Independent Investigation

Nantygwyddon Landfill Site

Supplementary Written Evidence

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On behalf of

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1. The Key Issues

1. The Key Issues that I would like to emphasise for this investigation, in addition to – or in support of - those raised in oral evidence, relate to the terms of reference for the Investigation and are:

   Issue One: Regulatory failings at Nantygwyddon and how the site measures up against best practice at the time. Including:

   Issue Two: The failure to properly address the 'Relevant Objectives' which arise from the Waste Framework Directive as transposed by the Waste Management Licensing Regulations 1994 – particularly in relation to Articles 3, 4 and 7. This has resulted in a failure to protect the health of the local population and adverse impacts on the environment in general.

   Issue Three: The failure to require appropriate financial provision

2. This supplementary evidence should be read together with the transcript of my oral submission on 18th April 2001.

3. I have tried, where possible, to avoid unnecessary duplication of factual issues which are not in dispute. Many other witnesses have provided detailed chronologies and RANT has provided testimony on their findings of the local health impacts. I have therefore not repeated this evidence.

4. Perhaps the main things which have resulted in the problems associated with Nantygwyddon including delays in abating them:

   · the engineering and operations of the site did not follow the best practice

   · the UK opposition to the emerging Landfill Directive has wasted more than a decade in abortive attempts to make landfill sustainable first, from 1986, by 'dry tombs' and, since 1995, by operating landfill sites as flushing 'bio-reactors'. The UK resistance to the requirements for effective pre-treatment prior to landfill has severely delayed the implementation of alternatives higher up the waste hierarchy and resulted in tens of millions of tonnes of putrescible waste being consigned to landfill when that is at the bottom of the waste hierarchy and does not represent the 'Best Practicable Environmental Option' for that waste.

   · The failure of the Environment Agency, and Waste Regulations Authority before them, to properly enforce the financial provision requirements of the 1990 Environmental Protection Act has meant that the Agency has been forced to allow continued, unsatisfactory, operations of the site just to allow some control through the licence[1]. Proper financial provisions

[1] This situation was entirely predictable – it is very similar to the situation that has been faced by the Agency at Cwmrhydyceirw quarry, Swansea and other sites in Wales. As long ago as May 1987 a paper by A Qadeer Khan, then Chief Scientific Officer of the South Yorkshire Hazardous Waste Unit to the Harwell Landfill practices Symposium, 20 May 1987 "Problems with enforcement of good landfill practices in the United Kingdom", said "*In my opinion this [landfill gas] is the major problem resulting from landfilling organic biodegradeable waste using modern methods….the only*

would have allowed remedial work, such as capping and gas management, to be carried out and the costs covered by the financial provisions. Not requiring proper financial provisions to be in place at any stage – and thus not undertaking the work using those provisions - was perhaps the most significant regulatory failing (of many) by the Environment Agency. This would have allowed the odour nuisance from the site to have been abated years earlier.

- The failure to require proper monitoring and modelling of all gas emissions from the site. Including NMVOCs is also another significant flaw in the regulatory regime. Of course any results would need to be viewed with an open mind rather than the spirit of denial that any health problems could have been caused by the landfill site. Unfortunately the extreme scepticism of the Environment Agency, the previous Labour controlled administration in Rhondda Cynon Taff and the relevant National Assembly Ministers / staff towards any possible linkage with health impacts has pervaded the approach to Nantygwyddon up to this stage.

5. I would recommend that lessons for the future from the Nantygwyddon experience should include:

- **that the Environment Agency must start taking seriously the very long timescales for which mixed waste landfills sites provide a threat to the environment and require commensurately large financial provision before operations commence. It is also essential that the details of these provisions are open to public scrutiny. The transfer of licences without making any or proper financial provision is a recipe for a repeat of the fiasco that has blighted the area around the Nantygwyddon site for far too long.**

- **that there should be an improved system of public registers for Waste Management Licenses/Pollution Prevention and Control permits – the current registers are disorganised, difficult to use and have been subject to the Environment Agency removing documents previously deposited.**

- **that landfill operators should have to regularly monitor their gas emissions for a broad range of non-methane volatile organic compounds**

- **that the pre-treatment requirements of the Landfill Directive must be taken seriously in order to reduce the gas and leachate generating potential of future landfill sites.**

- **The Environment Agency should adopt a more positive and open-minded approach to the concerns voiced by residents and community groups in relation to health impacts of regulated operations in the future.**

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power you have [in relation to landfill gas problems] is to serve on him a Scection 9 notice (assuming you have a suitable condition or after modification of the licence).

If he complies with this and solves the problem then you are lucky but if he does not do that then the only alternative you have is to revoke his licence.

What is achieved by such revocation? Nothing. You have actually lost all control of the site"

Issue One:

Regulatory failings at Nantygwyddon and how the site measures up against best practice at the time.

6. Nantygwyddon started receiving waste in January 1988[2] and is therefore, to all intents and purposes, a 'modern' landfill site.

7. The terms of reference of this investigation indicate that that one objective is to:

   "assess how the establishment, management and regulation of the Nantygwyddon site measures up against that benchmark (current best practice) as well as against best practice guidance at the time the decisions were taken"

8. Much of the contemporary guidance from when the site started operations is still fairly readily available. Construction and operations, for example, post-date the publication[3] of Waste Management Paper 26 'A Technical Memorandum for the Disposal of Wastes on Landfill Sites'. A perspective of the attitudes and advice being given at the time can also be gained from various parliamentary reports. Operations of the site only marginally pre-dates the Environment Committee investigations into 'Toxic Waste' started in early 1998 and published on 22nd February 1989. This was followed by the Wales specific inquiries of the Welsh Affairs Committee reporting in March 1990 on 'Toxic Waste Disposal in Wales'. There are also the detailed proceedings of the various Harwell Landfill Symposia held throughout the 1980's which provide great detail of the state of knowledge on landfill operations and design at that time.

9. The illustration in Appendix 1 is taken from the Environment Committee 1990 report on toxic waste and shows that double composite liners with intermediate leak detection systems were in operational use at that time.

10. It is clear that most of the engineering and detail relevant to operations of 'state of the art' landfill today was known at that time. That is not to say that landfill, even in 'state of the art' facilities is environmentally acceptable. Landfill was, and remains, at the bottom of the waste hierarchy and is rarely the 'Best Practicable Environmental Option' for municipal wastes. Even the best engineered landfill site, as can be seen below, presents a significant hazard to the environment for a very long period of time. That is one reason that starting from 16th July of this year, when the Landfill Directive comes into force, there will requirements to pre-treat wastes prior to disposal and legal targets to reduce the level of biodegradable municipal waste going to landfill sites (ultimately, by 2016 – or 2020 if the UK exercises a derogation - to 35% of the 1995 levels of such wastes). There is little doubt that if the Landfill

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[2] National Assembly for Wales, Transport, Planning and Environment Group Written submission to the investigation 15/1/2001 para 6.2

[3] in 1986

Directive is applied enthusiastically (which would be surprising given the historic resistance to the Directive manifested by the UK Government and Regulatory bodies, including the Environment Agency, over the past decade) then the Directive should go a long way towards ensuring that the Nantygwyddon problems are not repeated.

11. It may be helpful to take a broader perspective about what was known about the problems associated with waste disposal by the late 1980s'.

Historical Perspective – What Was Known and When?:

12. In 1906 the U.S. Geological Survey published its first paper on the prevention of groundwater contamination by careful well construction. In the same year Woodward[4] was warning that "*the geologist is naturally concerned at the way in which water bearing strata are rendered liable to contamination from the practice of shooting parish refuse into old chalk pits, limestone quarries or gravel pits..... the danger of pollution may be serious*". By 1910 the U.S. Geological Survey published its recommendation that dumping rubbish into sinkholes in limestone be abandoned because the practice was contaminating groundwater.

13. As early as 1923, researchers injected dye into the soil along with bacteria, indicating that bacteria did not flow through soil as far as chemicals did. Bacteria appeared to be filtered out by soil, but chemicals were not. Similar studies were undertaken in 1937 in Alabama, USA, and many other projects have since confirmed the findings.

14. The UK authorities have generally avoided systematically looking for evidence of groundwater pollution but the Americans have been slightly more thorough. In 1952 a task force of the American Water Works Association surveyed state governments for evidence of groundwater pollution. They reported, "*although ground water pollution by industrial-waste disposal is reported as relatively minor in many states, and even non-existent in some, it is, nevertheless, nation-wide in distribution*." Specific compounds mentioned as contaminating groundwater in 1952 and 1953 were petrol, phenols, picric acid, and cleaning fluid. When the same task force surveyed the states in 1957, 47 states replied and 42 of them reported groundwater contamination. Clearly the problem was growing or awareness of the problem was growing, or both. By 1960 the task force found the following chemicals contaminating groundwater in the U.S.: creosols, 2,4-D, dichlorophenol, petrol, hexachlorocyclohexane, hydrocarbons, kerosene, pentachlorophenol, phenol, picric acid, pyridine, and trichloroethylene.

15. The U.S. Public Health Service sponsored a national conference[5] in April, 1961, entitled "Ground Water Contamination." Attendees at the conferences reported the pollution facts given above, and a great deal more. The 1961 report of the conference makes it clear that the entire problem of groundwater

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[4] The Utilisation of old pits and quarries, and of cliffs, for the reception of rubbish Woodward HB, J.R. Sanit Inst., 27(9), 467-69.

[5] Ground Water Contamination, Proceedings of the 1961 Symposium April 5-7 1961 Cincinatti Ohio US Dept of Health, Education and Welfare. Available through NTIS.

contamination from chemical waste disposal, accidental spills and from landfilling of municipal wastes, was well known, well documented, and the subject of urgent warnings in 1961. The picture in 1961 was basically as we know it today.

16. The domestic regulatory framework was rather slow to catch up. The 17th December 1979 Council Directive on the 'Protection of Groundwater Against Pollution Caused by Certain Dangerous Substances' (80/68/EEC) provided the legal basis for system of groundwater protection which is still in place today. However this Directive should have been implemented by member states within two years of its notification (Article 21). It was clearly relevant to the Nantygwyddon site requiring, as it does, absolute protection of groundwater from List I substances in most circumstances.

17. The date of issue of the initial resolution to operate the Nantygwyddon landfill, June 1987, predated the implementation of the Directive into the domestic regulations. This was only affected in 1994 as Regulation 15 of the Waste Management Licensing Regulations 1994.

18. This tardy approach to the implementation of European Directives on Waste was not untypical (and continues with the late implementation of the Pollution Prevention and Control Directive). The Royal Commission on Environmental Pollution recommended in their Eleventh Report "Managing Waste: the Duty of Care"[6]:

    "13.2 In the waste management context we reiterate the comment in the 10th report that the United Kingdom should play a more positive role in the development of European Community environmental policy.

    There is every indication that UK policies and practices have less influence on European Community activities on waste management. Indeed, waste disposal is the only field that EEC Directives have not been implemented. Fortunately, the EEC Commission has so far turned a blind eye

19. As a matter of interest -the recommendations continued:

    "13.108 We consider that public acceptability of waste handling and disposal practices is essential. The process of seeking it has four necessary components:

    - *Information for the public*
    - *Involvement of the community*
    - *Incentives for the community*
    - *Implementation of high standards and their enforcement"*

20. Nantygwyddon and the handling of the problems has been a bad example on each of these components.

21. Containment landfill may have offered at least a temporary illusion that the risks of groundwater contamination could be averted and Nantygwyddon was part of a move in the UK, encouraged by WMP 26 the Department of the

[6] Cmnd.9675 December 1985

Environment technical guide to landfill practice, away from 'dilute and disperse' (or 'dump and pray') sites towards a new generation of containment sites – essentially 'dry tombs' where the intention was to keep the moisture input low and to calculate cell sizes to avoid, so far as possible, leachate generation during landfilling. An impermeable cap was then supposed to keep the waste from generating significant leachate – presumably in perpetuity.

22. WMP 26 acknowledged[7] that containment sites are intended to:

"3.10 …….isolate wastes and leachate from the environment for a considerable time (perhaps for decades, or even for hundreds of years)."

23. However it was obvious to those who considered the issue that such 'dry tomb' containment could only ever be a superficial solution. The Waste Management paper does not even address the obvious conflict between this advice and the statement later in the document that:

"4.55 The service life of a synthetic liner is expected to be up to 30 years. However since the use of liners is relatively new insufficient time has elapsed for data on their service life to be obtained"

24. Or, worse yet, at para. 4.60 that:

"most manufacturers will guarantee properly installed synthetic liners and soil sealants for only up to 25 years."

25. The almost inevitable failure of even a well laid composite liner before the site was complete had been made more clear in the US. Starting in the 1970s and continuing throughout the 1980s, the US. Environmental Protection Agency funded research which showed that landfill sites pollute ground and surface water. As long ago as 1981 USEPA said[8]:

"Manmade permeable materials that may be used for liners or covers (e.g. membrane liners) are subject to eventual deterioration, and although this might not occur for 10, 20 or more years, it eventually occurs and , when it does, leachate will migrate out of the facility."

26. By 1988[9] the position was stated even more clearly:

"First, even the best liner and leachate system will ultimately fail due to natural deterioration, and recent improvements in municipal solid waste landfill containment technologies suggest that release may be delayed by many decades at some landfills."

27. And more recently[10]:

28. *"Once the unit is closed , the bottom layer of the landfill will deteriorate over time and, consequently will not prevent leachate transport out of the unit."*

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[7] Para 3.10

[8] United States Federal Register - page 11128. 5th February 1981

[9] United States Federal Register 53(168)

[10] United States Federal Register 56(196) 9th October 1991

29. By 1993 Judith Petts was openly telling delegates at the Harwell Landfill Symposium in "*Let's not kid ourselves that containment provides the answer. Containment systems are not going to last the period leachates will be generated*".

30. The illusion that 'dry tomb' containment landfill provided a long term answer was not sustainable in the face of such clear statements of the fallacy that liners would last for the duration of the hazard they were supposed to protect the environment from. Waste Management paper 26 survived 9 years and the UK acknowledgement of the flawed concept of 'dry tomb' containment came with the publication of WMP 26B in 1995. This points out, for example:

    "It is now recognized that this [total containment and isolation of wastes] is unattainable and that it may be more responsible to design for controlled release than to attempt indefinite containment"

31. It was immediately obvious that "controlled release" of any leachate containing list I substances would be in conflict with the requirements of the Groundwater Directive. This was perhaps one of the less contentious aspects of WMP 26B however. The thrust of the WMP was the support of the bio-reactor concept of accelerated degradation. The aim was essentially to stay the implementation of the landfill directive and the emerging requirements for pre-treatment prior to landfilling as a solution to the long established problems of landfill sites. To support this attack on the Directive the Department of the Environment had published "UK Landfill Practice – Co-Disposal *Using nature's techniques to treat difficult wastes*". ENDS reported that the subsidiarity arguments being presented by the UK had better be good as it was difficult to find any evidence to support the technical ones.

32. Even the warnings on the necessary timescales for liner life at para. 3.10 of WMP 26 were understated. Freeze and Cherry[11] had reported in 1979 that landfills constructed by the Romans some 2000 years ago are still producing leachate.

33. Furthermore Belvi and Baccini[12] had confirmed in 1989, when operations at Nantygwyddon were starting that, landfill sites in a fairly wet climate could be expected to leak contaminants such as lead at above drinking water standards for thousands of years.

34. In 1996 Howard Robinson, of Aspinwalls, published a short paper in 'The Surveyor[13]' titled 'Timescales to Completion'. This showed what everybody who was keeping up to date already knew – that landfill sites, particularly deep ones, take centuries to complete. Robinson gave a simple methodology to calculate timescales for completion based on the need to flush between 5 and 10 bed volumes of clean water through a landfill site in order to reduce

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[11] Freeze,R.A. and Cherry,J.A.(1979) Groundwater Prentice Hall, Englewood Cliffs, NJ

[12] H.Belvi and P.Baccini (1989) "Long Term Behaviour of Municipal Solid Waste Landfills" Waste Mgt.&Res. 7:43-56

[13] 6/6/96

leachate strength to levels compatible with the surrounding environment without further treatment. More details of this are given below.

35. The problems of longevity were not only restricted to the liner, as described above. Even maintaining an effective landfill cap over the periods that would be necessary was implausible. The standard way to reduce the flushing of contaminants has been to engineer a low permeability cap on the site and WMP 26 emphasises:

    "3.33 ....The effects of the infiltration of rainfall make it imperative that both ground and surface water ingress into the landfill are controlled"

36. There is relatively little information in the contemporary literature on the magnitude of funds needed to properly maintain the cover of a landfill but Carden[14] conducted a review in 1981 of the potential costs of landfill maintenance. He wrote that the long term costs of post closure maintenance depends upon the rate of inflation; at 5%/yr inflation, the estimated cost for 200 years of cover maintenance for a landfill is $28 billion. At 10% inflation, that cost would be $154 trillion. This timescale, of course, seriously underestimates the period for which protection is required.

37. The final outcome of the shenanigans over the fifteen years since the publication of WMP26 is that the Council Directive 1999/31 on the Landfill of Wastes ("Landfill Directive") has been adopted in spite of the UK intransigence and comes into force on 16th July 2001.

38. The main objective of the Landfill Directive is to ensure high standards for the disposal of waste in the European Union, to stimulate recycling and recovery of waste and to reduce emissions of methane. The Directive's provisions aim to improve the standards of landfill disposal by placing controls on what nature of waste may be accepted at landfills and how such facilities are designed, constructed and managed. Most significantly, the Directive requires that, by 2016 (2020 at the latest[15]), the amount of biodegradable municipal waste going to landfill be reduced to 35% of the amount of such waste produced in 1995.

39. Article 1 explicitly refers to meeting the requirements of the Waste Framework Directive, and Articles 3 and 4 in particular, as the main aim of the Landfill Directive. This aim is to be met by way of stringent operational and technical requirements on the waste received and landfills themselves and measures to prevent or reduce as far as possible negative effects on the environment, in particular pollution of surface water, groundwater, soil and air and the global environment. Importantly, Article 1(2) explains that the Landfill Directive refers to the technical characteristics of landfills caught by the IPPC regime and that it contains the relevant technical requirements to "elaborate in concrete terms the general requirements of that Directive". The requirements of the IPPC Directive are deemed to be fulfilled if the requirements of the Landfill Directive are complied with.

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[14] Chemical Waste Disposal Facility Study, Heard, GA, Report for Heard County Commission, Georgia Technical University, Centre for Environmental Safety, Atlanta GA February 1981

[15] with the UK exercising a derogation available because of our high levels of landfill in 1995

40. Article 2 provides the necessary definitions and Articles 7, 8 and 9 deal with the application for, and the contents of a landfill permit. For landfills already in operation at the time of transposition of the Directive, they may not continue to operate unless certain steps are accomplished "as soon as possible and within eight years after the date laid down in Article 18(1) at the latest"[16]. The steps referred to include the presentation of a "conditioning plan for the site" within a year after the Article 18(1) date, which must include the particulars on the basis of which a competent authority has to satisfy itself before issuing a permit for a new landfill site under Article 8. A decision by the competent authority on whether operations may continue on the basis of the site conditioning plan must be made "as soon as possible".

41. Annex I details prescriptive engineering requirements for the different classes of landfill sites , Annex II waste acceptance criteria and procedures and Annex III detailed control and monitoring procedures during operations and aftercare.

42. A key Article of the Directive is Article 6 which requires that "Member States shall take measures in order that (a) only waste that has been subject to treatment is landfilled" The interpretation of 'treatment' will be crucial to the success of the Directive. The definition in Article 2 is:

    "'Treatment' means the physical, thermal, chemical or biological processes including sorting, that change the characteristics of the waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery"

43. Whilst a 'purposive' interpretation of the Directive would only define treatment as in a way which required that waste was moved up the hierarchy with only residual disposal some members of the industry (and, more worrying, the Environment Agency , have already argued that we already meet those requirements by the use of compactor collection vehicles or 'pre-sorting in the home prior to using bring collection systems'. The matter is not going to be resolved until the Environment Agency consultation on the definition which was due in January but I am now told has been postponed until July – perilously close to the implementation deadline.

44. Article 18 outlines the transposition of the Landfill Directive. Member states are to bring into force the necessary provisions to comply with the Directive no later than two years after its entry into force, i.e. 16th July 2001.

Site Engineering

45. It is clear that it was well known at the period the site was engineered that it was necessary to lay HDPE as a composite liner with clay or bentonite in order for it to be at all effective.

46. This can be seen, for example from the Welsh Affairs Committee[17] conclusions where they say:

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[16] Article 14

[17] 'Toxic Waste Disposal in Wales' Welsh Affairs Committee March 1990

"15 Well engineered sites are crucially important. It is extremely worrying that some operators have ignored the expert advice presented to them; e.g. Harwell advised Max Recovery to line its site at Cwmrhydycierw [which, like Nantygwyddon had a single HDPE liner] with bentonite but the operator failed to do so"

47. It was well known by the time the site was operated that the leakage from a geomembrane / composite could be empirically calculated from the formula derived by Giroud[18] et al:

$$q=c.a^{0.1}\ h^{0.9}K_s^{0.74}$$

Where:

q= flow rate (m^3/s)

c= a constant depending upon contact between the membrane and the subsoil (0.21 for good contact, 1.15 for poor contact)

h = head of leachate (m)

a= area of holes (m^2)

K_s = hydraulic conductivity of subgrade (m / s)

48. The impact of a composite liner over impermeable mineral rather than laying HDPE alone is shown in Figure 3.2 of WMP 26B. The seepage rates for HDPE alone with 5 x 3mm holes ha is 3,0000 litres / ha / day. Over mineral this is calculated to reduce to between 1 and 30 litres / ha / day. The source cited by WMP 26B is Gross et al (1990) but the results could certainly have been calculated before 1998.

49. Notwithstanding the poor construction of the site liner at Nantygwyddon if the precautionary advice in WMP26 had been followed then the site would not have been developed. The guidance given by the Department of the Environment in WMP 26 is quite clear about the risks to groundwater and says:

"If the failure of a liner would regardless of other precautions, result in an unacceptable deterioration of water quality, such a site should only be used for inert wastes"

50. This is sound advice and if more often applied some of the problems that are currently being stored for the future would be avoided.

51. Even if the site was proceeded with the technology was certainly available at the time to include leak detection systems. The Cleanaway landfill site at Sandy Lane, Bromsgrove was approved only about 4 years after Nantygwyddon and the technology used had been well established in the US and Europe . The Environment Agency public register for that site shows that the leak detection system has found many holes in the high density polyethylene liner which would otherwise remain undetected. Furthermore even site licence conditions requiring that the waste laid adjacent to any liner

[18] Evaluation of the rate of leakage through composite liners" Giroud JP, Khatami A & Badu-Twenboath K. Geotextiles and Geomembranes, Vol 8,pp 337-340

would be unlikely to cause damage has not prevented landfilled wood and metal penetrating through the 0.5 m sand protection layer and the liner. Holes of 9x7cm and 5x6 cm were created in this way on the Sandy Lane site. Even with moderate leachate heads holes of this size give massive leakage rates – especially with liners laid as at Nantygwyddon.

52. One reason that the operators (and regulators) do not favour these systems is that they clearly demonstrate the failings of current landfill operations. For example there are several holes which have been detected in the Sandy Lane liner but which have not been able to be repaired as they are buried under too much waste.

Gas Problems

53. Most attention in the late 1980s on landfill gas focused on methane risks following the explosions at Loscoe, Derbyshire in March 1986 and at Stone, Kent in December 1997.

54. The results of the lessons from these explosions were not being disseminated very effectively however. The Environment Committee[19] was particularly critical in February 1989 saying:

""62.....we regard the general lack of awareness on this issue to be a symptom of the immaturity, lack of professionalism and low status of waste management"

55. Methane generation was certainly not the only problem. The production of a wide range of non-methane volatile organic gases by landfill sites was well known and documented by the mid-1980's. By 1986 WMP 26 reported the gases shown in appendix 1 for example. Waste Management Paper 27 on Landfill Gas was also first published in January 1989 and raises the issue again.

56. The potential health risks of VOCs were also known. A paper presented in October 1998 by Hickman[20], for example, to an international conference at Chester said:

"Federal efforts to Regulate Air Emissions from Landfills

At the federal level, under the authorities of the Clean Air Act EPA is moving rapidly to establish national regulatory requirement for air emissions from landfills. The major concerns are directed at volatile organics (VOCS) and toxic constituents in landfill gas."

57. A paper presented by Gary Bennett to the 3rd International Symposium on Operating European Hazardous Waste Management Facilities, Dense, Denmark in September 1986 and subsequently published following peer

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[19] Environment Committee Second report 'Toxic Waste' Vol I, 22nd February 1989

[20] "Regulating Municipal Solid Waste Management in the United States" Hickman HL , executive Director Governmental Refuse Collection and Disposal Association in Proceedings of International Conference on Landfill Gas and Anaerobic Digestion of Solid Waste held in Chester England 4-7 October 1998 ISBN 0-7058-1159-X

review[21] listed 53 references predating the construction of Nantygwyddon detailing the emissions of non-methane volatile organic compounds from landfill sites. He concluded:

"it is clear that air quality considerations, modeling and ambient air modeling lag the status of groundwater by several years. But the problem is recognized and it appears the USEPA is on a fast-track approach to define the problem and its magnitude with a view to promulgation of regulations.

The regulations will probably be in two major areas: (1) requirements for measurement of air quality at the site with a view to control measures that limit the negative aspects of site activity, and (2) modeling of emissions resulting in a production of air quality with a view to limitations in chemicals placed in the landfill"

58. It is regrettable that more than fifteen years later the Environment Agency still does not require measurement or modelling of NMVOC emissions from landfill sites. Had Nantygwyddon monitoring been 'state of the art' from the late 1980s with full monitoring of methane and NMVOCs from the commencement of operations the data collected could have been extremely helpful for reviewing exposures which may lead to off site health impacts.

59. The risks of production of hydrogen sulphide from the actions of anaerobic bacteria on high sulphate wastes were also known and documented. WMP 26 says:

"7.147 Many hazards which exist at landfill sites, are common to other areas of employment , such as the extensive use of mobile plant and vehicles. It is essential therefore that those responsible for safety matters at a landfill site recognize and deal both with the normal hazards and those which are unique to landfill operations. These include:

….

(ii) the hazards which may result from the mixing of incompatible wastes – this hazard may be aggravated by a lack of knowledge of the precise composition of the waste e.g. gypsum in admixture with household waste can generate hydrogen sulphide"

60. A warning was also made about the generation of arsine [generally trimethylasine, $As(CH_3)_3$ from arsenic compounds under similar anaerobic conditions].

61. There is really no excuse, therefore, for the operators not knowing that the deposit of the calcium sulphate residues on the site would cause odour problems – particularly as there had been past problems with the calcium sulphate waste stream.

[21] Air Quality Aspects of Hazardous Waste Landfills, Bennett G F, Dept of Chemical Engineering, University of Toledo, Hazardous Waste & Hazardous Materials, Vol 4 No. 2 1987

Issue Two:

The failure to properly address the 'Relevant Objectives' which arise from the Waste Framework Directive as transposed by the Waste Management Licensing Regulations 1994 – particularly in relation to Articles 3, 4 and 7. This has resulted in a failure to protect the health of the local population and adverse impacts on the environment in general.

62. Council Directive 75/442/EEC, substantially amended by Council Directive 91/156/EEC established a set of rules on the disposal and recovery of waste. This "Waste Framework Directive" defines the various terms used, including most importantly the definition of "Directive waste"[22] and excludes certain other categories of waste from its scope[23].

63. The key objectives of the Directive are set out in Articles 3, 4 and 5 which must be implemented by member states through a system of permits for the disposal and recovery of waste provided for under Articles 9 and 10. The key objective is Article 4 which requires member states to take the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment and in particular without risk to water, air, soil plants or animals etc (see below for full wording).

64. Article 7 requires the competent authorities within member states to draw up waste management plans which must relate in particular to:

    (a) the type, quantity and origin of waste to be recovered or disposed of;

    (b) general technical requirements;

    (c) any special arrangements for particular waste; and

    (d) suitable disposal sites or installations.

65. The plans were initially implemented through plans that the Waste Regulatory Authorities[24] were required to draw up under section 50 of the Environmental Protection Act 1990 ("EPA 1990"). That provision was repealed by the Environment Act 1995 and now waste plans and strategies are produced by government which then inform the adoption of development plans by Local Planning Authorities. The first national plan relevant to Nantygwyddon was 'Making Waste Work', published in 1995 (described as a partial implementation of Article 7). The most recent plan is "Waste Strategy 2000" which will be supplemented, or superseded in Wales by the Welsh Waste Strategy due to be published later this year.

66. The system of waste management licensing set out in Part II of the EPA 1990 (as amended by the EA 1995) was modified in a number of ways to take

[22] Article 1

[23] Article 2

[24] It is understood that no s.50 plan was completed for the Nantygwyddon area

account of the Waste Framework Directive. Sections 33 to 45 provide an enhanced system of licensing control on the management of waste. A number of additional features were introduced to the previous system of waste disposal licensing under the Control of Pollution Act 1974. In addition the Waste Management Licensing Regulations 1994 were introduced in order to give effect to the Waste Framework Directive (and the Groundwater Directive, as described above) in particular they incorporated the definition of Directive waste into the EPA regime and implemented the objectives contained in Articles 3, 4 and 5, known for the purposes of the regulations as the "relevant objectives"[25].

67. The UK has transposed the Directive largely by means of the Waste Management Licensing Regulations 1994. Paragraph 2 (1) of Schedule 4 of the WMLRs states:

"....the competent authorities shall discharge their specified functions, in so far as they relate to the recovery or disposal of waste, with the relevant objectives."

68. The meaning of competent authorities and their specified functions are set out in Table 5, Schedule 4 of the Waste Management Licensing Regulations 1994 which indicates, inter alia:

Competent Authority	Specified Function
A Waste Regulation Authority. The Secretary of State or a person appointed under [section 114(1)(a) of the Environment Act 1995	Their respective functions under Part II of the 1990 Act in relation to waste management licences including preparing plans or modifications of them under section 50 of the 1990 Act [and preparing the strategy, or any modification of it, under section 44A of that Act].

69. The relevant 'competent authority' for Nantygwyddon has therefore been the Environment Agency since 1st April 1996 and the local authority Waste Regulation Authority from the opening of the site until that date. The specified functions includes the decisions made in relation to the issuing and regulation of Waste Management Licences.

70. The Relevant Objectives are:

Article 3:

"take appropriate measures to encourage ....
i) the recovery of waste by means of recycling, re-use or reclamation or any other process with a view to extracting secondary raw materials or
ii) the use of waste as a source of energy"

[25] see: Regulation 19 and paragraph 4 to Schedule 4, WMLR 1994

Article 4:

"take the necessary measures to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment, and in particular:

i) without risk to water, air, soil and plants and animals;

ii) without causing a nuisance through odours;

iii) without adversely affecting the countryside or places of special interest".

71. The interpretation of the Directive as part of UK law is attempted by policy guidance. As is noted in Circular 11/94[26]:

"This verbatim transposition avoids the need to interpret the Directive in the Regulations. However, it also makes it even more important to have clear guidance on the meaning of these provisions so that they are interpreted consistently by WRAs [Waste Regulation Authorities] and other regulatory authorities, and there is a common understanding of their effect."

72. According to circular 11/94 [27]

"The key objective which underlies the whole of the Directive is Article 4, and this has been transposed into the Regulations as paragraph 4(1)(a) of Schedule 4. This makes it a relevant objective to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment, ..."

73. The effect of the wording of Article 4 becoming "relevant objectives" is arguably to weaken its legal significance since the aim or purpose of provisions carries less importance when interpreting UK legislation than in interpreting EC legislation.[28] With or without 'direct effect'[29] there is no

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[26] Annex 1, Para 1.4

[27] DoE Circular 11/94 Annex 1 para 1.25

[28] This important difference of interpretation of laws was recognised in DoE Circular 11/94 Annex I para 1.3

[29] The Lombardia judgement [Comitato di Coordinamento per la Difesa della Cava v Regione Lombardia and Others (Case C-236/92)] investigates the question of whether Article 4 of the then unamended version of the Waste Framework Directive (75/442/EEC) meets the criteria to be directly effective. The Court concludes that as Article 4 is not 'unconditional' therefore the provisions are not directly effective. The Judgement also says that:

"12. Considered in its context, Article 4 of the directive, which essentially repeats the terms of the third recital in the preamble, indicates a programme to be followed and sets out the objectives which Member States must observe in their performance of the more specific obligations imposed upon them by Articles 5 to 11 of the directive concerning planning, supervision and monitoring of waste-disposal operations" [my emphasis]

The objectives are therefore considered to be 'obligations' albeit less specific than the 'obligations' imposed by the following Articles. Nowhere in the Lombardia Judgement, is there any comment that supports the argument that the relevant objectives can be treated simply as 'material considerations'. Furthermore *The Journal of Environmental Law* 'Case Law Analysis' comments:

"Kramer describes the prohibition in Article 4 that wastes must be disposed of without risk to human health or the environment as unambiguous. And, since Article 4 does not allow Member States a discretionary margin, for example to permit a method of waste disposal which poses a risk

authority for simply assuming that it is possible to interpret the relevant objectives in the terms of it being acceptable to allow some risk, or harm, to air, soil, plants or animals. Clearly it is a tough test. Professor Richard Macrory summed up the situation of the Waste Framework Directive in the ENDS Law report:

"As has so often happened with EC Directives, Member States no doubt agreed to the general principles concerning the disposal of waste without risk to human health and the environment without appreciating the full consequences of what they were doing."[30]

74. Paragraph 1.47 of Circular 11/94 Annex 1 states:

"The general duty in paragraph 2(1) [of Schedule 4 to the 1994 Regulations] means that in exercising the specified functions authorities must always consider the objectives of the Directive and aim to determine decisions ... in line with them" [emphasis added]

75. This is broadly the language of materiality (to consider) but the duty imposed by the relevant objectives is far more onerous than this implies. Para 2(1) actually requires that:

"*2(1) ...the competent authority shall discharge their specified functions, insofar as they relate to the recovery or disposal of waste, with the relevant objectives*" [my emphasis]

76. It is also plain from the wording of Article 4 and the reference to "ensure" that the duty is a mandatory one.

77. Besides the Article 4 duties which are clearly central to the protection of health and extremely relevant for the regulation of Nantygwyddon other important duties arise from the requirement to[31] *"implementing, so far as material, any plan made under the plan making provisions"*. This means that the decision must be made with the objective of implementing, so far as material, WS 2000 (or any earlier plans where these were prepared in accord with the requirements of Article 7 of the Directive). There are many important consequences which follow from this, not least the need now to consider Best Practicable Environmental Option (BPEO) for the waste which would be disposed of at the site in accordance with WS2000.

Best Practicable Environmental Option

78. The determination of Best Practicable Environmental Option (BPEO) for the waste streams disposed of at the landfill has therefore been relevant to the Waste Management Licensing functions since, at least, the publication of Making Waste Work in December 1995. Neither the Environment Agency nor the WRA before them have addressed this material issue in the determination or modification of the WMLs for operations on the site.

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to human health, he considers it to be sufficiently precise, and hence capable of producing direct effects."

[30] *'Key decision on BPEO and use of solvents in lime and cement kilns'*, ENDS 280, May 1998

[31] WMLR Sch 4 Para 4 (2)

79. The assessment of Best Practicable Environmental Option is particularly holistic and it is useful to consider the definition of BPEO. The Royal Commission on Environmental Pollution[32] definition of BPEO, which is adopted in 'Waste Strategy 2000' (and in 'Making Waste Work') is:

> *"A BPEO is the outcome of a systematic consultative and decision making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term"*

80. It is clear that although the assessment of BPEO is material at the Land Use Planning stage (following the decision in the high Court and Court of Appeal in R v Bolton Metro ex parte Kirkman and, more recently, the adoption of BPEO by PPG 10 in England) the concept must also be linked to the pollution control system. If it was not then the Royal Commission definition which implies continuous review and change could not be applied in practice as there is no realistic mechanism in the planning system for such review and change without payment of compensation. The pollution control permits can, by contrast, be unilaterally modified, whenever it is necessary by the Environment Agency.

81. The DETR Revised Departmental Guidance[33] helps to put BPEO in context for potentially hazardous operations and advises that:

> *The BPEO is a term of policy guidance. It is the option which provides the most benefit or least damage to the environment as a whole, at an acceptable cost in both the long and short term. The BPEO, as a concept with legal basis, was introduced with IPC under Part I of the Environmental Protection Act 1990. Operators of prescribed industrial processes which produce releases to more than one environmental medium must ensure that BATNEEC is used to minimise pollution to the environment as a whole, having regard to BPEO. Again, an element of cost versus environmental benefit/risk is brought into play in deciding which process option constitutes BPEO. A key feature of the BPEO approach is that decision-making is transparent and that an audit trail exists so that all stages in the choice of the BPEO can be scrutinised.*

82. Clearly the narrow definition from the Environmental Protection Act 1990 has now been brought closer to the Royal Commission Definition by Waste Strategy 2000 and PPG 10 but the term still requires that the process is completely transparent and that an audit trail is maintained.

83. It is clear, therefore, that in the assessment of BPEO the pollution control / risk / Hazard aspects of the proposals are material. This is consistent with the requirements of the "relevant objectives" Waste Framework Directive which are described below. Waste Strategy 2000 indicates that:

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[32] RCEP. 12th Report "Best Practicable Environmental Option". 1988

[33] Guidelines for Environmental Risk Assessment and Management, Revised Departmental Guidance DETR, 2000 available from **http://www.environment.detr.gov.uk/eramguide/index.htm**

"4.4 The right way to treat particular waste streams cannot be determined simply. The objective is to choose the Best Practicable Environmental Option (BPEO) in each case. BPEO varies from product to product, from area to area and from time to time."

84. Whilst BPEO must be site specific Waste Strategy 2000 includes a generic assessment of BPEO. This shows that the disbenefits associated with landfill are so great that it is very unlikely that a properly formulated BPEO assessment, according with the RCEP definition, would result in large scale landfill being selected for mixed waste with no pre-sorting or pre- treatment. This conclusion must be particularly strong for a site which presents so many other disadvantages and where the Environment Agency agree that the pollution control system cannot prevent disamenity to neighbours as the site is so close to housing (see below).

85. The Government has accepted that landfill is environmentally damaging as shown in Table C4 of Waste Strategy 2000 which indicates that the external costs are:

Table C4: **External costs and benefits of different waste management options**	
Waste Management Option	External Cost Estimate, £ Per Tonne of Waste,1999 Prices
Landfill	-3
Incineration (displacing electricity from coal-fired power stations)	+17
Incineration (displacing average-mix electricity generation)	-10
Recycling	+161
-Ferrous metal	+297
-Non-ferrous metal	+929
-Glass	+196
-Paper	+69
-Plastic film	-17
-Rigid plastic	+48
-Textiles	+66

86. It can be seen that landfill causes environmental damage valued at around £3/tonne whilst recycling the same waste gives environmental benefits of more than £160/tonne. The opportunity cost of landfill in terms of environmental protection is therefore extremely large.

87. These calculations from Waste Strategy 2000 are indicative and it is important to recognise that the disbenefits assessed in the assessments are limited. Energy, transport and greenhouse gas emissions are the principal environmental factors considered in the analysis. The life cycle analysis and economic valuations focus on the impact of air pollution from waste facilities and vehicles, and the emissions associated with energy use. The impacts of the greenhouse gases carbon dioxide, carbon monoxide, methane and nitrous oxide were considered, as were those of sulphur and nitrogen oxides and PM_{10} particulates. The cost of road accidents was also brought into the equation.

88. Several environmental costs and some benefits were excluded from the analysis however. Most importantly, these include the disamenity impacts of waste management facilities. Omitting them from the equation also means that other options get no credit for averting disamenity. Landfill leachate and

certain air pollutants, including dioxins emitted from landfill flares and incinerators were also excluded from the assessment. Another omission is any measure of the damage to nature and disamenity caused by mineral and peat extraction. Neither does the study include any scarcity value for non-renewable materials. If these factors were included then the environmental costs of landfill and incineration would almost certainly be significantly greater than the current estimates. Recycling and materials recovery options would therefore tend to have higher relative environmental benefits – certainly far exceeding the current incremental costs of materials recovery compared to landfill.

89. The BPEO assessment should provide detailed information about levels of waste arisings; their composition; their locations; and development of markets / alternatives.

90. When the National Waste Strategy for Wales is adopted then the Environment Agency will have to consider as part of the BPEO assessment the resolution of the Assembly passed in May 2000 by the National Assembly for Wales[34] including:

"that a planning presumption be introduced against further incineration and landfill developments in the interests of sustainability"

Health the Relevant Objectives and BPEO

91. The Matter of the potential health impacts on local residents is a key part of both the Relevant Objectives and of BPEO

92. There is significant concern that the operation of even modern landfill sites presents a health risk to neighbouring residents and some of the possible reasons for these impacts are detailed in the paper I prepared for the Welsh Office meeting on 10th November 1998 and which is already before the investigation.

93. I also submitted a March 2000 paper by Marine Vrijheid 'Health Effect of Residence Near Hazardous Waste Landfill Sites: A Review of Epidemiologic Literature' and published in Environmental Health Perspectives[35] This is derived from a March 1998 report by Martine Vrijheid (of the London School of Hygiene and Tropical Medicine) for the North West Region of the Environment Agency. The Environment Agency concluded that on the basis of the available evidence that there were no 'large' risks to human health but that landfill sites may represent real risks in certain circumstances. Large in this context was described by the Environment Agency as 'equivalent to smoking or young men driving cars' which would be much higher risks than most people would tolerate as involuntary risks from a landfill site and would not be compatible with the Relevant Objectives of implementing Article 4 of the Waste Framework Directive.

94. I have attached (appendix 2) a review of recent research on association of health impacts with landfill sites by Dr Peter Montague in the United States as

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[34] National Assembly for Wales, The Official Record, 10 / May 2000 http: / / www.wales.gov.uk

[35] Vol 108, Supplement 1 March 2000

an indication of the body of evidence at the time of the 1998 Welsh Office meeting. More work has been published since that review (and since that of Vrijheid in EHP) so it has been surprising that:

- The Welsh Office never followed up on the November 1998 meeting (nor did they give any feedback on my paper[36]) .
- it was so difficult to obtain the minutes of the meeting held at the Institute of Environment and Health (and attended by a variety of representatives of consultancies, Government bodies, Regulators and industry representatives. The Welsh Office was represented by Paul Tromans.

95. In response to the general concerns about the health impacts of landfill sites the Government announced a new research programme on landfill and health in September 1999[37] having commissioned a review by the Small Area Health Statistics Unit (SAHSU) following up on the work by Dolk. SASHU have not yet reported although it was initially anticipated that the work would have been completed by Summer 2000[38]. The research currently examining the risks associated is clearly relevant to the investigations at Nantygwyddon and it is hoped that the results of this study will be made available to the investigator (and for public/NGO review) before the close of the investigation.

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[36] I note that since submitting that paper there has been a great deal of material published indicating that low dose exposure to endocrine disruptors brings into question current standards for chemical exposure. Even in the last month, for example, there has been a major report by the US NTP (http://ntp-server.niehs.nih.gov/htdocs/liason/LowDosePeerFinalRpt.pdf) National Toxicology Programme in which a panel of academic, government and industry scientists has determined that there is "credible evidence" that some hormone like chemicals can affect test animals' bodily functions at very low levels – well below the "no effect" levels determined by traditional testing. Secondly a paper published in the Lancet (Renal function, cytogenetic measurements, and sexual development in adolescents in relation to environmental pollutants: a feasibility study of biomarkers The Lancet Volume 357, Number 9269 26 May 2001) which finds association between incinerators and health impacts (including reduced testes and breast sizes) and concludes "that current environmental standards do not prevent measurable biological effects."

[37] DETR Press Release No:928, 22nd September 1999 Government Announces New Research Programme on the Impacts on Health of Landfill Sites: "The research programme, which is being set up by the Department of Health, the Department of the Environment, Transport and the Regions, the Health and Safety Executive, and the Environment Agency, is a response to concerns caused by reports of a possible association between landfill sites and congenital anomalies.

The research is designed to provide further scientific data to support the development of Government policy on landfill in general, and to inform the debate on the possible effects on human health of landfill. It will also include projects on the known causes and geographical variation of congenital malformations to help put into context the results on congenital malformations and landfill sites."

[38] DETR Press Release No:928, 22nd September 1999 Government Announces New Research Programme on the Impacts on Health of Landfill Sites: "Note 4. SAHSU Study: The Small Area Health Statistics Unit (SAHSU), based at Imperial College is undertaking for funding Government Departments(DH, DETR, HSE, DHSS(NI), the Scottish Executive and the National Assembly for Wales), a study of health effects around landfill sites in England, Scotland and Wales. The study will examine birth outcomes, including congenital anomalies, and cancer in populations living near landfill sites. The study is expected to report next summer."

Issue Three:

The failure to require adequate financial provisions and to properly address the related issues of sustainability

96. Section 74 of the Environmental Protection Act 1990 requires that financial provision is able to be made which is adequate to discharge the obligations arising from any licence. Specifically this section requires that the Environment Agency shall not treat as being a 'Fit and Proper person' any person if it appears to the authority:

    (c) that the person who holds or is to hold the licence has not made and either has no intention of making or is in no position to make financial provision adequate to discharge the obligations arising from the licence.

97. The Environment Agency 'Financial Provision Manual' says that:

    "7.1.3 Operational life

    Costings will be greatly influenced by the estimated life of the site (including post closure stage). It is therefore vital that early agreement is reached with the licence holder/applicant on this issue, purely as it effects financial provision. This should, in any event, be a matter that has been taken into consideration in the design of the site. The life expectancy will affect the likely need for maintenance (and possible replacement) of pollution control systems, including gas and water monitoring boreholes, landfill gas and leachate extraction systems and containment systems, such as liners or impermeable pavements."

98. There is no indication that any agreement has been reached on the estimated life of the site in spite of the guidance indicating that this is 'vital' at an early stage. The target period for bringing landfill to a stable non-polluting state is 30 years[39] . This derives from paragraph 1.22 of Waste Management Paper 26B[40]:

    "1.22 The UK and many other countries are parties to the 1992 agreement on sustainable development at the Earth Summit. The UK's strategy for sustainable development was published in 1994. ***In the field of waste management, the strategy requires that the present generation should deal with wastes it produces and not leave problems to be dealt with by future generations. For the purposes of this Paper a generation is regarded as 30-50 years after completion of the landfill operation for each separate part of a site.*** [my emphasis]

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[39] generally taken as being 'one generation' which is consistent with the Environment Agency submission to the House of Lords "Sustainable Landfill" inquiry defining one generation as 30 years

[40] Waste Management Paper 26B - Landfill design, construction and operational practice, HMSO 1995

And:

"1.25 A key issue for landfilling is therefore how to optimise the design and operation of every site in order to achieve the overall objectives of environmental protection and beneficial afteruse, compatible with the aims of sustainable development."

99. The Agency financial provisions guidance goes on to say:

"For putrescible landfills, any discussion on life expectancy will be influenced by the extent to which the operator intends to achieve rapid stabilisation of the site. Where the site is to be designed and operated as a sustainable landfill (embodying the principles of Waste Management Paper No 26B, including sub-cap leachate recirculation and active gas extraction), it may be reasonably concluded that the site will have an aftercare period of 30 years (unless the applicant is able to demonstrate to the contrary). Where the manner of proposed operations is unlikely to give rise to rapid stabilisation, the aftercare period is likely to be significantly longer. In such circumstances the applicant should be asked to calculate the likely after care period."

100. A particular problem that faces the recirculation of leachate in the future should be the requirements of the landfill Directive that:

Article 5 (3) Member states shall take measures to ensure that the following wastes are not accepted in a landfill:

(a) liquid waste

101. Leachate is clearly a liquid waste. Furthermore the Directive requires that:

Annex 1 (2) Appropriate measures shall be taken ….in order to:

- control water from precipitation entering into the landfill body

- prevent surface and/or groundwater entering into the landfill body.

102. There has been no indication, in any case, that the operators of the Nantygwyddon site intended to recirculate leachate or were able to achieve accelerated stabilisation.

103. Even if this had been the intention then it would be important to have supplied as part of the licence detailed information on a range of factors which have clearly not been provided. This includes the rate of leachate recirculation; the method of introducing leachate to the site; the daily cover to be used etc.

104. To bring a landfill site to a stable non polluting state the following processes must have occurred within a period of 30 years :

a) Accelerated degradation has broken down all parts of the refuse to achieve a stable non polluting state.

b) Flushing of all parts of the waste mass has removed all soluble degradation products to a degree that the release of any future leachate from the site is of a quality compatible with the surrounding environment.

c) The amenity of the residents and protection of the environment must have been maintained both from the landfill and from ancillary

equipment such as that for gas collection, leachate treatment and recirculation – each of which would be under greater loading in the early years of a bio-reactor operation.

105. There is no evidence that these would (or even could) be achieved. In these circumstances it cannot be reasonable to assume that a 30 year period would be sufficiently long for a bond. A simple calculation can be used to demonstrate the timescale to completion without any flushing as currently proposed.

106. The calculation requires that the 'mean hydraulic retention time' (MHRT) of the landfill site (i.e. the period of time it would take to flush one bed volume of water through the site) is calculated. This is relatively a simple matter[41] - in this case it is calculated on the basis of the timescale per 10 m of site depth so that it can be applied more generically:

The assumptions made are that

Fc - Wastes field capacity[42] 43% by weight moisture content

Ir - Infiltration rate into waste 20 mm pa (flow through capped site)

ρ - Density 0.8 tonnes / m^3

D- per 10 m of Site depth = 10

$$MHRT = Fc \times \rho \times D / Ir$$

$$= 0.43 \times 0.8 \times 10 / 0.02$$

$$= 172 \text{ years}$$

107. To achieve long term storage quality it is estimated that between 5 and 10 bed volumes must be flushed through a site even if the waste was homogeneous.

i.e. a total time of between 860 and 1,720 years[43].

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[41] See, for example, 'Timescales to Completion', The Surveyor 6/6/96 – a similar calculation can also be undertaken using Landsim

[42] Field Capacity is defined as: "The condition when the waste contains the maximum amount of moisture that it can retain against the pull of gravity when allowed to drain freely. Any further addition of water would cause an equal amount of free leachate to drain from the waste." The figure of 0.33 agrees with the original WMP 26 which gives a figure (Fig 3.42 p 42) of general relationship between moisture content and waste density. It can be seen from this figure that the field capacity at a density of 1 tonne / m^3 is about 33% and rises to about 43% @ both 0.8 tonnes / m^3

[43] If these figures seem unreasonable it may be relevant to consider that Environment Agency evidence to a public inquiry in relation to a WML appeal at Stewponey showed that the Environment Agency calculations for the timescales to complete that site indicated that the time that would be taken for the leachate to reach a concentration of 5 mg/l of ammoniacal nitrogen was 1113 years (Bill Wilkes Appendix EA/BW/1). The Eastern Region also recently rejected a WML application for a landfill site at Sandon, Chelmsford on grounds including "the licence application provides little or no indication of the likely timescale to achieve stabilisation. In the absence of any specific proposals designed to enhance landfill stabilisation the Agency must assume that the timescale for landfilled wastes to achieve such conditions (as understood within Waste Management Paper 26B) is likely to be far in excess of 30-50 years".

108. To this must be added the time to reach field capacity and, less predictably, the time to soak those areas that have been bypassed because of inevitable short circuits for the water flow down through the site. Even if all the effective rainfall was allowed to enter the site the timescale would still be in the range of 86 to 172 years per 10m of site depth.

109. This is clearly not a sustainable option for the site and is not an option which can meet the requirements of Section 74 of the 1990 Environmental Protection Act.

110. Furthermore even if financial provision had been required by the Environment Agency it would not have provided for the necessary timescale – to the best of my knowledge no financial provision for any site in Wales to date is adequate to cover the long term environmental liabilities they present.

111. Article 8 of the Council Directive 1999/31/EC on the Landfill of Waste goes further than s74 of EPA 1990 in requiring, inter alia, not just that the holder of any permit should be in a position to make adequate financial provision but that:

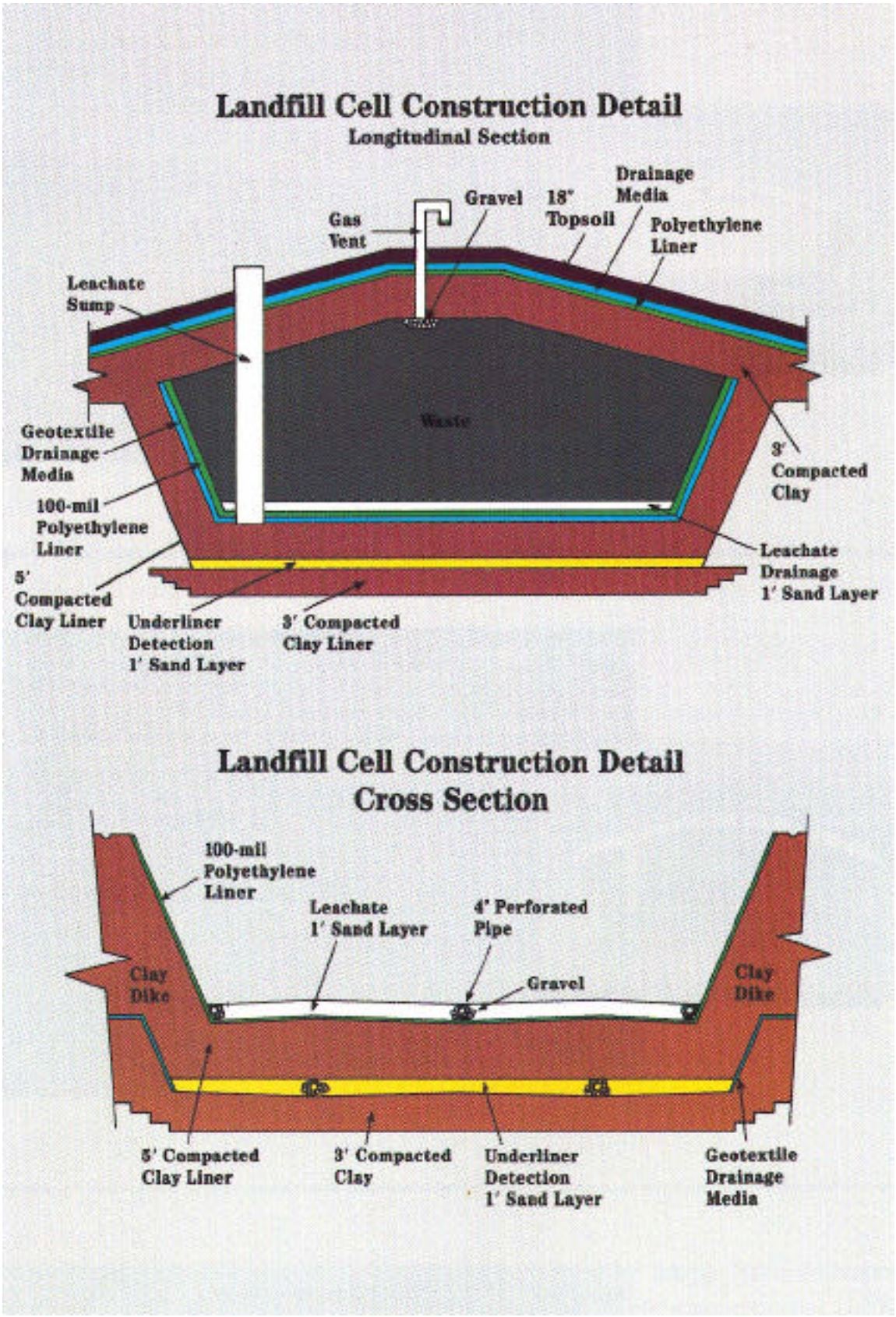
(iv) adequate provisions, by way of a financial security or any other equivalent, on the basis of modalities to be decided by Member States, has been or will be made by the applicant prior to the commencement of disposal operations to ensure that the obligations (including after-care provisions) arising under the permit issued under the provisions of this Directive are discharged and that the closure procedures required by Article 13 are followed. This security or its equivalent shall be kept as long as required by maintenance and after-care operation of the site in accordance with Article 13(d).

112. That is the actual provision must be made prior to the commencement of disposal operations. Article 13 (d) requires that this security must be provided:

(d) for as long as the competent authority considers that a landfill is likely to cause a hazard to the environment and without prejudice to any Community or national legislation as regards liability of the waste holder, the operator of the site shall be responsible for monitoring and analysing landfill gas and leachate from the site and the groundwater regime in the vicinity of the site in accordance with Annex III.

113. I recommend that a key recommendation of this investigation should therefore be that the Environment Agency must start taking seriously the very long timescales for which mixed waste landfills sites provide a threat to the environment and require commensurately large financial provision before operations commence. It is also essential that the details of these provisions are open to public scrutiny. The transfer of licences without making any or proper financial provision is a recipe for a repeat of the fiasco that has blighted the area around the Nantygwyddon site for far too long.

Appendix 1


Landfill Cell Construction Detail
Longitudinal Section
Gas Vent
Gravel
18" Topsoil
Drainage Media
Polyethylene Liner
Leachate Sump
Waste
Geotextile Drainage Media
100-mil Polyethylene Liner
5' Compacted Clay Liner
Underliner Detection 1' Sand Layer
3' Compacted Clay Liner
3' Compacted Clay
Leachate Drainage 1' Sand Layer
Landfill Cell Construction Detail
Cross Section
100-mil Polyethylene Liner
Leachate 1' Sand Layer
4" Perforated Pipe
Gravel
Clay Dike
Clay Dike
5' Compacted Clay Liner
3' Compacted Clay
Underliner Detection 1' Sand Layer
Geotextile Drainage Media

Appendix 2 – Landfills and Health

RACHEL'S ENVIRONMENT & HEALTH WEEKLY #617

-September 24, 1998-

LANDFILLS ARE DANGEROUS

A new study by the New York State Department of Health reports that women living near solid waste landfills where gas is escaping have a four-fold increased chance of bladder cancer or leukemia (cancer of the blood-forming cells).[1]

The new study examined the occurrence of seven kinds of cancer among men and women living near 38 landfills where naturally-occurring landfill gas is thought to be escaping into the surrounding air. Of the 14 kinds of cancer studied (7 each in men and women), 10 (or 71%) were found to be elevated but only two (bladder and leukemia in women) achieved statistical significance at the 5% level. The seven cancers studied were leukemia, non-Hodgkin's lymphoma, liver, lung, kidney, bladder, and brain cancer. In women living near landfills, the incidence of all seven kinds of cancer was elevated. In men, the study found elevated (though not statistically significant) incidence of lung cancer, bladder cancer, and leukemia.

What is most surprising about the New York study is that it only examined 38 landfills. The state Department of Health began looking at 131 landfills, but eventually studied only 38 of them (29%) on the grounds that only those 38 were likely to be releasing gases. In contrast, a 1990 study of 356 California landfills found 240 of them (or 67%) emitting one or more toxic solvents.[2] It is not clear why New York authorities assumed that gases are escaping from only 29% of New York landfills when toxic gases have been measured escaping from 67% of the landfills tested in California.

Landfill gas consists of naturally-occurring methane and carbon dioxide, which form inside the landfill as the waste decomposes. As the gases form, pressure builds up inside a landfill, forcing the gases to move. Some of the gases escape through the surrounding soil or simply move upward into the atmosphere, where they drift away.

Typically, landfill gases that escape from a landfill will carry along toxic chemicals such as paint thinner, solvents, pesticides and other hazardous volatile organic compounds (VOCs), many of them chlorinated.

The New York state health department tested for VOCs escaping from 25 landfills and reported finding dry cleaning fluid (tetrachloroethylene, or PERC), trichloroethylene (TCE), toluene, 1,1,1-trichloroethane, benzene, vinyl chloride, xylene, ethylbenzene, methylene chloride, 1,2-dichloroethene, and chloroform in the escaping gases.[1]

This is not the first study to show that people living near landfills have an increased incidence of cancer. A 1995 study of families living near a large municipal solid waste landfill (the Miron Quarry) in Montreal, Quebec reported

an elevated incidence of cancers of the stomach, liver, prostate, and lung among men, and stomach and cervix/uterus among women.[3]

A 1984 study reported that men (but not women) living near the Drake Superfund site in Pennsylvania, had an excessive incidence of bladder cancers, though occupational exposures could not be ruled out as the source of those cancers.[4]

A 1990 study found an increased incidence of bladder cancers in north-western Illinois where a landfill had contaminated a municipal water supply with trichloroethylene (TCE), tetrachloroethylene (PERC), and other chlorinated solvents.[5]

A 1989 study by the EPA [U.S. Environmental Protection Agency] examined 593 waste sites in 339 U.S. counties, revealing elevated cancers of the bladder, lung, stomach and rectum in counties with the highest concentration of waste sites.[6]

Increased incidence of leukemia has been reported in a community near a toxic waste dump in North Rhine-Westphalia, Germany.[7]

A 1986 study of children with leukemia in Woburn, Massachusetts statistically linked the disease to drinking water supplies that had been contaminated by a waste site.[8]

Thus leukemias and bladder cancer are the most commonly reported cancers among populations living near landfills, providing support for the recent findings in New York.

It should come as no surprise that living near a landfill is hazardous to your health --and it doesn't matter whether the landfill holds solid waste or hazardous waste. Hazardous waste landfills hold unwanted toxic residues from manufacturing processes. On the other hand, municipal solid waste landfills hold discarded products, many of which were manufactured from toxic materials. The wastes go out the back door of the factory while the products go out the front door, but after they have been buried in the ground both wastes and products create very similar hazards for the environment, wildlife, and humans. The leachate (liquid) produced inside the two kinds of landfills is chemically identical.[9] (See REHW #90.)

The most commonly reported effect of living near a landfill is low birth weight and small size among children. The first careful study of this subject took place at Love Canal near Niagara Falls, New York. In a blinded study published in 1989, researchers found that children who had lived at least 75% of their lives near Love Canal --the notorious toxic chemical dump --had significantly shorter stature than children who lived farther away from the dump site. These results held up even after controlling for birth weight, socio-economic status, and parental height.[10]

A previous (1984) study had shown that children who lived near Love Canal had abnormally low weight at birth.[11] The following year, another study confirmed low birth weight in children born to parents living near Love Canal.[12] There does not seem to be any remaining doubt that the children of Love Canal were put in harm's way by exposure to the 20,000 tons of chemical wastes buried in their back yards. Those wastes remain buried there, and the families that have recently moved into homes at Love Canal are likely in danger too.

Studies of children living near other landfills have confirmed these findings. A study of families living near the Lipari landfill in New Jersey reported low birth weight among babies born during 1971-1975, when the landfill was thought to have leaked the greatest quantity of toxic materials into the local environment.[13]

A study of people living near the BKK landfill in Los Angeles County, California in 1997 reported significantly reduced birth weight among children born during the period of heaviest dumping at the site.[14]

A 1995 study of families living near a large municipal solid waste dump (the Miron Quarry) near Montreal, Quebec found a 20% increased likelihood of low birth weight among those most heavily exposed to gases from the landfill.[15]

At least five studies have reported finding an increased chance of birth defects among babies whose parents live near a landfill. In Wales, the chances of birth defects were doubled among families living near the Nant-y-Gwyddon landfill.[16] A 1990 study in the San Francisco region found a 1.5-fold greater chance of birth defects of the heart and circulatory system among newborns whose parents lived near a solid or hazardous waste site.[17]

A 1990 study of 590 hazardous waste sites in New York state found a 12% increase in birth defects in families living within a mile of a site.[18] A 1997 study of women living within a quarter-mile of a Superfund site showed a two-to four-fold increased chance of having a baby with a neural tube defect, or a heart defect.[19] A preliminary report in 1997 found a statistically significant 33% increased chance of a birth defect occurring in babies born to families living within 3 kilometers (1.9 miles) of any of 21 landfills in 10 European countries.[20]

Researchers at the London School of Hygiene and Tropical Medicine recently reviewed 46 studies of the human health effects of landfills.[21] They concluded, "[L]andfill sites may represent real risks in certain circumstances." They also pointed out that exact mechanism of the hazard remains unknown. Is the biggest hazard air or water pollution? No one knows. But the evidence seems overwhelming: living near a landfill can be dangerous. So long as we remain a society addicted to chlorine chemistry and other toxic technologies, our discards will be toxic, and the places where we bury them will be hazardous to health for a long time to come.

--Peter Montague (National Writers Union, UAW Local 1981 / AFL-CIO)

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