

**An Assessment of
General Environmental Options
(GEO) Ltd's
Environmental Statement on the Proposed
Hespin Wood 'Energy Recycling Centre'.**

**by
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Executive Summary.

The report.

The detailed report on the application and environmental statement for the Hespin Wood incinerator has been compiled on behalf of Cumbrians' Against Waste Incineration. It looks at the technical information presented in the applicants' Environmental Statement, and where necessary, includes an additional information on aspects of the issues which the environmental statements fails to examine.

The report is in two sections:

Section one is a chapter by chapter evaluation of the environmental statement. The purpose of this is to raise issues of relevance to the planning authority, and identify any contradictions or ambiguities in the data presented.

Section two takes some of the issues identified in section one and analyses them in detail. This deals mainly with the issues of planning policy, sustainable development, air pollution and waste management.

Where necessary, references to information sources are given at the end of each chapter. In the analysis of the data contained in the statement, procedures and assumptions are stated where the data was not available in the statement itself.

Overview.

The environmental statement submitted with this application is, compared to other assessments I have examined, quite comprehensive. It covers all the fields specified in Schedule 3, paragraph 2(a to d), of the regulations^[1]. The main criticism I have about the environmental statement is the content of the non-technical assessment, which as stated in paragraph 2(e) of Schedule 3, must be a summary in non-technical language of the contents of the assessment. As it appears to me, the non-technical assessment does not summarise in a comprehensive manner the issues addressed in the statement, and much of the non-technical assessment is in fact an 'advertisement' for waste incineration, which has no direct reference to the material content of the statement.

Secondly, at no point is the reuse of the land discussed in detail. In effect, this will be a large industrial plant, in a rural area, with a basement sunk 3 metres into the earth. When the plant reaches the end of its lifetime, would the site be reused for industry - and given the proposed nature of the development a potentially polluting industry, would it be returned to a 'green field', or would a new incineration plant be built. These questions are not properly addressed. The point must also be made that as a waste disposal plant, and an incinerator, the site would be included in the proposed register of potentially contaminated sites. This would have obvious consequences for the reuse of the site.

The proposed 'energy recycling centre'.

Having read a large part of the environmental statement through, the term used by the applicant - "energy recycling centre" - is rather misleading.

From a physical point of view, energy is constant; it cannot be created or re-formed, and even in processes which take energy and raise it to a higher form, the efficiency of conversion is low. From a purely chemical point of view this plant does not recycle materials - it degrades them! It takes materials which have an energy value and releases this energy through combustion. Once released, these materials cannot be recreated without a much greater input of energy than that recovered from them. The term 'energy recycling centre' must therefore be looked upon as being completely misleading. This application is for a waste to energy incineration plant.

One of the topics I would expect to have seen addressed in detail in the environmental statement is the physical recycling aspect of this plant. However, the information on this in the statement is very poor, and it does seem as if the recycling of materials will be put very low on the list of operating priorities.

The data for recycling is given table 13.1 (in the traffic section) as paper/card 2400te, glass 1650te, non-ferrous metal 1350te, ferrous metal 1200te and plastics 500te. This comes to 7050te per year, or **5.6%** of the plants capacity (in total, 20% of the municipal waste stream). Section 7.7.2.d also notes that this figure is dependent upon the market for recycled materials. It also states that only 20% of the municipal waste stream is recyclable (a figure arrived at in a phone call by their consultants). Such a figure can be contrasted to some local authorities who are committing finances to achieve a recycling target of 50%^[2], and the plants which

ABT are building in Madrid and Berlin, which have much higher levels of materials reclamation. This fact would tend to confirm my earlier point that this is not a recycling centre.

Plant service area.

Section 2.2.2 on broiler litter notes that the plant will take waste from a 30 mile radius - within Cumbria. This is a somewhat confusing statement. Given that the plant is only a few miles from the border with Dumfries and Galloway (a region which also has a large number of broiler units) the company are, in effect, cutting their service area in half. I cannot see why this points is being maintained - especially when there are not enforceable planning grounds upon which the service area of a plant such as this can be limited.

Their argument on service area also prompts the question of location. If their service area is going to be cut in half because of their chosen location, wouldn't it make better economic sense to site it somewhere else?

Incineration vs. other waste management options.

Section 2.3 on page 2.8 is a questionable attempt to justify incineration against other forms of waste disposal. Each form of waste disposal has its good points, as well as its draw-backs.

It should be noted that there are no references attached to the figures given in this section. This is interesting, since the information contained in this section does not correspond with the literature currently being reviewed in the waste management industry - for examples the life-cycle analyses being carried out by PIRA Ltd on behalf of the Department of the Environment.

If we relate each of the wastes discussed to their 'best practicable environmental option' for disposal, the picture is very different.

The best solution for broiler litter (and the organic fraction of household/commercial waste) is anaerobic digestion to produce methane. The result of this is an inert compost - free of all pathogens, and large quantities of methane which can be burnt directly for heat or fed into gas engines to produce electricity. this solution is widely used in Denmark, where farms provide electricity and heat for rural communities using animal wastes.

The best solution for tyres (and plastics) is pyrolysis - not even mentioned in this section. AEA Technology Harwell & Herbert Bevan Ltd have developed a modular pyrolysis plant^[3] for a low cost (£250,000) and which is capable of processing 400 tonnes of tyres per year. The plant produces a gas (mainly ethane/methane with some butane and propane) - some of which is used to fire the plant, but the surplus can be used in furnaces or a gas engine. It also produces an oil which can be processed to recover organic compounds, or burnt (has a similar

calorific value to diesel). The residue left in the 'pot' is a carbon char - activated to a low grade, and so able to be used in cleaning industrial discharges.

Finally, the best solution for the non-organic part of household/commercial waste is reclamation. Some plants in Europe^[4] which sort **unsegregated** wastes are recovering 20-40% of plastic film, 25-30% of dense plastic, 60-90% of ferrous metals, 25-50% glass and 10-30% of paper. As compost, plants achieve 100% reclamation of the organic content of the waste stream. These figures can be significantly increased if there is primary separation of waste streams by the public.

So, applying the criteria above, the TIF incinerator comes off worst because...

- * it has the highest capital costs of all the processes above.
- * it has the highest environmental impact in terms of emissions of greenhouse gases than the above.
- * it generates the least employment out of all the processes above.

Fly ash and Fujibeton.

The purpose of the environmental assessment process is to examine the potential risks involved with **all** the materials associated with a process. However, in the ES we are not informed about the 'secret ingredients' in Fujibeton. They may be toxic, carcinogenic, explosive, even radioactive, but there is no information.

The 'five other additives in minor quantities' should be described in the ES. Fujibeton is trade-marked, and so it is presumably patented as well. This should provide more than enough protection for the manufacturer without the necessity for secrecy. Fifty years ago secrecy was a valid commercial safeguard, but with today's chemical analytical techniques, secrecy is useless.

Geology.

The geological assessment has failed to note local tectonic influences on the geology. The underlying Permo-triassic strata are acknowledged, as are the Quaternary deposits - but there is no information on tectonics (fault lines). The geological information in the ES does not identify whether the boundary between the sandstone and the shales is regular, an unconformity or a fault. Also, given that the nearby Pennines area is one of the most seismically active in the country, and the fact that in 1979 Carlisle experienced one of Britain's largest earthquakes in recent times, the lack of seismic data gives cause for concern.

Traffic Assessment.

Section 7.1.1 on the first page makes it clear that the traffic assessment is incomplete, and that traffic levels will not be known until the plant opens....

"Until waste contracts are finalised for the supply of poultry litter and tyres, the wider traffic impact on the area cannot be assessed."

In this case, what validity can be given to their traffic assessment?

The main criticism of the traffic analysis must be that despite the numerous junctions the traffic will have to negotiate when the new link road is built, and despite the fact that there will be a large number of (predominantly) HGV's generated by this development, there has been no modelling of traffic flows at major junctions to assess the likelihood of congestion

Ecological assessment.

With regard to this whole application, GEO have made much of the fact that by developing this site, they will be able to safeguard an area of ecological importance. However, on page 3.8 of the statement it is acknowledged that GEO's own consultants are cautious about developing the site originally identified by GEO/ABT. Penny Anderson Associates recommendation 4.4 states about the site originally chosen:

"it is concluded that the site is of sufficient ecological value to be worthy of protection and conservation. It would not be a suitable location for an energy recycling centre".

Given the fact that the current site is only a short distance across the field, is the current site any more acceptable, and if so, on what basis. Given the distance, the disturbance from noise and localised air pollution (e.g. dust from lorries on the road) will be attenuated by only a small amount.

Landscape impact assessment.

In section 10.4.7 ('Conclusions', page 10.12) it states:

"There can be little doubt that the proposed Energy Recycling Centre at Todhills will have a visual impact on the area. The chimney will certainly be viewed from around the area and the main building will be a major component of the local landscape. However, the proposed Centre's proximity to Hespian wood and other woodland, together with the local topography, will significantly reduce the visual impact on the landscape."

"Site planning and design will reinforce the existing planting and, together with proposed earth mounding and shrub and tree planting, the lower parts of the main structure, ancillary buildings and services will be screened. This will reduce the visual intrusion of the Energy Recycling Centre significantly, particularly to those areas adjacent to the structure. The finished material and its colour must also be taken into account as a mitigating factor."

Firstly, the first paragraph seems contradictory. It begins by stating that the plant will be a major component of the local landscape, and then states that its surroundings will reduce the impact - rather confusing.

Secondly, any additional planting will take between fifteen and twenty-five years to become effective - by which time the plant will be nearing the end of its operational life.

Thirdly, whilst admitting that the stack will be a dominant feature, the rest of the section then ignores the impact the stack will have on the surrounding environment.

Socioeconomic impact.

With reference to the local unemployment statistics, this plant, (considering the investment in initial and operation costs) will present a minimal improvement to the local employment market.

Considering this development in terms of the jobs it would create, 59 staff (quoted in ES, page 11.7) in an area of 14 acres (quoted in ES, page 5.6) means that **only 4.2 jobs per acre will be created**. Local authorities normally assume that warehousing will produce 10 jobs per acre. Light industry can create 20 jobs per acre. Office development, depending upon height, can create 25 to 70 jobs per acre. In terms of employment potential, this plant is the worst type of development to devote land to.

If we also consider the costs involved, £3 million would set up a moderate light industrial unit employing thirty or forty people. In essence then, 14 acres of land are being sacrificed to 59 jobs, rather than other types of development which could create in excess of 200 jobs (assuming 15 jobs per acre).

Planning and incineration policies.

Given that this plant is clearly in breach of the local development plans, it is strange that more effort was not put into finding sound 'planning grounds' for why it should be allowed to go ahead. Only one section, 11.5.3, deals with planning issues in any way.

Section 11.5.3 concludes by stating:

"This potential conflict in the structure plan has been noted. However, it is beyond the scope of an environmental statement to comment further on the situation...."

This is a curious stance, since ultimately the decision to approve or refuse permission for this development will have to be phrased within the bounds of planning law and ministerial guidances - the application does not rest on the content of the environmental statement.

Royal Commission on Environmental Pollution's 17th Report⁵¹.

Many have viewed the Royal Commission on Environmental Pollution's (RCP) report on waste incineration as a 'red carpet' thrown to incinerator developers. This is not completely the case. If we take the conclusions of the report:

"10.1 The purpose of this study has been to establish the environmental acceptability, and appropriate role, of one form of waste treatment, incineration. This does not represent a comprehensive study of all aspects of waste management, in the manner of the Commission's Eleventh Report published in 1985. The Commission's general approach to waste management can be presented as a four-stage decision procedure:

1st: wherever possible avoid creating wastes.

2nd: where wastes are unavoidable recycle them if possible.

3rd: where wastes cannot be recycled in the form of materials, recover energy from them.

4th: when the foregoing options have been exhausted, utilise the best practicable environmental option to dispose of wastes."

Therefore, according to the RCP, waste minimisation and materials recovery should take precedence over incineration. Recent studies in the northwest have shown that waste minimisation is not only possible in industry, but can also turn a profit, and as outlined elsewhere in the main report, there are commercially available systems to deal with the wastes proposed for this plant in a manner which recovers more materials for reuse, and which have a lesser environmental impact.

Air Quality Impact.

When first looking at the air quality impact section, I was struck by the fact that, like the "Human Health Assessment" circulated last year, there was very little detail on the exact modelling procedure used to predict pollutant concentrations from the plant. This may be partly due to the over-reliance on computer software packages, where much of the data which goes in to the modelling process is standardised or pre-defined.

The first thing noted was that the air quality assessment failed to include a wind rose. However, there are maps plotting isopleths, so a wind rose must have been used in the assessment procedure. **Without the wind rose, none of the data on pollutant distribution can be independently verified and proven to be correct.**

Normally, dispersion modelling is carried out by calculating a standard ground concentration for an emission of 1g/s^{-1} of a particular pollutant. To arrive at the correct figure, the source strength of the pollutant - that is the number of grams of pollutant emitted every second from

the stack - is multiplied by the standard figure.

The source strength can be calculated by taking the concentration of the pollutant - in grams per metre cubed of exhaust gas - and multiplying by the total metre cubed of gas emitted every second (the emission volume). This is calculated as the cross sectional area of the stack orifice multiplied by the exit velocity.

While calculating the emission volume I noted that GEO's document is not precisely correct. The accuracy of the source strength is very important, as the ground concentration is directly proportional to the source strength level. Any error in the source strength figure is therefore carried over into the ground concentration results. The source strength in the environmental statement has been underestimated by nearly 24%. This means that the figures in the environmental statement have also been underestimated by 24%.

Human Health Assessment.

In December 1992, ABT released a 'Human Health Assessment'^[6] for the Hespian Wood plant. Information from this assessment has been included in section 8.3, pages 8.26 - 8.27. However, some of the modelling procedures in the environmental statement are different from those in the health assessment, and consequently, the risk figures quoted in the health assessment are not valid. Much of the difference in the figures is due to the modelling of plume downwash due to building effects. Although the accuracy of this is arguable, the health assessment should have been revised to take account of these new pollutant level predictions.

Mass Balance.

To give a general overview of the materials passing through the plant I have prepared a simple mass balance for the plant, compiled using data in the environmental statement.

This simple table shows that the vast majority of the waste products fed into the incinerator emerge from the stack. In effect then, over the plants lifetime, nearly 2 million tonnes of incinerated materials will be spread into the atmosphere.

The results of the mass balance are illustrated on the following page.

The utilisation of incinerator ash wastes as secondary aggregate.

We should consider the differences between operations using pulverised fuel ash (pfa) from coal-fired power stations, and

GEO's proposal to turn incinerator wastes into aggregates. In absolute scale, there is a disparity between the two. Blockmaking plants at the major power stations utilise hundreds of thousands of tonnes of fly and bottom ash each year. According to the figures presented by GEO in the ES^[7], the maximum amount of material which will be handled will be 57 tonnes per day (about 16,650 tonnes per year). It is difficult to see how the plant, producing only two lorry loads of aggregate per day, can compete with the large quarries in the area which producing hundreds of tonnes of aggregate per day, and aggregate plants at power stations producing hundreds of tonnes per day.

Secondly, there is the question of quality. Aggregates from primary sources are of a guaranteed quality, and are chemically inert. The aggregate produced from the incinerator will not be of a homogenous nature because of the variations which can occur in the feedstock. There is also the problem that, even if the Fujibeton sealant is as effective as claimed, there will always be the 'psychological' deterrent that the aggregate comes from an incineration plant, and contains heavy metals and dioxins.

In Japan, where the process of turning incinerator ash into aggregates has been perfected, the lack of primary aggregates and thus the high cost of road fill makes the use of 'secondary' aggregates economic. In the UK, it has long been acknowledged that secondary aggregates have a use in large building projects, but only where the costs are not significantly greater than that of primary aggregates.

If this material does not go for aggregate, it will have to be dumped in the Hespian Wood landfill site nearby. This again presents problems as incinerator ash can have its chemical toxins leached out under the biological and chemical conditions produced when it is co-disposed with municipal waste. The Royal Commission's report on incineration recommends that incinerator wastes should be disposed of to a purpose built facility^[8]. Manchester City Waste Disposal Authority has already instituted these measures for its incinerator ash, and other authorities will be following suit. The question is then, if this material cannot be co-disposed at Hespian Wood landfill, and it cannot economically be turned into aggregate, where will it go to?

Waste Classification.

The composition of the waste fed into the incinerator has a direct effect upon the composition of the waste gases coming out of the stack. When this proposal was originally discussed, it was stated that the plant would take commercial waste, tyres and chicken litter. The classes of waste in the ES are notionally different. During the lengthy debate leading up to this application, GEO and ABT have stressed that the plant would not be used for burning domestic refuse or sewage sludge. It is true that the plant cannot burn sewage sludge for technical reasons - although it could do so if preheating was supplied to the primary air - but domestic refuse has always been a certainty. This fear has now been confirmed in the environmental statement (ES).

The ES uses the term 'municipal waste'. The term 'municipal waste' has no definition in UK law - it is an American term. As it has no definition in the UK, it may cause some confusion - and even appears to do so within the ES itself! In the UK, waste classes are defined in Section 75 of the Environmental Protection Act (EPA) 1990. The EPA defines the term

'controlled wastes' and then goes on to specify three different types of controlled waste - household, industrial and commercial. Mine and quarry waste along with agricultural waste is generally excluded from control and regulation under Part II of EPA 1990.

Programmable logic controllers and automated control systems.

Due mainly to the safety problems surrounding the Sizewell 'B' Reactor Protection System evaluation by the Institute of Electrical Engineers (IEE) and the British Computer Society (BCS), there has been a re-evaluation of the effectiveness of computerised control systems in industry.

There are two types of computerised control system:

- * Dedicated Control Systems: these are computers which are built and programmed to perform specific tasks. These are the most effective - but expensive - form of automated control system.

- * Programmable Logic Controllers (PLC's): in effect these are small single processor computers consisting of a CPU, memory, and a complex input/output port. They are of a standard design - 'off-the-peg' almost - which can be installed into a system and programmed to perform a limited set of functions.

This plant, according to the information in the environmental statement, will be using both types of controller in tandem. Dedicated control systems can be effective, but as in the case of the Sizewell 'B' Reactor Protection System, there comes a point where the sheer size and complexity of the hardware and software systems becomes too big for the human brain to handle. The problem in the case of the incinerator is slightly different. It is not a matter of the size, but the interconnection of PLC's and a dedicated system. In essence you have two 'brains' making decision - and it may not be the same one.

The program code for these control systems is written according to the stated requirements, and then tested. Indeed, some definitions of reliability are based on meeting the specification rather than the error frequency, avoiding the problem and ignoring the implications. The accuracy and completeness of the design specification is basic to the safety of all parts of the process. Errors, or 'bugs', are the result of a fault in design or writing of the program. When a bug is detected, code is written or altered to correct it. Unfortunately, one correction may introduce more bugs, which then have to be corrected, and so on.

Two kinds of bug can occur. A revealed bug is one that leads to a safe failure, and these are accounted for in fail-safe systems. An unrevealed bug is usually only spotted afterwards, and it is this one that is the most dangerous. It is also the most difficult to find. Eliminating all bugs in a program, especially a complex one like a process control system, is acknowledged as unfeasible. This leaves the possibility of unrevealed bugs buried deep in the code, waiting for the set of conditions - usually extreme and dangerous - that will trigger a failure. Bugs in large, complex testing simulators can overlook aspects of the operation, and testing every conceivable situation is not possible. The IEE/BCS report points out that it is not yet possible to provide guarantees that software is error free'.

Peter Mellor, a lecturer at the Centre for Software Reliability at City University 'cannot see a way of assessing the risk of software in safety critical systems.' Traditional methods of testing, running the system for 10 times the required safe time, means running for 10 billion hours for a reliability of 10^{-9} . Even then, unrevealed faults may not be discovered until there has been testing up to 100 times.

Energy 'recycling and sustainable development.

The most reprehensible section of the whole environmental statement must be section 9.2.5. It claims that this plant fulfils the criteria for 'sustainable development'. In fact, this whole section distorts current policies on sustainability to suit GEO's cause, and uses examples which are either wholly untrue or factually unsound.

Let's take a few statements from section 9.2.5 and examine them:

The ERC will generate energy without using fossil fuels:

Plastics are made from oil - a fossil fuel. Car tyres are made from oil - a fossil fuel. Paper is a material made from organic fibres, but the processing uses fossil fuels.

Directly or indirectly, this plant is burning fossil fuels. What is worse, materials like paper which can be recycled - in the process saving small amounts of fossil fuels - will have to be replaced with virgin materials, so increasing the use of fossil fuels. It cannot be said that the plant does not burn fossil fuels - it does - and in doing so removes materials from the system which if reclaimed could lessen current fossil fuel consumption.

Both atmospheric emissions and liquid effluent discharges from the ERC are many orders of magnitude less than would be associated with the generation of an equal amount of energy from more traditional fossil fuel power stations:

Firstly, one order of magnitude equals 10. Many could be 100, or 1,000, or 1,000,000.

Secondly, if we take a traditional fossil fuel such as coal, it contains more energy per unit volume than waste. If we take data from ETSU^[9] comparing coal to waste derived fuel (RDF):

Parameter.	Coal.	RDF/Coal,		
		RDF.	percent:	
Calorific value, GJ/te ⁻¹ .	28.1	15.9	56%.	
Density, kg/m ⁻³ .	900	600	66%.	
Ash content, %vol.	6.5	15.7	240%.	
Moisture content, %vol.		6.1	7.4	120%.

Burning RDF to achieve the same energy output as coal therefore requires 56% more material by weight - which equates to nearly three times the volume of material. Also, to produce the same amount of energy, burning RDF produces 420% more ash.

In burning all the extra material, there will be extra discharges to air - it would be impossible to burn more material and create a smaller discharge. It is true that a traditional coal-fired power station's discharges are many times greater than an incinerator, but then again it is producing over one hundred times as much energy.

This statement by GEO's consultants is factually incorrect and is a misleading 'untruth' to persons reading the document.

As a means of producing energy from a non-fossil fuel source the ERC places minimal demands on the environment:

Incorrect - the chicken litter and other organic materials could be dealt with in anaerobic digestion plants which utilise methane to produce energy. The combustion of methane is also much cleaner and much more efficient per unit of energy than waste incineration. Likewise, pyrolysis of tyres produces gases which can fire gas engines to generate electricity more efficiently and cleanly, and the hydrocarbon rich residues left over can be processed into new products, so displacing oil base products currently used for similar purposes. In comparison to other technologies available, this statement is therefore factually incorrect.

Currently, a number of alternative disposal routes for these 'wastes' is causing enormous environmental damage:

In a recent study^[10], only 18% of all landfill sites experienced pollution problems. Of these problems 48% were due to landfill gas, 4% were due to fire, 27% were due to surface water ponding and 6% subsidence. Only 15% - or 2.7% of all landfill sites - experienced problems with pollution of groundwater off-site.

How can GEO's consultants describe an incidence of 1 in 40 landfill sites leaking as 'enormous'? Yet again, GEO are misleading the public from the facts.

Taking the key statements in the ES, and applying the present 'sustainable' criteria to them, it can be clearly seen that this plant is un-sustainable. This is because it destroys resources - denying their use to future generations. In destroying these resources it forces society to use up more energy to recreate new materials from virgin raw materials. Finally, in the destruction of these resources which forces the creation of new resources, there are increased emissions to the air and land when compared to other available technologies which could effectively recycle all the wastes selected for this plant.

Recommendation to the planning authority.

Having carried out a thorough assessment of the environmental statement I would urge the planning authority to reject this application, primarily on the grounds that it does not conform with the development plan, and while acknowledging the Government's recent support for waste incineration, the benefits of development on this site are not sufficient to outweigh the environmental and social costs.

Secondly, although the environmental statement has been put together in a 'comprehensive' manner, there are flaws in the arguments put forward, and some of the claims made are completely and utterly untrue.

References:

[1] Town and Country Planning (Assessment of Environmental Effects) Regulations, 1988 - SI 1199/1988.

[2] NATTA - Open University.

[3] MPD TP-2000 Tyre Recycler. Contact AEA-Beven, Building 404, Harwell Laboratory, Didcot, Oxon. OX11 0RA. (0235) 432245.

[4] J.R. Barton, 'Mechanical sorting technology for municipal solid waste reclamation', in "Waste Management in the UK", Harwell Waste Symposium, 1988.

[5] Royal Commission on Environmental Pollution 17th Report - 'Waste Incineration', HMSO, May 1993.

[6] ERL for ABT(UK) Ltd., "Energy Recycling Centre - Hespian Wood: Human Health Risk Assessment". December 1992.

[7] ES, page 5.20 and 5.23. The 57 te/day is calculated as 42 te/day of fly ash and 15 te/day of noncombustibles.

[8] Royal Commission on Environmental Pollution 17th Report, paragraph 9.68.

[9] M.P. Landy, paper to Annual Wastes Management Conference, Torbay, 1987. Ref.: ETSU-L-20.

[10] "Landfill failure risk assessment survey", David Roche, Frank Graham Consulting Engineers, 1993. 0392 432748.

END OF SUMMARY.