Air Quality and Health Impacts of Waste Management Options

Dr Amanda Gair (BSc, PhD, MIEnvSc, MIAQM)
Gair Consulting Ltd
Dr Amanda Gair

- Independent air quality and odour consultant
- Twenty years experience in air quality and human health impact assessments
- Specialising in power generation and waste management
- Providing support to North Yorkshire County Council on potential impacts of proposed bids for the residual waste contract
- Briefly discuss options likely to be considered and their potential impact on health
Previous Involvement

- Proposed Tockwith Energy from Waste Facility
- Support to Bilton-in-Ainsty with Bickerton Parish Council
- Reviewed assessment provided by BCB Environmental Management Ltd
- Provided representation at NYCC Committee Meeting regarding the proposal
- Major concerns relating to the BCB proposal at Tockwith
BCB Proposal at Tockwith

- Thermal treatment of hazardous waste
- Unproven technology proposed for waste treatment
- Inadequate stack height proposed
- Lack of human health impact assessment
- Errors and inconsistencies in the assessments provided
- Lack of information to allay public fears relating to health impacts
Thermal Treatment

- Energy from Waste (EFW) often referred to as incineration
- Gasification
- Anaerobic digestion
- Autoclave with subsequent production of fuel for use on-site or at an alternative facility
- All have the potential to generate air pollutants and to impact on human health
- Will need to comply with the requirements of the Waste Incineration Directive (WID) and be strictly regulated by the Environment Agency
Alternative Treatment Options

- Waste minimisation – NYCC already has in place measures to encourage waste reduction
- Composting – not without air quality and health impacts
- Landfill – undesirable option due to environmental impact
Landfill

- Large area of land take and sterilisation of land use for many years
- Environmental impacts to groundwater
- Odour impacts
- Control of landfill gas and leachate
- Generation and release of methane (a greenhouse gas which is 21 times more potent than carbon dioxide)
- Treatment of landfill gas via combustion
- Likely to be some requirement for landfill
Composting

- Only deals with a small proportion of waste generated (organic waste)
- Large areas of land required
- Generation of bioaerosols and health impacts
- Potential odour impacts
- Difficulties when treating anything other than garden or park waste
- Product often difficult to market due to contamination (e.g. glass, plastics, kitchen waste)
Anaerobic Digestion

- Only deals with a small proportion of waste generated (organic waste)
- Treated in batches, several weeks for treatment of each batch
- Large areas of land required for processing waste
- Generates a biogas (methane) which can be used to generate electricity resulting in combustion pollutants
- Gas can be fed into the National Transmission System
Autoclave Technology

- Generation of a fuel from waste
- Treatment of waste at high temperature to generate a fibre
- Aids in removal of residual recyclable material
- Residual fibre can be used as soil improver but due to potential contaminants is more often used as a fuel
- Requires the use of a fuel for raising heat and steam for process
- If fibre used as fuel then the process must be WID compliant
Thermal Treatment

- No comparison to mass burn incinerators of the past
- Strictly regulated by the Environment Agency and WID compliant
- Requires air pollution control to reduce emissions of toxic substances to air
- Strict monitoring and management of the process
- Potential impact on health from emissions to air (e.g. dioxins and furans, trace metals, fine particles)
- Residual ash some of which requires specialist disposal
Main Chemicals of Concern

- Dioxins and furans
- Fine and ultra-fine particles
- Trace metals
- Consider impacts from a typical energy from waste plant
Human Health Impact Studies

- Look at typical energy from waste facility and associated impacts – Invergordon in Scotland, 100,000 tonnes per annum, 70 m stack
- Compare the intake of dioxins/furans to the tolerable daily intakes (TDI) set by the UK Committee on Toxicity
- Provide comparison of trace metals with soil guideline values
- Particles, magnitude of impact and extent of impact (e.g. impact on airborne concentrations near and far)
- Estimate of risks
Dioxins & Furans (Sources)

- Family of chemicals some of which are carcinogenic
- Ubiquitous in the environment as they are persistent and tend to accumulate
- Generated from industry and combustion processes including combustion of wood and coal
- Emissions from thermal treatment of MSW as a fraction of the UK total have reduced from 56% in 1990 to less than 5% in 1998 due to the requirements of the 1989 municipal waste incineration directive (former NSCA report, 2001)
Dioxins & Furans (Defra 2009)

- Incineration (incl. crematoria) - 4%
- Iron and steel industry - 14%
- Industrial combustion - 7%
- Agricultural waste burning - 13%
- Burning of waste at home - 19%
- Accidental fires (house/cars) - 22%
Dioxins & Furans (Key Points)

- Toxic organic micro pollutants
- Some known to be carcinogenic
- Persistent in the environment
- Can accumulate in the food chain
- Not solely associated with thermal treatment of waste
- Emitted principally during uncontrolled combustion processes
- Already present in food stuffs that we regularly consume
Typical Human Health Risk Assessment

1. Proposed Facility Emissions
   - Airborne Concentration
     - Wet and Dry Deposition
       - Root Uptake
       - Soil Ingestion Grazing
       - Concentration in Plants
       - Concentration in Animals
         - Meat and Dairy Consumption
         - Soiling Ingestion
       - Ingestion
       - Concentration in Breast Milk
         - Receptor Intake
     - Concentration in Soil
       - Erosion Runoff
       - Leaching
       - Concentration in Water
         - Bioconcentration
         - Water Consumption
         - Fish Consumption
       - Concentration in Fish
       - Inhalation
Concentration of Dioxins in Milk and Eggs Relative to EU Maximum Levels

- Farmer Firth North: 0.27% Milk, 0.00% Eggs
- Farmer Firth South 1: 0.01% Milk, 0.00% Eggs
- Farmer Firth South 2: 0.01% Milk, 0.00% Eggs
Intake of Dioxins Relative to Committee on Toxicity (CoT) Tolerable Daily Intake (TDI)
Trace Metals (Sources)

- Mercury – coal combustion, incineration emissions significant as they include crematoria (dental amalgam), naturally occurring
- Arsenic – coal combustion, copper, zinc and lead smelters, naturally occurring
- Cadmium – non-ferrous metal production (zinc, aluminium), iron and steel production, naturally occurring
- Chromium – coal combustion, iron and steel manufacture, naturally occurring
Metals in Soil as a Percentage of the UK Soil Guideline Value

- Arsenic
- Cadmium
- Chromium
- Inorganic mercury
- Nickel

- Farmer Firth North
- Fisher Tomich
- Resident Invergordon East
Fine and Ultra-fine Particles

- Long term exposure and short term increases in exposure can lead to damage to health
- No threshold of effect can be identified
- Any increase in particle exposure should be assumed to have some effect on health
- Emissions of particles (whether fine or ultra-fine) are very small (0.03%) in comparison to other sources (e.g. 27% for traffic and 25% for other industry) – Defra 2006
Particle Size and Particle Number

- PM₁₀ which are small enough to pass upper airways
- PM₂.₅ high probability of depositing in the gas exchange zone of the lung
- PM₀.₁ are ultra fine particles
- Measurements of PM₁₀ and PM₂.₅ will also include PM₀.₁
- Epidemiological evidence relating to particle exposure to incinerators has considered PM₁₀ and PM₂.₅ measurements that include PM₀.₁
Impact of Thermal Treatment on Particle Exposure

- Emissions of total particles (includes PM10, PM2.5 and ultra-fine particles) is strictly controlled
- Particle size distribution not substantially different from other sources and industrial processes
- Emission from a stack resulting in good dispersion and dilution of emissions before reaching ground level
- Predicted public exposure to particles substantially lower compared to traffic (uncontrolled emission at ground level) and other industries
Magnitude and Extent of Particle Impacts for Typical EFW plant

Background Contribution (e.g. other sources)  Contribution from EFW plant
Predicted PM$_{10}$ Concentrations

- European Union and UK air quality objective (AQO) for PM$_{10}$ of 40 µg/m$^3$
- Background concentration (e.g. from other sources, such as road traffic, other industry) of 9.5 µg/m$^3$ (24% of the AQO)
- Maximum contribution from EFW plant is 0.015 µg/m$^3$ (less than 0.04% of AQO)
- At 5 km (3 miles) contribution from EFW plant is 0.0005 µg/m$^3$ (0.001% of AQO)
- At 20 km (12 miles) contribution from EFW plant is 0.0001 µg/m$^3$ (0.0003% of AQO)
Health Protection Agency Statement (September 2009)

- ‘While it is not possible to rule out adverse health effects from modern, well regulated municipal waste incinerators with complete certainty, any potential damage to the health of those living close-by is likely to be small, if detectable.’
- ‘Since any possible health effects are likely to be very small, if detectable, studies of public health around modern, well managed municipal waste incinerators are not recommended.’
- ‘Studies published in the scientific literature showing health effects in populations living around incinerators have, in general, been conducted around older incinerators with less stringent emissions standards and cannot be directly extrapolated with any reliability to modern incinerators.’
## Comparison with Everyday Risks

<table>
<thead>
<tr>
<th>Activity</th>
<th>Annual Risk (Source BMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable annual risk in the UK</td>
<td>1 in 1,000,000</td>
</tr>
<tr>
<td>Smoking 10 cigarettes per day</td>
<td>1 in 200</td>
</tr>
<tr>
<td>Influenza</td>
<td>1 in 500</td>
</tr>
<tr>
<td>Road accident</td>
<td>1 in 8,000</td>
</tr>
<tr>
<td>Playing football</td>
<td>1 in 25,000</td>
</tr>
<tr>
<td>Accident at home</td>
<td>1 in 26,000</td>
</tr>
<tr>
<td>Accident at work</td>
<td>1 in 43,000</td>
</tr>
<tr>
<td>Hit by lightning</td>
<td>1 in 10,000,000</td>
</tr>
<tr>
<td>Release of radiation from nuclear power plant</td>
<td>1 in 10,000,000</td>
</tr>
<tr>
<td>Invergordon Farmer</td>
<td>1 in 15,900,000</td>
</tr>
<tr>
<td>Invergordon Resident</td>
<td>1 in 87,500,000</td>
</tr>
<tr>
<td>Invergordon Fisher</td>
<td>1 in 100,000,000</td>
</tr>
</tbody>
</table>
Conclusions

- All residual waste options will have some health impact
- Currently residual waste goes to landfill, undesirable due to impacts on health and environment
- Thermal treatment main issue is public perception of health impacts
- For pollutants of concern, thermal treatment not sole contributor and mostly minor compared to other sources
- Considered a typical incinerator (Invergordon), impacts were negligible, risk well below level considered acceptable
- HPA conclude that ‘any potential damage to the health of those living close-by is likely to be small, if detectable.’