Is there an excess of childhood cancer in North Wales on the Menai Strait, Gwynedd?

Concerns about the accuracy of analyses carried out by the Wales Cancer Intelligence Unit and those using its data.

Chris Busby PhD
Richard Bramhall

Green Audit Aberystwyth
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Abstract

In 1993 Green Audit obtained the entire small areas cancer incidence database of Wales Cancer Registry (WCR) aggregated to the level of small areas termed Areas of Residence (AoRs). Since 1998 we have been conducting research into the distribution of cancer in Wales utilising these data, which show cancer incidence by year, sex, age, site and AoR from 1974 – '90. In a series of reports, Green Audit drew attention to the existence of an apparent sea-coast effect on cancer driven by habitations near radioactively contaminated intertidal sediment. This was particularly the case of the Menai Strait in north Wales, where anomalously high rates of childhood leukaemia and brain tumours were found, notably in Bangor and Caernarfon. These phenomena were denied by the Wales Cancer Intelligence and Surveillance Unit (WCISU) which claimed that its own studies showed no such increases. The WCISU studies were consistently backed up by the Committee on Medical Aspects of Radiation in the Environment (COMARE).

This paper addresses the studies and claims of WCISU and its collaborators. It shows that WCISU have consistently made serious errors in their epidemiology. In particular, WCISU and its collaborators have used incorrect base populations for the areas they have been analysing. We show how, through an elementary error, WCISU misallocated census wards to the AoRs, thereby hugely overestimating the base populations considered to be at risk and commensurately underestimating incidence ratios relative to national averages.

In a letter to Green Audit in January 2001 Dr. John Steward, WCISU's Director, presented his allocation of wards in Gwynedd, showing all wards were allocated to 5 AoRs. However, in the WCR database, there were 35 AoRs. Thus the levels of cancer in the Menai Area would be under-assessed by WCISU by a factor of up to 7-fold. Indeed, we show here that WCISU used the population of Caernarfon and Bethesda (both of which were AoRs in their own right) in addition to the population of Bangor as a base population to reduce the apparent risk factors for childhood leukaemia in Bangor.

We also show that WCISU had made a similar error in an inquiry concerning cancer rates in Mold in Clwyd, a case where in 2000 and 2003 WCISU and the Director of Public Health for Flintshire rubbished a Green Audit report on this issue. WCISU used incorrect ward assignments to deduce that the levels of cancer shown in the WCR database were normal whilst in fact they were significantly high. This was despite the fact that a detailed explanation of the error had been given by us to Dr. Steward in 2001 (Steward et al 2000).

1. Background

There has been continuing debate over the incidence and spatial distribution of cancer in north and mid-Wales since Green Audit carried out an analysis of the Wales Cancer Registry 1974-1989 small area database in 1997-2000 and reported significant excess risks of childhood cancer in the Menai area (Busby 1998, Busby 2000)

The three year analysis (Busby 2000, referred to as GA1 in what follows) was funded by the Irish State in connection with a case in the Irish High Court; Short and others *v.* BNFL. The results showed that there was a curious and highly significant excess risk of most (but not all) types of adult cancer in a narrow band 0-2km from the sea, and that these effects were driven largely by towns on the north Wales coast. The results were presented at the 2002 British Nuclear Energy Society International Conference in Oxford in September 2002 and were published by BNES (Busby 2002). The method employed was straightforward. Standardised Incidence Ratios were calculated for the small areas used by the Wales Cancer Registry, based on 1981 census populations and relative to England and Wales national rates in 1979. Various statistical tests and regression methods were used to examine these areas in groups by distance from the sea, by rainfall, by disadvantagement, by radon in homes and by various other possible causes. Only proximity to the sea, or the variable SEAPU derived from measurements of plutonium in sea-to-land transfer, could explain the findings. There were highly significant statistical effects in adults of all ages combined. But for children, although the numbers were low, there were much bigger relative risks. For some towns near the highest levels of Sellafield radioisotope contamination on the Menai Strait and by the second half of the 16 year period Relative Risks were similar to those found in the Seascale child leukaemia cluster (i.e. between 5 and 15-fold RR).

The results for children in North Wales were picked up by the BBC and a documentary, *Sea of Troubles,* implicating the radioactive discharges from the Sellafield nuclear plant, was transmitted in February 1999. These mutagenic radioactive substances e.g. plutonium-239, Caesium-137, Strontium-90 etc. have been routinely measured on the north Wales coast by the Ministry of Agriculture and later the Food Standards Agency. Radioactive particles concentrate in the intertidal sediment and are brought ashore by a phenomenon termed sea-to-land transfer, discovered in the 1980s (Eakins et al. 1984a). Plutonium in the air (which may represent a flag for exposure) is highest in the 1km distance zone and falls off rapidly. It can be inhaled and incorporated in humans and animals and has been found in humans in autopsy measurements of the lung drainage lymph nodes (Popplewell et al 1988) and also in sheep faeces (Eakins and Lally, 1984b).

Due to the peculiar tidal conditions in the Irish Sea, levels in the sediment are highest around the Menai Strait between Anglesey and the mainland, and also along the north Wales coast to the estuary of the river Dee. This is still the case: levels in 2004 in intertidal silt on the coast near Caerhun at the northern entrance to the Menai are 160Bq/kg (RIFE 2004). These were also the areas where the highest levels of adult and childhood cancer had been found by the GA1 study.

We found it curious that the Wales Cancer Registry (WCR), an official division of the Welsh Office which had supplied the data on which the GA1 studies were based, was shut down almost immediately after the data were released. The WCR had already drawn attention to high levels of cancer in children in North Wales in its final report published in 1994 just before it was closed (WCR, 1994). An obvious next move was to examine the spatial distribution of the child cancer in north Wales to see if there were any

epidemiological pointers to its cause, but it should be noted that access to small area cancer data was being increasingly restricted over the period 1990 onwards. Indeed, access by Green Audit to the WCR data was only obtained through the intercession of the then Medical Officer of Health at the Welsh Office, Dr Deidre Hine, after pressure had been brought by the Association of Welsh County Councils. Dr. Hine left around the same time as WCR was closed. There was a gap of about 18 months before the cancer registration system was taken over by a new organisation, WCISU. During this time Green Audit obtained a second and independently downloaded set of small area data covering the period 1974-1990 from the Statistics Division of the Welsh Office. Thus Green Audit had two independent sets of the same data to compare. There was one major difference between the two datasets. A group of child leukaemia records labelled "all leukaemias" in the first set had disappeared from the second. This was puzzling, and the origin of these child leukaemia figures has never been adequately resolved. We were of the opinion that there had been some cover-up, but since WCISU stated that the files had been removed from the mainframe when they took over, the question seems unanswerable. The extra cases were all in mid and north Wales. The GA1 report analysed the spatial distribution of adult cancer, childhood cancer, childhood leukaemia and childhood brain tumours. Since the two datasets differed on child leukaemia we analysed the data both with and without the extra "all leukaemias" files. Rates for childhood leukaemia were higher in the dataset which included them, however, for both analyses, there was a clear sea coast effect. The highest childhood cancer and leukaemia rates were apparent in the Menai Strait coastal towns and along the north Wales coast where the levels of radioactive pollution were highest.

The BBC Wales TV documentary *Sea of Troubles* caused considerable controversy. WCISU denied the existence of excess childhood cancer. They carried out a separate analysis and showed that childhood cancer on the coast was actually lower than inland and presented their results to the government Committee On Medical Aspects of Radiation in the Environment (COMARE), a 'watchdog committee' set up following the Black report on the Sellafield leukaemias in 1984. Without showing this report to Green Audit or asking for any independent peer review, COMARE and WCISU presented their analysis to the Press and to the Welsh Assembly (COMARE 1999). A statement was released claiming that the WCR data were corrupt and that Green Audit's study was wrong — there was no increase in childhood cancer in North Wales. The Press took the report straight to Green Audit and our analysis (*Radioactive Times* 1999, 2000) revealed major problems and inaccuracies in the WCISU approach but nothing was done and no retraction was made.

Close examination of the WCISU study would have shown that WCISU had removed 18% of the children with cancer from the database they obtained from WCR. At the same time, the WCR database had been removed from the Welsh Office mainframe computer. Later it was argued that these children had been coded wrongly, and were in fact adults. This emerged during a plenary session of the three-day international Workshop convened by the Committee Examining Radiation Risks of Internal Emitters (CERRIE) in Oxford in July 2003. The Director of the Oxford Childhood Cancer Research Group, Dr. Gerald Draper, asked Dr. Busby why his presentation on cancer epidemiology had not mentioned the alleged miscoding. In reply Dr. Busby asked why the apparent miscoding was specific to the north Wales coast, a question Dr. Draper was unable to answer. It has never been answered.

But the debate remained. By 2003, the argument had passed from COMARE to the new CERRIE Committee which the Environment Minister of the day, Michael Meacher, set up to look at this and other evidence that the risks from radioactive materials from nuclear

sites may have been significantly underestimated. In the interim, more evidence that this was the case had been emerging from Chernobyl affected territories and new science was showing unequivocally that the mechanistic assumptions underpinning estimates of risk from releasing radioactivity to the environment were incorrect. The CERRIE committee, consisting of scientists from the Nuclear Industry, from the National Radiological Protection Board and from independent organisations, was split over the issue and the disagreements remained (CERRIE Majority 2004, CERRIE Minority 2004).

By 2003, toward the end of the CERRIE process, and after Michael Meacher had been sacked, there was another development relating to the question of cancer in children in North Wales. A north Wales HTV researcher, Linda Parry, had a friend who developed cancer in her 20s. Linda noticed how many children from the Menai were being treated. She knew of the controversy over the BBC TV documentary and decided to carry out her own research. She collected a database of some 40 children with their names and addresses and she approached Green Audit to ask if it represented an excess. Based only on the named children, we found there was a highly significant excess of child leukaemia and also of brain and nervous system cancer. Relative Risks for leukaemia in the town of Caernarfon were about 20 times the national average. Checking to see whether the risks extended into the 34 wards around the Menai, where much of the population lives further from the coast, the RR was still more than 5 times the national average. For brain and nervous system cancers the story was similar with risks of 18-fold in children to age 15 in Caernarfon and, again, more than 5-fold in the 34 Menai Wards. This led to a new documentary, *Cancrs Plant*, transmitted by the Welsh-language TV channel S4C in February 2004.

To inform HTV's research a report was prepared (Busby 2004), putting Linda Parry's findings in the context of the earlier period covered in the GA1 study, which had also drawn attention to high levels of childhood cancer on the Menai. These earlier results are shown in Table 1 below.

Table 1 Areas of Residence with more than one case and also high (>3) relative risk of leukaemia in the 0-4 age group in the north Wales area from 1982-1990 (Wales Cancer Registry validated data).

AoR	Number of cases	Relative Risk (a)
71CC Colwyn Bay	3	5.6
74CA Bangor	3	11.2
74CE Caernarfon	2	8.1

(a) based on England and Wales, 1979

The paper was peer reviewed and presented at the International Conference on Childhood Leukaemia organised by Children with Leukaemia in September 2004 in London (Busby, Bramhall and Parry, 2004).

At the time of the HTV broadcast WCISU made no substantive comment (though a non-committal statement was released on 13th Feb. 2004; the same statement was provided to the subsequent CERRIE meeting, 27th Feb.), but by Spring 2005, WCISU reported that they had re-examined the findings of Green Audit (White et al, 2005). The authors reported that there was indeed an excess of childhood leukaemia which was not statistically significant but no excess of brain tumours. In a document dated 9th March 2005 (NPHSW 2005) which was based on their report, the National Public Health Service for Wales denied

that there was *a continuing trend of increased incidence of childhood leukaemia*. There were *no significant results ... for childhood leukaemia ... in either Anglesey or Gwynedd LHB populations for the 2000-2003 period or any previous period.* They could *see no reason for public concern.*

COMARE also endorsed WCISU's report (COMARE 2005)

2. The problem — Bias and spin in WCISU analysis

Interestingly, in addressing our findings for 1982 – 1990, WCSIU did not use the technique they had used in 1999 — i.e. removing the children from the database on the basis that they were misclassified adults. This might have been too dangerous, given that there appeared to be a reporter who was capable of finding the cases and may indeed already have found them. So the WCISU report contained the same numbers of observed cases as Green Audit's. The difference was in the Relative Risks. Results are compared in Table 2.

Table 2 Areas of Residence with more than one case and also high (>3) relative risk of leukaemia in the 0-4 age group in the north Wales area from 1982-1990 (Wales Cancer Registry validated data). Relative Risk calculated by WCISU in 2005 and by Green Audit using the GA1 data and method.

AoR	Number of cases	Relative Risk (95%CI) WCISU 2004	Relative Risk Green Audit 2000
71CC Colwyn Bay	3	1.70 (0.35, 4.97)	5.6
74CA Bangor	3	2.48 (0.51, 7.26)	11.2
74CE Caernarfon	2	2.32 (0.28, 8.37)	8.2

It should be noted that the Relative Risks WCISU calculated are elevated. However, the lower Confidence Intervals in column 3 are in every case less than 1, allowing the inference that the actual number of cases found could have occurred by chance. This is just what WCISU did infer.

We face a situation where a marked cluster is officially dismissed as a chance finding on the grounds that it is not part of a long-term trend or pattern. Given that WCISU's figures for the number of cases in the 1982-90 period agree with ours it was intriguing to consider how the apparent excess had been minimised. Where was the difference between the two studies?

Statistical significance

First though, let us address significance. The GA1 results were important to present in Busby 2004 since they appeared to show that there was some cause of increased levels of childhood leukaemia comparable with the levels of risk near Seascale, the notorious Sellafield child leukaemia cluster; and therefore, the Linda Parry cases in the late 1990s and early 2000s were a continuation and a worsening of this. As the NPHSW discussion report argued, the numbers are small, but then so were the numbers at Sellafield and an entire enquiry under Sir Douglas Black had been set up to look into that one issue. In Seascale and the coastal villages (Drigg, Carleton, Bootle, Waberthwaite and Muncaster) there were 2 deaths from leukaemia within 4 deaths of all cancers in the 0-14 year age group in the 16 years between 1963 and 1982. There were 9 cases (incidence) from childhood cancer in Seascale and the coastal villages in the same 16 year period (Beral et al, 1993). Here we are looking at 8 cases of leukaemia alone in the Menai coastal towns in the 9 years 1982 to

1990, and the Linda Parry data gave 3 cases in Caernarfon in 2000-2003 and 6 cases in the combined Menai wards over the same period. Thus we have a much larger cluster than Seascale and the Cumbrian coastal villages since in the 13 years 1982-1990 and 2000-2003 for which we have data, there were 14 cases of child leukaemia ages 0-4 not counting any other cancers, compared with 9 childhood cancer cases in the 0-14 age group at Seascale and the coastal villages in 16 years.

The numbers are not disputed, but there are many ways in which epidemiologists can bias results or affect conclusions drawn from data. WCISU have been responsible for holding the raw data from the north Wales area and should have been aware of the increases in child leukaemia and brain tumours there — the cases found by HTV. Why did they not draw attention to this, given that they eventually had to concede it in their 2004 report? Is it because amidst much noise and controversy they had already denied Green Audit's earlier claims and the 1994 claims of the Wales Cancer Registry?

Whatever the answer, their 2005 report began by attacking our GA1 report of excess levels of child leukaemia over the period 1982-90 in Caernarfon, Bangor and Colwyn Bay (shown in Table 1). If they could show that the levels were not significantly high, then the high levels found by HTV for the later period, 2000-03, might be discounted as a 'small cluster in time', rather than part of an ongoing and serious environmental health problem.

WCISU used three ways of reducing the significance of the observed numbers. In ascending order of seriousness these are 1) the use of a different national rate to generate a number of cases expected; 2) disaggregating the base population; 3) over-estimating the base population.

1) National rate: WCISU employed all Wales national rates for 1982-90 whereas Green Audit Risks, which were used to examine overall trends in time, were based on England and Wales rates for 1979. This, however would not affect the results by more than a few percent and can be justified.

2) Disaggregating the base population: This argument is about high levels of childhood leukaemia near the Menai. The ideal would be to define the population of the entire 2 kilometer strip nearest the sea, but we do not have data to this level of disaggregation. The next best is to combine the data we do actually have which defines a population living that close to the sea — in other words, the populations of the coastal towns. So the statistical test should not disaggregate the data. To reduce this to absurdity, it would be possible to deny the significance of any finding if we broke the individual cases down to the streets in which they lived, since the numbers would be too small. Table 4 shows that when the three towns are taken as an entity even WCISU found significant elevated risks.

3) Over-estimating the base population; serious errors in WCISU's assumptions of the Welsh Areas of Residence: We shall show here that WCISU made a massive and elementary error which dwarfs the other two points we have described above, certainly as far as its impact on the present dispute is concerned.

The average incidence rate of a disease determines the number of cases expected in any population. Comparing what is expected with what is observed determines the Relative Risks. One can calculate back, using the RRs given by WCISU and by us to find what the expected numbers of cases were and then, using national rates, work out the size of the base populations. The formula is:

$$O / RR = E$$

where O = cases observed; RR = Relative Risk; E = cases expected.

Table 3 shows the results for Green Audit; Table 4 shows them for WCISU. (These tables also show the results of aggregating the three coastal towns.)

Table 3 Green Audit analysis: Areas of Residence with more than one case and also high (>3) relative risk of leukaemia in the 0-4 age group in the north Wales area from 1982-1990 (Wales Cancer Registry validated data). Relative Risk calculated by Green Audit in 2000 and reported in 2004 with numbers of cases expected based on their RRs from Table 1.

AoR	Number of cases observed	Number of cases expected (RR)	Relative Risk (Poisson p-value)
71CC Colwyn Bay	3	0.53	5.6 (0.01)
74CA Bangor	3	0.26	11.2 (0.0004)
74CE Caernarfon	2	0.24	8.1 (0.02)
All three	**8**	**1.03**	**7.76 (0.00005)**

Table 4 WCISU analysis: Areas of Residence with more than one case and also high (>3) relative risk of leukaemia in the 0-4 age group in the north Wales area from 1982-1990 (Wales Cancer Registry validated data). Relative Risk calculated by WCISU in 2005 with numbers of cases expected based on their RRs from Table 2.

AoR	Number of cases observed	Number of cases expected (RR)	Relative Risk (Poisson p-value)
71CC Colwyn Bay	3	1.76	1.7 (0.24)
74CA Bangor	3	1.21	2.48 (0.12)
74CE Caernarfon	2	0.86	2.32 (0.23)
All three	**8**	**3.83**	**2.09 (0.04)**

We needed to look more closely at the way in which we and WCISU determined the base population. Taking as an example the Area of Residence 74CA BANGOR MB as defined by the Wales Cancer Registry, WCISU's expectation was 1.21 cases; ours was 0.26. We can calculate the different 0-4 populations of this area as assumed by these quite different expectations. The formula is:

$$\text{Population} = E \times 100{,}000 / (5.1 \times 9)$$

where E is the expected number; the rate is 5.1 per 100,000 per year and we are concerned with 9 years' data. The result is given in Table 5.

Table 5 0-4 Population of 74CA BANGOR MB obtained by back calculation from all leukaemia rate 5.1 per 100,000 and expected numbers given by Green Audit and by WCISU.

Expected number of cases 1982-90	0-4 Population based on WCISU expectation	0-4 Population based on Green Audit expectation
0.26 (GA)		566
1.21 (WCISU)	2,636	

So, we must ask whether 566 or 2636 more truly represents the 0-4 population of Bangor over the period 1982-1990. This will decide which analysis is correct and which relative risk is correct and therefore whether there is statistically significant excess

childhood leukaemia in AoR 74CA BANGOR MB. We began with a very rough check. Assuming a square demography (all age groups roughly equally represented between 0 and 70), there are 14 of the 5-year age groups which would roughly give a total population of Bangor as 7924 as calculated by Green Audit, or 36,900 as calculated by WCISU. 36,900 is clearly absurd — around three times what's really there now.

The back calculation can be checked against the 1991 census populations of Bangor. The 1991 wards of Bangor town are shown in part of the official ward map in Fig 1. The 1991 ward names and populations in the 0-4 age group (798 children) are in Table 6. Table 7 shows ward names and 0-4 population at the 1981 census (620 children). The population derived by back calculation from Green Audit's "Expected" number is 30% lower than the 1991 census population and apparently lower by 9% than the 1981 census (which is explained by the GA1 study employing 1979 rates which are slightly lower. Green Audit employed 1981 census data adjusted for changes in inter-censal population changes. Since the GA1 study examined the period 1974-89 and was interested in the time trend in disease we used 1979 cancer and leukemia rates.

However, the base population WCISU appears to have used is 330% too high.

Table 6 1991 wards in Bangor

Map No	Ward name	Designation	0-4 Persons	All ages Persons
4	Deiniol	51SZFD	40	961
6	Dewi	51SZFF	102	1545
7	Garth	51SZFG	22	637
9	Glyder	51SZFJ	87	1601
10	Hendre	51SZFK	106	1234
11	Hirael	51SZFL	61	1230
19	Marchog	51SZFU	298	2685
20	Menai Bangor	51SZFW	82	1299
All	**Bangor**		798	11,192

What happened? At this point we must say that analysis of the WCR data absolutely required us to ascertain the definition of the obsolete Areas of Residence. By 1998, two years after the closure of WCR and the dispersion of their personnel, this involved considerable detective work. WCISU were of no help in this search. In 1997 Helen Beer, a researcher at WCISU, said they had no idea of the composition of the AoRs. Eventually in 1998 we obtained lists from ONS, allowing us to determine the precise extent of the AoRs and their logical structure and relationship to 1974 wards and communities. Three AoRs in northern Arfon (the County District) are listed in Table 7 and are shown, with their constituent 1981 census wards, in the coloured map Fig 2. It should be noted that the 1981 extent of AoR 74CA BANGOR MB in which WCR recorded the 1982 – 1990 cases is a close (if not exact) match with the Bangor 1991 census wards (Fig.1), confirming the size of the 0-4 population Green Audit used to analyse leukaemia risk in that period.

Table 7. AoRs in north Arfon near Bangor and their constituent 1981 census wards (from ONS)

Ward No/ parish/community	**County/ Local Authority**	**Ward/civil parish**	**AoR**	**1981 ward code**	**1981 pop. 0-4 *(all ages)* persons**
1 Bangor comm..	Bangor MB (pt.)	North or Upper Bangor ward (pt.)	74CA Bangor M.B	51SZAA	43 *(1220)*
2 Bangor comm..	Bangor MB (pt.)	North or Upper Bangor ward (pt.)	74CA Bangor M.B	51SZAB	32 *(899)*
3 Bangor comm..	Bangor MB (pt.)	South or Town ward. (pt.)	74CA Bangor M.B	51SZAC	71 *(928)*
4 Bangor comm..	Bangor MB (pt.)	South or Town Ward (pt.)	74CA Bangor M.B	51SZAD	207 *(2903)*
5 Bangor comm..	Bangor MB (pt.)	East or Hirael ward	74CA Bangor M.B	51SZAE	43 *(1081)*
6 Bangor comm..	Bangor MB (pt.)	West or Glanadda ward (pt)	74CA Bangor M.B	51SZAF	103 *(2054)*
7 Bangor comm..	Bangor MB (pt.)	West or Glanadda ward (pt.)	74CA Bangor M.B	51SZAG	121 *(2178)*
13 Bethesda Comm	Bethesda U.D (pt.)	Ogwen ward	74CC Bethesda UD	51SZAN	139 *(2118)*
14 Bethesda Comm	Bethesda U.D. (pt)	Gerlan ward	74CC Bethesda UD	51SZAP	70 *(972)*
15 Bethesda Comm	Bethesda U.D. (pt.)	Rachub ward	74CC Bethesda UD	51SZAQ	58 *(939)*
30 Aber Comm; Llanllechid Comm	Ogwen RD (pt.)	Aber CP Llanllechid CP	74CN Ogwen RD	51SZBG	73 *(1050*)
31 Llandegai Comm (pt.)	Ogwen RD (pt.)	Llandegai CP (pt.)	74CN Ogwen RD	51SZBH	86 *(1450)*
32 Pentir Comm. (pt.)	Ogwen RD (pt.)	Pentir CP (pt.)	74CN Ogwen RD (pt.)	51SZBJ	71 *(1378*)
33 Llandegai Comm. (pt.) ; Pentir Comm. (pt.)	Ogwen RD(pt.)	Llandegai CP (pt.) Pentir CP (pt.)	74CN Ogwen RD (pt.)	51SZBK	88 *(1328)*

Fig 1. 1991 wards in the Menai area of north Wales; Bangor is circled.

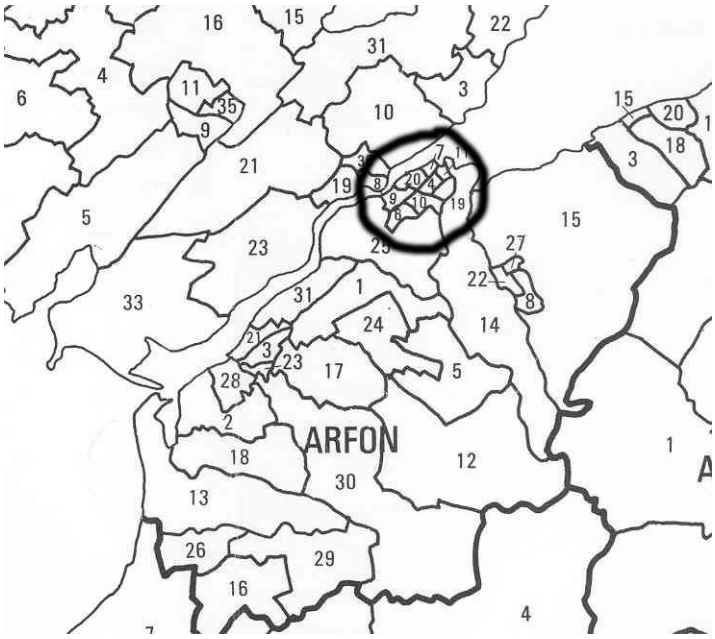
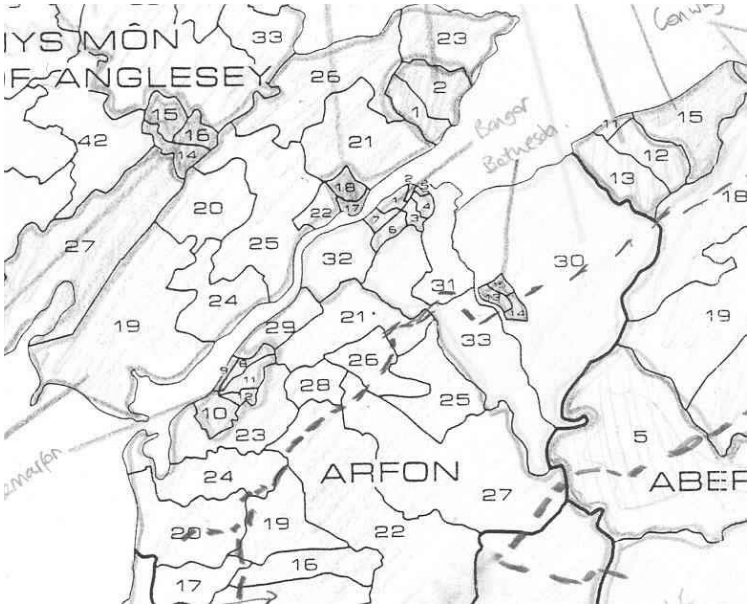


Fig 2 Constituent 1981 wards of some Areas of Residence in Gwynedd near Bangor.
In northern Arfon, AoR *74CA BANGOR M.B* is shaded blue, AoR *74CC BETHESDA R.D* is green, AoR *74CL OGWEN R.D* is the yellow shaded area surrounding Bethesda.



Once we had obtained the ward information of which Table 7 is a sample work could go ahead. A dispute with WCISU soon arose which it is instructive to consider.

3. A parallel case: Cancer incidence in Mold, Flintshire.

In 2000, Green Audit was asked to examine cancer in Mold, Clwyd in connection with the proposed development of a cement kiln at Padeswood where hazardous waste was to be used as fuel. In examining the WCR database it became clear that there was already a significant excess adult cancer risk in the Area of Residence 71EE MOLD UD. The Padeswood Cement Public Enquiry ensued. In this case, WCISU collaborated with the Flintshire Director of Public Health Richard Roberts to examine the Green Audit claims. Professor C. V. Howard of the University of Liverpool collaborated with Green Audit and presented our results at the Public Enquiry. Correspondence between the Director of WCISU and Professor Howard showed clearly that WCISU was making a large error in assembling the base populations.

Our results for the 71EE MOLD UD AoR are given below in Table 8.

Table 8. Relative Risks for cancer incidence in 71EE MOLD UD between 1974 and 1989 based upon 1979 England and Wales rates. Calculation by Green Audit 2003.

Site	Observed	Expected	Relative Risk	p-value
All malignancy all ages	1161	555	2.09	0.0000
Child cancer 0-4	4	1.149	3.5	0.03
Female breast	131	56	2.3	0.0000
Lung	180	111	1.62	0.000

WCISU advised that these risks were not real, on the grounds that we had used the wrong wards as the base population. In a letter to Professor Howard dated 5th Dec 2000, Dr. Steward listed the wards he had used to examine our report. He explained that his calculation assumed that 71EE MOLD UD was made up of 12 wards. Using these wards as a base population he found the results given in Table 9 below, which he supplied as an attachment to his letter.

Table 9 Cancer in 71EE MOLD UD according to Dr. Steward and on which the publication Roberts et al 2003 was based. (Can be compared with Table 8.)

Site	Observed	Expected	Relative Risk	p-value
All malignancy all ages	1161	1173.6	0.969	NS
Child cancer 0-4	4	3.3	1.218	NS
Female breast	138	145.6	0.948	NS
Lung	180	233	0.773	NS

Dr. Steward observed:

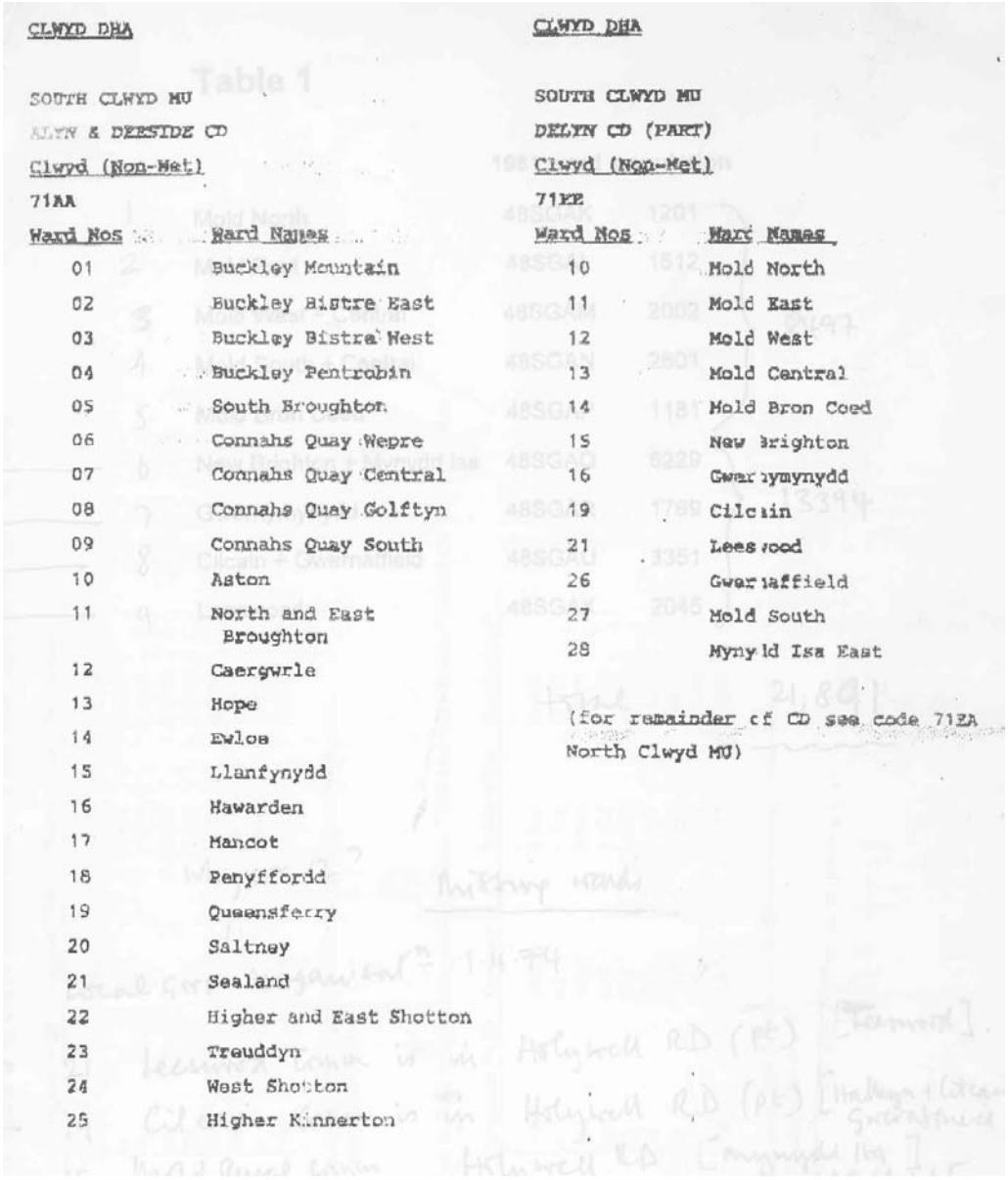
> *... if we consider the populations of the 1981 wards included in the AoR area 71EE we get different versions according to whether we include all the wards in the population at risk or just those wards with Mold in the name – see Table*

1 attached. Judging by the population figures quoted by Dr. Busby [of Green Audit] *, he has clearly used those wards with Mold in the name rather than the whole set. In layman's terms he is comparing proverbial apples with oranges. In our view, this has caused a spurious increase in the relative risk and an artefactual "cancer cluster". When the correct populations are used, this effect disappears.*

In a separate table WCISU showed how they had been able to replicate our alleged mistake by using the populations of the "correct" five wards.

The question arises, How is it that WCISU are so sure they are right and we are wrong? Dr. Steward's letter enclosed a photocopy of what he described as being *from the official OPCS Area of Residence Classification Manual from the relevant period.* It consisted of 25 pages (apparently typed). We show an example at Fig. 3.

Fig 3. Copy of the claimed *official OPCS Classification manual* sent by Dr Steward of WCISU to Dr Howard in connection with the assignation of wards in the WCR Areas of Residence used by Green Audit.



CLWYD DHA

SOUTH CLWYD MU

ALYN & DEESIDE CD

Clwyd (Non-Met)

71AA

Ward Nos	Ward Names
01	Buckley Mountain
02	Buckley Bistre East
03	Buckley Bistra West
04	Buckley Pentrobin
05	South Broughton
06	Connahs Quay Wepre
07	Connahs Quay Central
08	Connahs Quay Golftyn
09	Connahs Quay South
10	Aston
11	North and East Broughton
12	Caergwrle
13	Hope
14	Ewloe
15	Llanfynydd
16	Hawarden
17	Mancot
18	Penyffordd
19	Queensferry
20	Saltney
21	Sealand
22	Higher and East Shotton
23	Treuddyn
24	West Shotton
25	Higher Kinnerton

CLWYD DHA

SOUTH CLWYD MU

DELYN CD (PART)

Clwyd (Non-Met)

71EE

Ward Nos	Ward Names
10	Mold North
11	Mold East
12	Mold West
13	Mold Central
14	Mold Bron Coed
15	New Brighton
16	Gwernymynydd
19	Cilcain
21	Leeswood
26	Gwernaffield
27	Mold South
28	Mynydd Isa East

(for remainder of CD see code 71EA North Clwyd MU)

The column on the right of the page lists 12 wards. This, WCISU claimed, was the 71EE MOLD UD AoR into which WCR had allocated cancer cases in the data files released to us. It includes Mold itself as well as other wards nearby. The WCR files do indeed have an AoR called "71EE MOLD UD". Our own records, obtained from ONS, show that it comprises only five wards — the ones numbered 10 -14 in Fig. 3.

Examining the set of copies provided by WCISU we can see it is a set of ward lists presented county by county. It seems to show the ward composition of entities at a level below the *Management Unit.* These entities have labels such as 71EE, where 71 is unique to Clwyd, 74 unique to Gwynedd and so on. A similar labelling system identified the AoRs used by WCR, but in the document provided by Dr. Steward there are many fewer than are in WCR records. In his December 5 2000 letter Dr. Steward refers to this document as being *from the relevant period* but by the time Roberts et al 2003 was published it had become *Office of Population Censuses and Surveys Area of residence classification manual (1992 amendments).* It is clear that there must have developed in the late 1980s (since post-

1988 wards are included) a coding system for parts of Health Management Units that took over the earlier AoR code of one large town within the Unit area and employed this as the designation code; it is this later list of the Management Unit sub districts that WCISU mistook for the AoR list Wales Cancer Registry had used to place their cancer cases. It is not hard to see how a superficial appraisal might have resulted in such an error. It is harder to see how it persisted; any deeper analysis would have revealed that subsumed within the areas so defined were other AoRs which had their own separate designation code (and cancer cases). In the case of Bangor and Caernarfon, which we turn to below, the persistence of such a mistake is bizarre.

Table 10 List and number of AoRs assumed by WCISU on basis of alleged OPCS classification manual in Clwyd and list and number of AoRs used by Wales Cancer Registry for coding purposes.

Area	**WCISU's " AoRs " assumed from OPCS coding manual**	**WCR AoRs in which cancer cases are distributed**	**Overall number of AoRs assumed in Clwyd**
Clwyd	71LA, 71CA, 71EA, 71GA, 71GC, 71JA, 71AA, 71EE	71AA, 71AC, 71AL, 71CA, 71CC, 71CL, 71CN, 71EA, 71EC, 71EE, 71EL, 71EN, 71GA, 71GC, 71GE, 71GL, 71GN, 71GP, 71GR, 71GT, 71JA, 71JC, 71JL, 71LA, 71LL, 71LN, 71LP	WCISU = 8 WCR = 27

Consider, for example, the page shown in Fig. 3. The list on the left, the wards in 71AA, contains four *Buckley* wards, four for *Connahs Quay,* and a *Hawarden.* When we consult our WCR datafiles we find that 71AA BUCKLEY is an AoR in its own right. CONNAHS QUAY UD is AoR 71AC; and Hawarden is represented by two AoRs — 71AL HAWARDEN RD and 71LL HAWARDEN RD. If WCISU was looking at WCR's data and trying to match it with what they thought was the OPCS manual, why did they not notice that a list which on their logic would be one AoR contained three communities bearing the same names as four of WCR's AoRs? This, in the context of the dispute about populations, ought to have alerted them to the possibility that their assumptions were wrong. [Note that the code at the top of that column is 71AA, that the Buckley wards are the top four within the column, and that the code for WCR's *Buckley* AoR was 71AA BUCKLEY UD. The right hand column for 71EE MOLD UD is analogous.]

Looking across nearby borders into other Management Units, Glyndwr, which on WCISU logic would be one AoR, contains Llangollen and Ceiriog wards; WCR data shows Llangollen as an AoR coded 71GC LLANGOLLEN UD and Ceiriog as 71GL CEIRIOG RD.

Nearby Wrexham-Maelor has AoRs:

71LP WREXHAM RD (pt),
71GT WREXHAM RD (pt),
71LA WREXHAM MB
71LN MAELOR RD.

We note that Dr Richard Roberts, who was working with WCISU to attack our work and who was one of the authors of the Roberts et al 2003 paper, is a consultant in Public Health Medicine and an Honorary Senior Lecturer. He is based at the North Wales Health Authority in Mold. It seems fair to expect him to have, or to have access to, a little local knowledge of management systems even if they are defunct.

The existence in the list of wards that did not exist at the 1981 census and indeed only came into being after 1988 means that the ONS manual dates from after 1988, and cannot possibly have related to AoR codes which were used by WCR from 1974. This is elementary, but seems to have been overlooked by WCISU although in the analysis they carried out for Mold they subsumed these new wards within the older 1981 wards that they had been divided from. (See Table 11 below)

We have demonstrated that WCISU's scheme for Mold was in error and their populations were incorrect. We communicated this to Dr. Steward in detail in a letter on 18th December 2000. Nevertheless, the report of Roberts et al was eventually published in part in the Journal of Public Health Medicine with the error in the basic population data uncorrected. The fact that an article has been published in a peer review journal is no guarantee of its accuracy, unfortunately.

Table 11 Constituent wards of 71EE MOLD MB and AoR assignment of other wards included in 71EE MOLD MB by WCISU

Ward	**Number**	**AoR**	**1981 census ward**
Mold North	10	71EE MOLD MB	48SGAK
Mold East	11	71EE MOLD MB	48SGAL
Mold West	12	71EE MOLD MB	48SGAM
Mold Central	13	71EE MOLD MB	48SGAN
Mold Bron Coed	14	71EE MOLD MB	48SGAP

New Brighton	15	71EL HOLYWELL RD (PART)	48SGAQ
Gwernymynydd	16	71EL HOLYWELL RD (PART)	48SGAR
Cilcain	19	71EL HOLYWELL RD (PART)	48SGAU
Leeswood	21	71EL HOLYWELL RD (PART)	48SGAX
Gwernaffield	26	71EL HOLYWELL RD (PART)	Not in 1981 census
Mold South	27	71EE MOLD MB (?)	Not in 1981 census
Mynydd isa East	28	71EL HOLYWELL RD (PART)	Not in 1981 census

Base population error in Menai cluster study

The first page of WCISU's paper on the Menai child cancers (White et al 2005) states that, in order to examine our claim that excess risk was apparent in the 1982 – 1990 data, *Population figures were taken from the 1971 census Area of Residence (AoR) to calculate relative risk by WCISU.* We suggest that this is the source of the discrepancy between WCISU's relative risks and Green Audit's. We remind the reader that WCISU and Green Audit agree that the discrepancy can only arise from the use of wrong populations and that resolution of the difference is crucial to the question of whether the levels of cancer currently observed in the area are a significant public health issue or not.

Fig 4 Copy of part of the claimed 'official OPCS classification manual' sent by Dr Steward of WCISU to Green Audit on Jan 2nd 2001 in connection with the assignation of wards in the WCR Areas of Residence

GWYNEDD DHA

ABERCONWY MU
ABERCONWY CD
Gwynedd (Non-Met)
74AA

Ward Nos	Ward Names
01	Deganwy
02	Marl
03	Pensarn
04	Conwy
05	Betws-y-Coed
06	Mostyn
07	Gogarth
08	Penrhyn
09	Craig-y-Don
10	Tudno
11	Lafan
12	Pandy
13	Bryn
14	Cwrst
15	Pant-yn-Afon
16	Eglwysbach
17	Uwch Conwy
18	Caerhun
19	Penmaenan
20	Trefriw
21	Bro Machno
22	Bryn Rhys
23	Capelulo
24	Fforddlas
25	Gower

GWYNEDD DHA

ARFON MU
ARFON CD
Gwynedd (Non-Met)
74CA

Ward Nos	Ward Names
01	Menai (Bangor)
02	Garth
03	Deiniol
04	Marchog
05	Hirael
06	Dewi
07	Glyder
08	Hendre
09	Menai (Caernafon)
10	Seiont
11	Cadnant
12	Peblig
13	Ogwen
14	Gerlan
15	Rachub
16	Talysarn
17	Penygroes
18	Llanllyfni
19	Pentir
20	Llandwrog
21	Bethel
22	Waunfawr
23	Bontnewydd
24	Llanwnda
235	Deiniolen
26	Penisarwaun
27	Llanberis
28	Llanrug
29	Y Felinheli
30	Llanllechid/Aber
31	Llandygai

13

In Table 1 we identified excess risks in three of the coastal towns — Bangor, Caernarfon and Colwyn Bay. WCISU derived quite different values for each. The question is how. We infer that in the case of Bangor, for which WCR used the AoR code 74CA BANGOR MB, WCISU assumed that the entity 74CA as defined in Fig. 4 above was correct. However, just as in the Mold example, the list has the actual Bangor wards at the top (the first eight) and goes on to list a further 23 wards, some of which are obviously not in Bangor, even to someone who is not as highly qualified as Dr. Steward and his staff. *Number 9 Menai (Caernarfon)* is an example; it is followed by the remaining Caernarfon wards, then by 13 Ogwen, 14 Gerlan and 15 Rachub which are in Bethesda. In the WCR data inherited by WCISU, Caernarfon, Bethesda UD and Ogwen RD are all AoRs in their

own right; respectively 74CE CAERNARFON, 74CC BETHESDA UD and 74CN OGWEN RD. This is the answer to how WCISU obtained such a high base population. It was the population 0-4 of the whole of Arfon, including Caernarfon.

Following this one must ask how they derived populations for the other towns where they offered specific RRs — Colwyn Bay and Caernarfon. Colwyn Bay is WCR's AoR 71CC; Caernarfon is 74CE but neither of these codes appears in the OPCS document WCISU was using, so where did they find data? WCISU must explain the entire rationale.

Table 12 List and number of AoRs assumed by WCISU on basis of alleged OPCS reference manual in Gwynedd, and list and number of AoRs used by Wales Cancer Registry for coding purposes.

Area	**WCISU and alleged OPCS coding manual AoRs**	**WCR Areas of Residence in which cancer cases are distributed**	**Overall number of AoRs assumed in Region**
Gwynedd	74AA, 74CA, 74EA, 74GA, 74JA	74AA, 74AC, 74AE, 74AG, 74AJ, 74AK, 74AL, 74AN, 74AP, 74CA, 74CC, 74CE, 74CL, 74CN, 74EA, 74EC, 74EE, 74EL, 74EN, 74GA, 74GC, 74GE, 74GG, 74GJ, 74GL, 74GN, 74GP, 74JA, 74JC, 74JE, 74JG, 74JJ, 74JL, 74JN, 74JP	WCISU = 5 WCR = 35

5. Discussion

The epidemiological evidence supports the argument that populations living in close proximity to intertidal sediment contaminated with plutonium and other radioisotopes suffer excess cancer risk. This shows itself in all cancer types in adults and in childhood leukaemia and brain tumours. The source of these substances is Sellafield, and the cancer rates began to increase in the early 1980s when the material from the major releases from Sellafield to the Irish Sea began to build up on the coast in areas of low tidal energy like the shores of the Menai Strait.

COMARE's response to Green Audit's evidence of excess child leukaemia in the Menai area (COMARE 2005) relied partly on WCISU's error but was supported by a curious, spurious digression into the paternal preconception irradiation hypothesis (PPI). COMARE casts doubt on PPI but then observes that if it were a plausible explanation for high cancer rates it failed to match the temporal pattern we have observed in north Wales. According to COMARE, higher risks (if any existed and if they were caused by Sellafield) would be seen shortly after the peak discharges of the 1960s and '70s. This is a smokescreen. The continuing migration of radioactivity around the Irish Sea is well described and deposition in sediment continues. Sea-to-land transfer is established, so children are indisputably exposed to inhaling the radioactivity. Given the vast uncertainty about the effects of internal radioisotopes, any number of mechanisms can be advanced to

account for the observations including the accumulation of germline mutations in the exposed population. It is clear that COMARE's ridiculous statement is a form of the familiar argument that the increases in childhood leukaemia near Sellafield itself could not be caused by radiation as doses were too low. However, new science in the area of genomic instability and bystander effects has emerged together with the realisation that absorbed dose, the basis for discounting the Sellafield leukaemias, is not a valid measure of risk for internal irradiation (CERRIE Majority Report 2004; ICRP 2004). This is because internal irradiation may result in high ionisation density in one place (e.g. the DNA). The discovery of anomalous Chernobyl effects at very low doses (as conventionally measured) enabled a figure to be placed on the errors in the conventional risk model. The analysis of infant leukaemia in the children who were in the womb in five different countries (Busby 2000a plus discussion in *Radioactive Times* 2005) and who were exposed to lower doses than the Sellafield children has demonstrated unambiguously that errors in excess of 300-fold exist in the application of the conventional ICRP model to internal irradiation. The increase in childhood cancer in North Wales must be seen as part of this problem. The institutional cover up of child and adult cancers in north Wales is disgraceful and must be addressed. In an atmosphere of debate about the future of nuclear power, the proposals to build new nuclear stations must be considered within the context of the real consequences so that accurate costs can be put against the possible benefits to society.

6. Recommendations

- Data on the incidence and mortality from cancer in north Wales by postcode or small area from 1982 to 2003 should be made available for research, and funding should be made available for a joint study to be carried out using this data and involving Green Audit and two independent epidemiological groups agreed by all who are involved in the study. Legal rules of evidence should pertain and the process should be overseen by a senior judge.
- The authors of the 2003 paper on cancer near Mold should write to the editor of the Journal of Public Health Medicine and retract the paper with an apology to Green Audit.
- The authors of the White et al 2005 paper should retract it and issue an apology.

Afterthought: *The Truth is Out There*.

An article, *The Truth is Out There,* by Richard Wakeford and Robin Thornton in *BNFL World*, June 2003 virulently attacked Green Audit's work in general. They wrote:

> *COMARE has serious concerns about studies, such as those of Green Audit, that are published without formal peer review that would be carried out by a reputable scientific journal in a standard way. Such publications often raise public concern, which is subsequently difficult to allay if the results are unsustainable, as is the case here [1]. COMARE wishes to emphasise that any organisation or individual dealing with epidemiological data has a responsibility to ensure that the data are correct before publication.*

[1] This refers to a COMARE press release of 18 March 2003 *Cancer Mortality Around Bradwell Nuclear Power Station, Essex*, which concerned another dispute where, once again, data used by an agency had been found to be incorrect. In this case it was the Small Area Health Statistics Unit.

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