, health surveillance and personal protective equipment (13). As AfOR makes clear, “This updated Guide has been written for site managers and aims to impart sound practical advice regarding occupational health and safety. It is intended that this new updated Guide will enable managers to make employees aware of their legal obligations and to ensure that appropriate on-site procedures are implemented” (8).

The Guide builds on a previous health and safety guide for composters, which was published in 2004, and is endorsed by HM Inspector for the Health and Safety Executive (7 and 10). LondonWaste, a large commercial waste management company has also affirmed its support for the Guide: “This guide will assist in promoting safe working conditions throughout the biological waste industry” (7). There have already been impacts on the professional practice in the composting industry (confidential reports), and the management of an occupational hazard has improved (14, 15 and 16).

There are some specific illustrative examples of how our research (4, 5 and 6) has informed the recommendations contained in the Guide (13) regarding the monitoring required to assess and evaluate workers’ exposure to compost organisms (p.28/29 and Appendix 1; 14, 15 and 16), use of respiratory protective equipment (p.51), model procedures for task-specific risk assessments (p.31), health surveillance (p.34), early warning symptoms of bioaerosol exposure (p.18), introduction of risk zones and workplace exposure limits (p.28), and evaluation of exposure to dust as an indirect or proxy measure of harmful endotoxins (p.29). All of which are informing the practice of the industry (14 and 15) in the way that was anticipated by the British Occupational Hygiene Society when it commented on one particular project it funded on vehicle cab drivers’ exposure to bioaerosols: “It is hoped the research will raise awareness and change working practises within the composting industry and beyond, especially in relation to the impact that poor practises have on operator exposure in this working environment” (9, 14, 15 and 16).

The research and its impact continue to inform the sector through other forms of industry engagement. Sykes is a member of the Chartered Institute of Wastes Management’s special interest groups on Food Waste Collection and on Health and Safety, a member of the AfOR Health and Safety Committee (13), a member of the Welsh Government’s Health Impact Assessment Steering Group for the Wales Waste Strategy, and an invited delegate and contributor to

Environmental Agency workshops on bioaerosols from green-waste composting. He has also disseminated our research through media communication (e.g., Daily Mail, Daily Telegraph, BBC Radio Sussex).

5. Sources to corroborate the impact (indicative maximum of 10 references)

There are three main types of sources to corroborate the impact: the industry guidance document that is derived from the underpinning research (7-12); endorsement from organisations within the sector (13); and testimonials from senior staff with responsibility for health and safety and / or waste management in the composting sector (14-16).

7. Association for Organic Recycling (2012). *Health and safety at composting sites. A guide for site managers* (3rd ed.). London: AfOR. ISBN 978-0-9547797-7-1
8. Association for Organic Recycling (no date). AfOR working to expand health and safety knowledge base. Available from: http://www.organicsrecycling.org.uk/page.php?article=2198andname=AfOR+Working+to+Expand+Health+%26+Safety+Knowledge+Base
9. British Occupational Hygiene Society (2008). *Funding secured for composting research*. Available from: http://www.letsrecycle.com/news/latest-news/general/news-in-brief-296
10. An investigation of vehicle operators' exposure to dust and endotoxin in the composting sector and an evaluation of current control measures. Funded by the British Occupational Hygiene Society (£10,236) March 2008 – April 2009. Unpublished
11. Health and Safety Executive (no date). *Composting – Recycling biodegradable waste*. Available from: http://www.hse.gov.uk/waste/composting.htm
12. Letsrecycle.com (2012). Health and safety guide for composters issued, 27th September. Available from http://www.letsrecycle.com/news/latest-news/compost/health-and-safety-guide-for-composters-issued
13. Technical Director, Renewable Energy Association. Written testimonial.
14. Operations Manager, FCC Environmental, Wrexham Site. Unpublished confidential report. Occupational Health Screening, assessment of workers exposure to dust, endotoxin and viable organisms and development of risk assessment and risk mitigation procedures for FCC Environmental IVC facility Wrexham. Since January 2009, contract value £19,395 to date, on-going.
15. Operations and Health and Safety Manger, Cwm Environmental Ltd. Written testimonial. Since February 2007, contract value £5,900 to date, on-going.
16. Landfill and Aftercare Officer, Cardiff City Council. Written testimonial, January 2007 to date, on-going.