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PESTICIDES IN THE AQUATIC ENVIRONMENT

NRA

National Rivers Authority

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PESTICIDES IN THE AQUATIC ENVIRONMENT

Report of the National Rivers Authority

Prepared by the National Centre for Toxic and Persistent Substances (TAPS)

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EXECUTIVE SUMMARY

INTRODUCTION

Monitoring by the National Rivers Authority (NRA) has shown low concentrations of a wide range of pesticides in many environmental waters. Research has also indicated they may be present from time to time in the atmosphere and rain. Although these concentrations are not sufficiently toxic to have an immediate and adverse effect on aquatic life - except in a few isolated incidents - the significance of long-term exposure to individual pesticides and the combined effects of mixtures of pesticides are still not fully understood.

This publication by the NRA is the first comprehensive report on pesticides in the water environment in England and Wales. Drawing on the data of two year's extensive regional monitoring of pesticides at 3,500 sites it indicates the occurrence and distribution of pesticides in surface waters and groundwaters. It also includes detailed summaries on the complex legislation relating to pesticides, information on pollution incidents and current pesticides research projects.

A concise analysis of the current position, the report makes 20 recommendations designed to reduce pesticide pollution of environmental waters and to promote action on future work and initiatives.

PESTICIDES IN THE AQUATIC ENVIRONMENT

During 1992 and 1993 the NRA monitored for 120 different pesticides. Samples were taken from around 3500 sites and almost 450,000 separate analyses of pesticides in water were recorded. Analysis revealed that 100 of the 120 pesticides were detected at low concentrations. The remaining 20 were never detected.

For the purposes of this report the data were compared against two criteria; the Environmental Quality Standards (EQSs) in operation at the time, and the pesticide standard in the EC Drinking Water Directive.

An EQS is the concentration of a substance which must not be exceeded in the aquatic environment in order to protect its recognised uses. The standards are used as the basis for decisions on pollution prevention and control; and are specific to individual pesticides depending on their toxicity, persistence and potential to accumulate in fish, plants and animals. Statutory EQSs for a limited range of pesticides have been set in European legislation and in the UK by the Department of the Environment (DoE). Other non-statutory EQSs for priority pesticides have been developed by the NRA to control discharges into the water environment and to assess water quality.

The monitoring data indicated, for the 20 or so pesticides where standards were available, that over 96% of sites were satisfactory. Standards for the statutory EC "Dangerous Substances" priority pesticides were exceeded at less than 1% of sites, with the most frequent breach being for total hexachlorocyclohexane (HCH). The exceeding of EQSs for other pesticides, such as PCSD/eulan and permethrin, was due mainly to effluent from the textile industry.

The pesticide which exceeded its non-statutory EQS most frequently was the sheep dip insecticide diazinon. Sheep dips are classified as veterinary medicines even though they contain similar active ingredients to those used in other pesticide formulations. Most of the instances where limits were exceeded involved sewage containing trade effluents resulting from wool washing and related processes, but at a few sites it was due to sheep dipping.

Preliminary examination of the 1992 and 1993 data for the 25 pesticides commonly found in environmental waters for which the NRA has now proposed operational EQSs, indicates that there are very few exceedences of these proposed standards.

The Drinking Water Directive sets a Maximum Admissible Concentration of 0.1µg/l (micrograms/litre) for any pesticide in drinking water, irrespective of its toxicity. The NRA is not directly responsible for the quality of drinking water, but must take appropriate action to safeguard resources when it is notified by water companies of any breach of the pesticide limit. Therefore, any exceeding of the standard in environmental waters provides a good indication of those pesticides most likely to require action or treatment in order to comply with the Drinking Water Directive.

The exceeding of the 0.1 µg/l standard in groundwater is particularly important because most groundwater sources used for drinking water have no treatment facilities designed to remove pesticides. Of most concern in this context are the herbicides atrazine, diuron, bentazone, isoproturon and mecoprop. The same pesticides exceed the standard in surface waters. All these pesticides are likely to have come mainly from diffuse sources following their approved use.

Serious incidents of pesticide pollution are rare, comprising about 0.2% of all substantiated pollution incidents. However, when they do occur, they can cause serious environmental damage. During 1992 and 1993, 87 pesticide pollution incidents were reported of which eight were classified as the most serious, Category 1. Some resulted in fish kills and others in the closure of drinking water abstraction intakes.

RESEARCH AND DEVELOPMENT

The NRA is currently investing in research to: identify the sources of pesticide inputs to the aquatic environment; determine how they move to surface and groundwater; and to establish the significance of the concentrations of pesticides found in Controlled Waters. The development of analytical methods and EQSs for pesticides found in environmental waters is particularly important. The NRA is developing a computer based modelling tool POPPIE (Prediction Of Pesticide Pollution In the Environment), which will assist in assessing the risk of pesticide pollution to ground and surface waters across England and Wales. This will help target national pesticide monitoring programmes and assess the environmental impact of individual pesticides.

RECOMMENDATIONS FOR FUTURE ACTIONS

1. A national strategy aimed at minimising pollution of the water environment by pesticides should be produced and implemented. The strategy should consider the results of pesticide monitoring in environmental waters and address a range of pollution prevention measures, define clear roles and responsibilities and draw upon latest scientific knowledge and best practices. The task will require the active participation of Government Departments, regulatory organisations, pesticides producers and distributors, the farming industry and other pesticide users.

2. The current Government review of the use of the List I pesticide, gamma HCH (lindane), should consider its impact on the aquatic environment. Possible causes of EQS failures should be identified and appropriate action taken to ensure that the standard is met.

3. The Government should review ways to meet its commitments under the 1990 North Sea Conference Declarations for those pesticides where the 1995 reduction target is unlikely to be met. The review should look at ways of achieving the targets for those pesticides which arise principally from diffuse sources. The review should also consider new requirements for other pesticides identified at the 1995 Conference.

4. The wool processing and textile industries should continue to improve effluent discharges. The NRA will continue to revise discharge consents as necessary to enable rivers to meet appropriate EQSs. Sewage and industrial discharges containing sheep dip pesticides and moth proofing agents should remain a high priority for pollution control. Solutions involving changing processes or treatment will be sought from industry and the water companies.

5. The Ministry of Agriculture, Fisheries and Food (MAFF) and the Health and Safety Executive (HSE) should ensure that appropriate data are available to the NRA from the approval and review process, so that informal standards can be established. The NRA will continue to develop non-statutory EQSs for pesticides which are commonly detected in environmental waters and may present a risk to the aquatic

environment. Future EQS development should also focus on the possible impact when a mixture of pesticides arise and on pesticide breakdown products.

6. As part of the EC reviews of the triazine herbicides, bentazone and diuron, specific consideration should be given to the consequences of their use in groundwater catchments used for drinking water supply.

7. Pesticide distributors and agronomists should always consider water protection issues when recommending pesticides. Wherever possible they should advise the use of improved formulations with lower dose rates. The NRA will liaise with the British Agrochemicals Association to look at ways to try to ensure this approach is understood and adopted by advisors.

8. Amenity pesticide users, such as local authorities, Railtrack and public utilities should continue to be targeted by the regulators, manufacturers and the British Agrochemicals Association to alert them to the risk of contamination from the amenity use of pesticides.

9. Arrangements for the disposal of sheep dip should be reviewed by the Government. The NRA's task of protecting Controlled Waters would be helped if the Authority was notified of the location of sheep dips and the proposed method of disposal of spent solution. The development of an effective treatment process to make spent sheep dip solution harmless should be a priority for the industry.

10. The Government should seek improved information on the use of pesticides on non-agricultural land, in sheep dips and other veterinary medicines, and as industrial biocides. This information should be published routinely.

11. Analytical techniques which could be adopted by the water industry should be developed for agricultural fungicides and pyrethroid insecticides at detection limits required by their EQSs. Pesticide manufacturers should assist with the development of practical analytical methods for pesticides in common use. The NRA will work with the pesticide manufacturers and Standing Committee of Analysts to help with this process.

12. To avoid duplication of monitoring programmes water companies should be encouraged to continue to exchange and review pesticide data with the NRA. The NRA will provide water companies with pollution risk information about individual pesticides to assist them to target their monitoring.

13. Further assessment of the economic case for Water Protection Zones to control pesticide pollution in water supply catchments should be considered by the Government, water companies and the NRA, so that the full costs of catchment control versus those of water treatment can be fully evaluated.

14. The Government should, as a priority, examine the case for "no spray" zones of appropriate width adjacent to all watercourses to prevent overspray, and to minimise spray drift and run-off (except for those pesticides approved for use in or near water). The NRA believes that these should be a minimum of six metres for all pesticides. Larger zones may be necessary for highly toxic pesticides and for application techniques likely to cause increased drift e.g. aerial or orchard application.

15. To help offset the cost of "no spray" zones more effective use should be made of set-aside to create buffer zones along watercourses and this should be a priority for MAFF. The optimum solution would be to change the existing rules to allow a six metre vegetated strip to qualify for the set-aside payment. This change would need to be negotiated through the European Union.

16. Future opportunities arising from the Common Agricultural Policy and land use change should be taken to reduce the risk of pesticide pollution from agriculture.

17. The independent registration scheme for the pesticide industry - BASIS - should continue to inspect distributors' pesticide stores. The extension of BASIS inspection and certification to all large pesticide stores (e.g. manufacturing plants, large farm stores and other user stores such as local authorities and spraying contractors) should be encouraged. A similar scheme advocating minimum pollution prevention requirements for all pesticide stores should be developed and introduced.

18. The pesticide industry should further improve formulations and techniques for handling pesticides to reduce the risk of environmental contamination from spillages and disposal e.g. tablet formulations and refillable containers. In addition, machinery manufacturers should be encouraged to continue developing improved spraying techniques, such as direct injection systems, self-cleaning sprayers and container rinsing systems and the NRA will encourage their use.

19. Pesticide manufacturers, distributors and representative groups (National Farmers Union, Country Landowners Association etc.) should inform their members of current pesticide pollution issues and provide advice on pollution prevention and "best practice". The NRA will assist by publishing pesticide data, providing leaflets, attending agricultural shows and holding seminars.

20. Current research on less intensive farming systems should be extended and the findings implemented by the farming industry. Particular emphasis should be placed on systems which require lower pesticide inputs such as Integrated Crop Management, biological control and insect resistant crops.

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2 SOURCES OF PESTICIDES IN WATER

A pesticide is defined, under the Food and Environment Protection Act (1985), as "any substance, preparation or organism prepared or used for destroying any pest". Pesticides include herbicides, fungicides, insecticides, molluscicides, rodenticides, growth regulators and masonry and timber preservatives. Their use is not confined to agriculture, but also includes use on roads and rail tracks, in homes and gardens, and as antifouling paints, timber treatments, surface biocides and for the protection of public health. Sheep dips are classified as veterinary medicines even though they contain similar active ingredients to those used in other pesticide formulations.

Pesticides are not new. The use of inorganic substances, such as copper, for controlling insects and diseases is mentioned in the Bible. However, the first synthetic pesticides, the organochlorines, were not developed until the 1940s; since then hundreds of new pesticides have been produced to control a wide range of weeds, pests and diseases. They offer a number of benefits including reducing diseases of humans and animals, improving the safety of roads by reducing weeds and increasing visibility, and guaranteeing a plentiful supply of good quality cheap food. However, this increase in pesticide use has led to some pesticides finding their way into surface and groundwater.

2.1 THE USE OF PESTICIDES IN THE UK

Currently there are about 450 pesticide active ingredients approved for use by the Ministry of Agriculture, Fisheries and Food (MAFF) and the Health and Safety Executive (HSE) in the UK, the majority of which are used in agriculture. Table 1 shows the 50 most used pesticides by weight in England and Wales for 1992.

Pesticides have revolutionised arable farming allowing consistently high yields of better quality crops and the reduced chance of crop failures. In striving for higher yields, farmers have become increasingly reliant on pesticides and it is not uncommon for six or seven different pesticides to be applied to a crop during the growing season.

The amount of individual pesticides applied each year is influenced by the quantity and type of crops grown, the weather and the availability of new pesticides. Also, pesticides have different application rates. Some of the new herbicides are applied in very low doses whilst the older ones may need higher rates. For example, the recommended rate for metsulfuron methyl is 6 g/hectare, whilst for isoproturon it is 2500 g/hectare. The introduction of new pesticides with lower application rates and the more efficient use of older pesticides has contributed to reductions in pesticide use in recent years. Also, modern pesticides are less persistent in the environment. This trend towards lower application rates and shorter persistence is likely to reduce exceedences of the 0.1 μg/l individual pesticide parameter, set in the EC Drinking Water Directive (80/778/EEC). However, it does not guarantee there will be no environmental effects, since most modern pesticides are highly active.

Livestock farmers also use pesticides - on animals as well as pasture. Until 1993 it was compulsory to dip sheep to control parasitic diseases such as Scab. Sheep dipping involves large quantities of a pesticide solution which needs careful disposal after dipping has taken place. Discarding large volumes of dilute pesticides in small areas can contaminate water if adequate precautions are not taken.

1 INTRODUCTION

The National Rivers Authority (NRA) is a public body whose task is to protect and improve the water environment in England and Wales, and to provide protection against flooding from both rivers and the sea. In April 1996 it will be transferred to the Environment Agency which is being established under the Environment Act (1995).

The NRA has statutory duties and powers to protect the aquatic environment from pollution. These duties are contained in the Water Resources Act (1991), which is the primary legislation for controlling and preventing water pollution. The authority is required to monitor water quality, investigate pollution incidents, control discharges by consents, and to maintain an improvement in the quality of all inland, coastal and groundwaters.

The use of pesticides has increased substantially since the development of synthetic pesticides in the 1940's and there are now over 450 different pesticide active ingredients approved for use in the UK. As part of its monitoring programme, the NRA currently carries out over 200,000 separate pesticide measurements in environmental waters each year. Regions store the data and the information is publicly available on request. In the past the data had not been summarised nationally so it was difficult to derive information on the occurrence and distribution of pesticides across England and Wales. To address the problem the NRA has set up a national pesticides database, maintained in Anglian Region, as part of the work of the National Centre for Toxic and Persistent Substances (TAPS).

This is the first pesticide report of its kind produced by the NRA and as such contains much detailed information. The report mainly investigates the concentrations of pesticides in Controlled Waters[1] in England and Wales in 1992 and 1993. In addition, it summarises complex legislation, provides information on pollution incidents and current pesticide research projects, and recommends future work and initiatives to minimise pesticide pollution of environmental waters.

1 Controlled Waters are waters defined in the Water Resources Act (1991) and include all rivers, lakes, groundwaters, estuaries and coastal waters.

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TABLE 1
Annual usage of pesticides in agriculture and horticulture in England and Wales in 1992. Information courtesy of Pesticide Usage Survey Group, Harpenden.

No.	Active ingredient	tonnes/year	No.	Active ingredient	tonnes/year
1	Sulphuric acid	6,023	26	Diquat	159
2	Isoproturon	2,750	27	Propiconazole	153
3	Chlormequat	2,214	28	Simazine	151
4	Mancozeb	1,208	29	Flusilazole	128
5	Chlorothalonil	936	30	Fluroxypyr	127
6	Mecoprop	607	31	Chloridazon	117
7	MCPA	590	32	Dimethoate	114
8	Chlorotoluron	579	33	MCPB	101
9	Sulphur	535	34	Atrazine	100
10	Fenpropimorph	516	35	Phenmedipham	99
11	Mecoprop P	513	36	Terbutryn	97
12	Pendimethalin	498	37	Ethofumesate	93
13	Maneb	466	38	Mepiquat	91
14	Trifluralin	347	39	Flutriafol	91
15	Glyphosate	288	40	Bentazone	90
16	Tri-allate	262	41	Bromoxynil	89
17	Fenpropidin	259	42	Linuron	88
18	Carbendazim	255	43	2,4 DB	86
19	Metamitron	247	44	Paraquat	83
20	Tridemorph	195	45	Metaldehyde	82
21	Prochloraz	190	46	1,3–Dichloropropene	81
22	Formaldehyde	186	47	Methabenzthiazuron	78
23	Tar oil	181	48	2,4 D	75
24	Propachlor	177	49	Propyzamide	72
25	Methyl bromide	175	50	Cyanazine	72

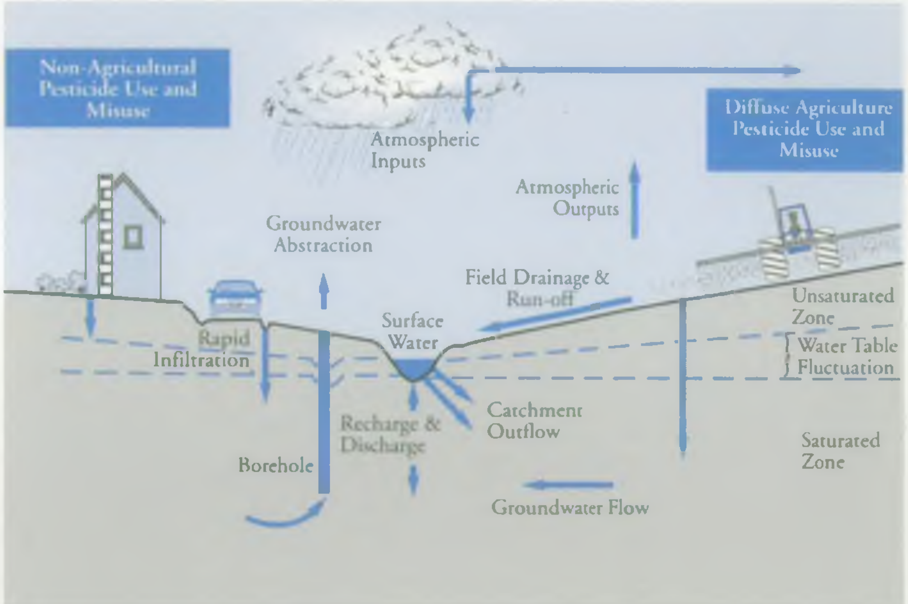
Pesticides also have amenity uses, such as clearing weeds from railway tracks, roads and paths. Because these applications are primarily made to hard surfaces, the likelihood of pesticides being washed off into drains, watercourses and soakaways is increased, especially if rain follows spraying. Another use is in forestry, where pesticides may be applied to clear weeds in young plantations.

Industrial uses of pesticides also exist. Moth proofing agents are used on wool during carpet manufacture, wood preservatives on timber and fungicides on some cloths. Discharges from these sites must be strictly controlled to ensure the environment is protected.

Some pesticides can also be applied directly into water. Certain herbicides are used for controlling aquatic weeds in rivers and lakes. These herbicides are specifically approved for this use because of their low toxicity to aquatic organisms. However, before applying a herbicide in or near water the prior agreement of the NRA must be obtained to ensure that there is no risk to the aquatic environment or to water abstracted for drinking or spray irrigation.

Other pesticides and biocides which may come into direct contact with Controlled Waters are those used on the hulls of boats to prevent fouling by marine organisms. Historically, tributyltin was widely used for this purpose, but restrictions limiting its use to boats over 25m in length were imposed in 1987, because it was affecting shellfish populations and growth.

FIGURE 1
Diagram showing how pesticides enter water.



2.2 PESTICIDES AND THE AQUATIC ENVIRONMENT

Pesticides can enter the aquatic environment from point or diffuse sources. Point sources (i.e. from identified sites) are potentially the greatest threat for acute incidents. Some of these sources, such as those from manufacturing plants, are strictly controlled by Consents (Section 4.2). Others are less easily controlled and include spillages, inappropriate disposal of sheep dips and dilute pesticides, and run-off into drains. Pollution from diffuse sources, such as spray drift into watercourses and leaching from the soil can also occur. In addition, there is evidence that some pesticides can be transported in the atmosphere over considerable distances (Water Research Centre 1995). Figure 1 shows how pesticides can enter water.

Pesticides vary widely in their chemical and physical characteristics and it is their solubility, mobility and rate of degradation which governs their potential to contaminate Controlled Waters. This, however, is not easy to predict under differing environmental conditions. Many modern pesticides are known to break down quickly in sunlight or in soil, but are more likely to persist if they reach groundwater because of reduced microbial activity, absence of light and lower temperatures in the sub-surface zone.

The extent of the toxicity of pesticides to aquatic life is not fully understood. Although chronic toxicity testing is required for new substances, little is known about the long-term effects of older pesticides. Also, very little is known about the toxicity and occurrence of the products formed when pesticides break down (metabolites) or the many non-pesticidal additives (co-formulants and adjuvants) used in pesticide formulations.

There is still a great deal to be learnt about the impact of pesticides on the aquatic environment. New pesticides are continually being developed which are safer for users and the environment, more specific in action and require lower application rates. Nevertheless, the correct storage, appropriate use and safe disposal of all pesticides will remain of crucial importance in safeguarding the aquatic environment.

PLATE 1
Incorrect and illegal storage of pesticides poses a risk to the aquatic environment

PLATE 2
Amenity spraying along a motorway

PLATE 3
Spray trains are used to clear weeds on railway lines

PLATE 4
Agricultural spraying

PLATE 5
Sheep in drip pens immediately after dipping. Photo supplied by A. Virtue, Tweed River Purification Board

PLATE 6
Aerial spraying of pesticides. Photo supplied by 'Farmers Weekly'

PLATE 7
Pesticides in water can arise from industry, although these sources are carefully regulated by the NRA

PLATE 8
Dead fish resulting from pesticide pollution

3 PESTICIDE REGULATION

3.1 LEGISLATION

Comprehensive legislation governs the use of pesticides in the UK. These controls are set out and implemented through Part III of the Food and Environment Protection Act (1985) (FEPA), The Control of Pesticide Regulations (1986) (COPR) and the Medicines Act (1968), which from the 1st January 1995 was replaced by the Marketing Authorisations for Veterinary Medicinal Products Regulations 1994.

The primary aims of FEPA are to:

i. protect the health of human beings, creatures and plants;
ii. safeguard the environment;
iii. secure safe, efficient and humane methods of controlling pests; and
iv. make information about pesticides available to the public.

These are achieved by prohibiting the advertising, sale, supply, storage or use of pesticides unless they have been granted approval by Government Ministers.

3.2 APPROVING THE USE OF PESTICIDES

To obtain approval to use a new pesticide under COPR, manufacturers submit a large quantity of data, including aquatic toxicity tests on trout, *Daphnia* (an invertebrate species) and *Chlorella* (an algal species), and studies on bioaccumulation, mobility and persistence, to the relevant Government organisation. These are:

i. Ministry of Agriculture, Fisheries and Food (MAFF) Pesticides Safety Directorate (PSD) for pesticides used in agriculture, horticulture, amenity, forestry and gardens.

ii. Health and Safety Executive (HSE) Pesticides Registration Section (PRS) for non-agricultural pesticides, including wood preservatives, surface biocides, antifouling paints and pest control products.

(Pesticides used in paint, paper and manufacturing are exempt from the COPR. However, they may soon be controlled by the proposed EC Biocides Directive which is currently under negotiation).

Approval for veterinary medicines encompases two stages of environmental risk assessment. The first phase is to assess likely exposure of the environment resulting from use, excretion and disposal. If this exposure is significant, then the second phase is undertaken, where data on ecotoxicology and fate are required according to the environmental exposure. Data are submitted to:

iii. Ministry of Agriculture, Fisheries and Food (MAFF) Veterinary Medicines Directorate (VMD) for pesticides used as veterinary medicines e.g. sheep dips.

Approval for the use of pesticides and most biocides requires approval by six Government Departments following recommendations made by the Advisory Committee on Pesticides (ACP). The ACP is a panel of experts which assesses the evidence for the potential impact of the pesticide.

Pesticide registration is currently being harmonised across Europe under The Council Directive of 15th July 1991 concerning the placing of plant protection products on the market (91/414/EEC), commonly referred to as the Authorisations Directive. (Further details of the approval process and the Directive are given in Appendix I).

The purpose of the approvals process is to ensure that the pesticide is safe to the user, consumer and environment, and that it is effective at controlling the target pest.

One of the current requirements of this approval is that there is an analytical method capable of detecting the pesticide at 0.1 µg/l, the maximum concentration permitted in drinking water. Although this is a welcome inclusion in the registration requirement, it may still not be possible or practical for the NRA to use these analytical methods routinely for large numbers of samples. The difficulty is that most pesticides are analysed in "suites" (Section 4.6). Therefore, if a pesticide cannot be added to an existing suite, but requires unique analysis, the cost may be prohibitive. The Authorisations Directive will, however, require analytical methods for the older pesticides, some of which were not previously available, so this should allow monitoring to be undertaken.

Sheep dips and other veterinary medicines are approved by a different mechanism. Licences are issued by the licensing authority (Ministers of Agriculture in the four countries of the UK) acting on the advice of the independent Veterinary Products Committee (VPC) which has the same role as the ACP.

3.3 WATER POLLUTION CONTROL LEGISLATION AND PESTICIDES

As "Guardians of the Water Environment", the NRA has statutory duties and powers to protect the aquatic environment from pollution. These duties are contained in the Water Resources Act (1991), which is the primary legislation for controlling and preventing water pollution. Under Section 85 of this Act it is an offence "to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste to enter any Controlled Waters."

Point source discharges to Controlled Waters are regulated by means of consents to discharge under Section 88 and Schedule 10 of this Act. Diffuse discharges can be controlled by the establishment of Water Protection Zones under Section 93, and activities likely to result in water pollution can be restricted within these zones, although to date no zones have been set by the Secretary of State. Alternatively, Regulations under Section 92 of the Act can be used to restrict individual pesticides. The Act also proposed the establishment of Statutory Water Quality Objectives and Standards and these are shortly to be introduced for certain rivers in England and Wales, on a pilot scale basis.

Pesticides are potentially "poisonous, noxious or polluting" substances, and therefore the NRA is responsible for controlling and preventing pesticide pollution of water. Furthermore, the NRA is responsible for ensuring water quality meets standards set in a number of EC Directives, some of which specify values for pesticides. The NRA can only use its consenting powers to limit pesticides discharged from manufacturing or industrial plants in order to meet the standards in the EC Directives. It is not possible to use this approach to control pesticides arising from diffuse sources i.e. their normal use.

Table 2 indicates the Directives which include measures for controlling pesticides in water.

Directive (76/464/EEC) on pollution caused by the discharge of dangerous substances into the aquatic environment, created a framework for the elimination or reduction of pollution by substances considered dangerous in terms of their persistence, toxicity and bioaccumulation. This "Dangerous Substances" Directive classified substances into two categories, List I (to be eliminated) and List II (to be reduced) (Appendix II). The Directive also sets quality standards to be achieved.

Eighteen substances have been classified as List I by the EC in subsequent "daughter" Directives, of these 8 are pesticides - hexachlorocyclohexane (HCH), DDT, pentachlorophenol, the "drins" (aldrin, dieldrin, isodrin, endrin) and hexachlorobenzene. (DDT and the "drins" are now banned from all uses in the UK under the Control of Pesticides Regulations). Environmental Quality Standards (EQSs) are set in

TABLE 2
Directives which include measures for controlling pesticides.

EC Directive Title	Directive No.	Implemented by	Reference
Pollution caused by the Discharge of Dangerous Substances into the Aquatic Environment	76/464/EEC	Surface Water (Dangerous Substances) (Classification) Regulations 1989	SI 2286
Limit values and quality objectives for discharges of hexachlorocyclohexane	84/491/EEC	Circular 7/89 DoE Advice note set out standards for List II substances	
Limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC (DDT, CCl_4, PCP)	86/280/EEC		
Amending Annex II to Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC (aldrin, dieldrin, isodrin, endrin, hexachlorobenzene, hexachlorobutadiene, chloroform)	88/347/EEC		
Quality of Surface Water for Drinking	75/440/EEC 79/869/EEC	Surface Waters (Classification) Regulations 1989	SI 1148
Quality required for Shellfish Waters	79/923/EEC	Currently DoE advice notes. Regulations in preparation.	
Groundwater	80/68/EEC	COPA 1974 Part 1 EPA 1990 WRA 1991 Town and Planning Acts	

these Directives and are required to be transcribed into UK legislation. For the above substances this was done via the Surface Waters (Dangerous Substances) (Classification) Regulations 1989. A formal Direction and Notice has been issued by the DoE requiring the NRA to control, monitor and report on these substances.

Directive 76/464/EEC leaves identification of List II substances and the setting of appropriate EQSs to individual Member States. In the UK, DoE has set standards for a number of substances via Circular 7/89, a form of Government advice note. Included in the advice note were the pesticides cyfluthrin, permethrin, sulcofuron, flucofuron, PCSDs, tributyltin and triphenyltin. No formal Direction or Notice has been issued to date, however, the NRA continues to monitor downstream of known discharges of List II substances.

The "Shellfish Waters" Directive (79/923/EEC) lays down requirements for the quality of designated waters which support shellfish (defined as bivalve and gastropod molluscs). Its purpose is to protect or improve designated waters in order to support shellfish life and growth and thus to contribute to the high quality of shellfish products directly edible by man. DoE/Welsh Office have designated 18 areas under this Directive to date. Thus this Directive is primarily aimed at protecting the shellfish populations themselves rather than the health of the consumers, which is covered by a more recent Directive (91/492/EEC).

An advice note was issued by the DoE in November 1980 which gave advice on suitable water quality standards for the metal and pesticide determinands in the Directive. These standards were not, however, in line with those established by subsequent Dangerous Substances legislation. The NRA has highlighted these discrepancies and DoE are currently considering what standards should be applied to particular parameters, including pesticides, in the context of formally transposing the Directive into UK regulations. The pesticides to be monitored in designated shellfish waters are DDT, parathion, lindane (gamma HCH) and dieldrin.

The "Surface Water Abstraction" Directive (75/440/EEC) is concerned with the quality required for surface water intended for the abstraction of drinking water. It aims to improve the quality of rivers and other surface waters used as sources of drinking water and ensures that the water is given adequate treatment before being put into public supply. It includes standards for the three pesticides, parathion, BHC (gamma HCH) and dieldrin to be applied at abstraction points identified under the Directive. A second Directive (79/869/EEC) recommends analytical methods and specifies the frequency of analysis required. The standards apply at the points where water is abstracted for drinking water supply (normally via treatment) from a river or water supply reservoir.

The "Drinking Water" Directive (80/778/EEC) is designed to ensure that water from the tap is fit to drink. It specifies limits for a number of parameters, including a Maximum Admissible Concentration of 0.1 µg/litre for individual pesticides. This value is not based on the toxicity of individual pesticides, but on a uniform and very low level set to minimise the occurrence of pesticides in drinking water. The Directive is incorporated into UK law through the Water Industry Act 1991 and the Water Supply (Water Quality) Regulations (1989). It is the responsibility of the water supply companies to ensure drinking water complies with the Regulations. Although the NRA is not directly responsible for the quality of drinking water, it must take appropriate action to safeguard resources following notification by water companies of any exceedence of pesticide limits, as recommended under Paragraph 7.15 of the DoE/Welsh Office document "Guidance on Safeguarding the Quality of Public Water Supplies (1989)". This involves investigating possible sources of the pollution and taking action to prevent further exceedences.

The "Groundwater" Directive (80/68/EEC) is designed to protect groundwater against pollution from Dangerous Substances including pesticides. These substances are broadly divided into two groups in a similar way to the Dangerous Substances Directive (Appendix III). Specific measures are required to prevent List I substances entering groundwater and to restrict the entry of List II substances. The NRA is responsible, under a direction from the Secretary of State for the DoE, for classifying substances into the appropriate list. The Groundwater Directive National Advisory Group, established by the NRA in 1992, assists with this process.

Groundwater was also the subject of an EC Seminar at The Hague in November 1991. Environment Ministers for the European Union adopted a resolution to manage and protect groundwater on a sustainable basis, by preventing over-exploitation and pollution. Plans for an extensive action programme are now being drafted and a revised Groundwater Directive is anticipated.

In recognition of the EC declaration, and to meet some of the requirements of the EC Groundwater Directive and its duties under the Water Resources Act, the NRA produced its report on "Policy and Practice for the Protection of Groundwater" in December 1992. This includes sections on measures for preventing groundwater contamination by pesticides and states that wherever possible, only non-persistent, degradable compounds should be used in areas where groundwater is vulnerable to pollution. A series of vulnerability maps are being prepared which may be used to assist with this. These are available from HMSO. The NRA will inform users of the risk from pesticides and advise on methods of application in areas where groundwater is particularly vulnerable.

In addition to the requirements of the Directives, UK Ministers have agreed to at least halve the input loads of 36 priority hazardous substances (Annex 1A) discharged to the North Sea by 1995 (Appendix IV shows substances and target reductions). Eighteen of these substances are pesticides. As a result, the NRA is required to monitor the quantity of these substances discharged via estuaries or direct to coastal waters to show whether these reduction targets are being met. In addition to these 36 substances, further common actions were agreed with respect to the reduction of other groups of substances including 18 substances used as pesticides (Annex 1B - Appendix V), the use of which should be strictly controlled or banned.

The NRA is also a statutory consultee for Integrated Pollution Control (IPC). IPC is a system of pollution control intended to apply to the most potentially polluting or technologically complex industrial processes and covers polluting discharges to air, water and land. The enforcing (and authorising) authority of IPC is Her Majesty's Inspectorate of Pollution (HMIP). Following the introduction of IPC, HMIP authorises the discharge to Controlled Waters of liquid effluents from "prescribed processes" as defined in the Environmental Protection (Prescribed Processes and Substances) Regulations (1991). Operators of prescribed processes require an "Authorisation" from HMIP, which stipulates certain conditions to be met to prevent pollution.

As a statutory consultee, the NRA has powers to require HMIP to set conditions within the Authorisation for discharges to Controlled Waters. In this way the NRA can control the release from point sources of many toxic substances including pesticides.

The NRA also has responsibilities under other UK legislation and guidelines for controlling pesticides. It is a statutory consultee for planning, waste disposal, the use of aquatic herbicides, aerial applications, and pesticide storage and disposal. The NRA is also required to control point and diffuse source inputs, promote the use of best environmental practice and is referred to in numerous MAFF/HSE Codes.

Until recently, the NRA has not participated directly in the approval process for assessing the potential environmental impact of pesticides. However, the NRA supplies monitoring data to MAFF and HSE for pesticide reviews. These occur once a pesticide has been approved for use for a certain length of time, or when further information is needed on an approved pesticide. In supplying these data, the NRA comments on any areas of concern. This contributed to the 1993 ban on the use of atrazine and simazine on non-agricultural land. Concerns are discussed via DoE, with MAFF's ACP or VPC. Since January 1995 the NRA has become the official advisor to the DoE, on the potential impact on the aquatic environment of the pesticide products being assessed by the ACP.

3.4 STORAGE, USE AND DISPOSAL OF PESTICIDES

The storage, use and disposal of pesticides are regulated by Consents under FEPA, Codes of Practice, the Control of Substances Hazardous to Health (COSHH) Regulations and other legal mechanisms issued under COPR. There are also a number of non-statutory guidance notes produced by Government Departments and organisations such as the British Agrochemicals Association (BAA), National Office of Animal Health (NOAH) and other trade associations such as the British Wood Preserving and Damp Proofing Association (BWPDA). Details of legal aspects of storage, use and disposal of pesticides are given in Appendix VI. Procedures for the disposal of agricultural waste are expected to be incorporated into an EC Directive, following consultation in 1995.

The NRA has a role in developing the advice given in the Codes and Guidance Notes on storage, use and disposal. The NRA is also directly involved in consultation during the drafting of Codes of Practice and Guidance documents and takes a practical involvement in approving pesticide stores registered under the BASIS scheme. (BASIS is the Independent Registration Scheme for the pesticide industry as recognised under COPR).

Much of the FEPA legislation on pesticides is enforced by the HSE. A Memorandum of Understanding between HSE and the NRA covers the regulatory areas of the two organisations which overlap, including the control of pesticides. The legislation governing pesticides is extensive. If Codes and Guidance notes are followed the risk of pollution from pesticides will be reduced. However, the ultimate responsibility for preventing pollution lies with the user.

4 NRA MONITORING PROGRAMMES

The NRA's pesticide monitoring programme is strongly governed by statutory requirements to monitor pesticide concentrations in water, sediment and biota. The NRA is also required to monitor and control pollution problems, particularly those from pollution incidents. Additional non-statutory monitoring of pesticides is also undertaken and is tailored to known or predicted local problems. It is estimated that the cost of the NRA's pesticide analytical programme is £3m per annum.

4.1 ENVIRONMENTAL QUALITY STANDARDS

Monitoring aims to measure water quality, detect any changes and check that water is suitable for its recognised uses. This suitability or "fitness for use" is assessed by comparing water quality with Environmental Quality Standards (EQSs).

An EQS is the concentration of a substance which must not be exceeded within the aquatic environment in order to protect it for its recognised uses. For example, Circular 7/89 lists different standards for List II substances for the protection of aquatic life, for water for abstraction for drinking and for saline water. EQSs are specific to individual substances (including some pesticides) and are produced using the best available environmental and ecotoxicological information. Currently, EQSs only relate to surface water.

Statutory EQSs have been set in legislation by the European Commission (EC) and in the UK by the Department of Environment (DoE). Other non-statutory EQSs have been developed by the NRA to control discharges and assess water quality.

Some substances within the definition of List I (as defined in EC Directive 76/464/EEC) have had statutory EQSs set in daughter Directives. They have been transcribed into UK legislation via the Surface Water (Dangerous Substances) (Classification) Regulations of 1989 and 1992. Any exceedence of these statutory EQSs downstream of relevant discharges are reported annually to the DoE and action is taken to prevent further exceedences. These EQSs have been defined as annual average values.

Although statutory standards for List II substances have yet to be set in UK legislation, the Government Advice note Circular 7/89 sets out EQSs for a number of List II substances which are being applied as if they were statutory. These EQSs are either annual average values, maximum concentrations, or 95% percentiles. (For 95 percentiles the concentration must not be exceeded for 95% of the time)[2].

In addition, the DoE has proposed EQSs in a 1991 consultation document for those pesticides on the Red List (the UK's original priority hazardous substances list detailed in Appendix VII). These take the form of a maximum value to protect the environment in the short-term and an annual average figure, to safeguard against long-term damage. Although non-statutory at present, the Government is committed to the reduction of Red List Substances discharging to the North Sea. The NRA uses the standards to assess the effects of these substances on the environment and to derive consent conditions for point source discharges of these compounds.

2 UK reports to Europe only those sites downstream of point source discharges as the relevant Directives refer to the control of discharges and processes. However, in this report comparison of sites with the EQSs has been made whether or not the site is downstream of a discharge, with the result that there are a number of sites exceeding EQSs which are not included in the annual returns to DoE. In such cases the NRA will investigate possible causes of any exceedences and take remedial action wherever possible.

The NRA is developing operational EQSs for priority pollutants through its national Research and Development Programme. Although non-statutory, these standards are used by the NRA to derive consent conditions. The standards usually take the form of maximum and annual average values.

The pesticide EQSs that were used by the NRA in 1992 and 1993 are shown in Table 3. A further 25 NRA operational standards have been proposed since this time.

4.2 MONITORING EFFLUENT DISCHARGES

Consents to discharge are issued under the Water Resources Act (1991) and are used to control point source inputs of effluents into watercourses. Consent conditions are set to avoid any environmental impact and where an EQS is available, conditions are calculated to ensure the EQS is met in the receiving water. Industries manufacturing or formulating pesticides, washing wool and manufacturing textiles are regulated by consents to control pesticide levels in effluent discharges.

Effluent discharges containing only a few specific pesticides are controlled by consent limits for the individual substances. Complex discharges containing mixtures of

TABLE 3
Environmental Quality Standards for the protection of aquatic life (used by the NRA in 1992/93)

Pesticide	Freshwater			Saline water		
	Maximum µg/l	Annual average µg/l	95 percentile µg/l	Maximum µg/l	Annual average µg/l	95 percentile µg/l
HCH (A)		0.1 (0.05 NNS)			0.02	
pp DDT		0.01			0.01	
Total DDT		0.025			0.025	
Pentachlorophenol (A)		2			2	
Total drins		0.03			0.03	
Endrin		0.005			0.005	
Hexachlorobenzene		0.03			0.03	
Total Atrazine/ Simazine (A)	10 (PWRc)	2 (P)		10 (PWRc)	2 (P)	
Azinphos methyl	0.04 (PWRc)	0.01 (P)		0.04 (PWRc)	0.01 (P)	
Dichlorvos (A)		0.001 (P)			0.04(P)	
Endosulfan (A)	0.3 (PWRc)	0.003 (P)			0.003 (P)	
Fenitrothion (A)	0.25 (PWRc)	0.01 (P)		0.25 (PWRc)	0.01 (P)	
Malathion (A)	0.5 (PWRc)	0.01 (P)		0.5 (PWRc)	0.02 (P)	
Trifluralin (A)	20 (PWRc)	0.1 (P)		20 (PWRc)	0.1 (P)	
Diazinon (A)	0.1 (P NRA)	0.01 (P NRA)		0.15 (P NRA)	0.015 (P)	
PCSDs (A)			0.05 (P)			0.05 (P)
Cyfluthrin (A)			0.001 (P)			0.001 (P)
Sulcofuron (A)			25 (P)			25 (P)
Flucofuron (A)			1 (P)			1 (P)
†Tributyltin (TBT) (A)	0.02 (P)			0.002(P)		
†Triphenyltin (TPT) (A)	0.02* (P)			0.008(P)		
Permethrin (A)			0.01 (P)			0.01 (P)

P = Proposed (DoE)
P NRA = Proposed (NRA)
PWRc = Proposed (Water Research Centre)
NNS = National Network Sites
All others are statutory

* = 0.09 µg/l at abstraction points
† = data on TBT and TPT was not available for this report
A = Approved for use in the UK

pesticides (e.g. from manufacturing sites), may be more appropriately controlled by means of toxicity based consents. These specify limits for the toxicity to target organisms e.g. herbicides may be assessed using phytotoxicity tests as well as general aquatic toxicity tests on shrimps and trout. The concept of Direct Toxicity Assessment is currently being evaluated by the NRA.

Monitoring of discharges and receiving water is carried out to ensure compliance with consents and where appropriate the EQS. The sampling frequency depends on the volume and location of the discharge, but is typically 12 times a year. The costs of monitoring the discharges and assessing their impact are recovered from the discharger via the NRA's Charging for Discharges Scheme.

4.3 EC DIRECTIVES MONITORING REQUIREMENTS

A number of EC Directives have requirements to monitor pesticides in surface fresh, estuarine and coastal waters. There are no formal requirements to monitor groundwater. Many of the pesticides specified are the older, more persistent pesticides, most of which are no longer used in the UK. This emphasis on older products ties up resources, but has been a useful source of data on the disappearance of pesticides from the environment.

Most pesticides now found in the environment are newer products, frequently herbicides and in most cases not covered by Directives, the Red List or Annex 1A. There is now a need to concentrate on pesticides currently being used to ensure that any new problems are detected early.

4.3.1 Surface waters

The NRA is required to monitor downstream of all known discharges of List I and List II substances. Additionally, List I substances must be monitored at background environmental monitoring sites, known as "national network" sites. (For HCH the standard to be applied at these background monitoring sites differs from that at downstream monitoring sites.) Certain List I substances must also be monitored in sediments (Section 4.3.2).

Abstraction points identified under the "Surface Water for Abstraction" Directive must also be monitored for the relevant pesticides, as must designated waters under the "Shellfish Waters" Directive. Monitoring for List I, List II and EQS exceedences must be reported annually to DoE.

4.3.2 Sediment and biota

For those List I substances prone to accumulation in sediment or biota, monitoring of those substrates is required in waters receiving discharges of List I substances. There are no specific standards to be met for the pesticides covered, but a "standstill provision" applies. This means that there should be no significant increase over time. The provision applies to the following pesticides:

- hexachlorocyclohexane (HCH)
- hexachlorobenzene
- pentachlorophenol
- dieldrin
- isodrin
- aldrin
- endrin
- DDT.

Results of sediment and biota monitoring are required to be reported to DoE annually.

4.4 ADDITIONAL GOVERNMENT MONITORING REQUIREMENTS

The NRA undertakes monitoring as part of the Harmonised Monitoring Programme. This was set up by the DoE in 1974 to provide a network of sites at which river quality data at the lower end of the catchment could be collected and analysed in a nationally consistent manner. Its purpose is first to enable estimates to be made of the loads of materials carried through river catchments into estuaries; and second, to allow long-term trends in river quality to be assessed. The complete list of substances is diverse and includes about 115 parameters.

The list includes the pesticides aldrin, dieldrin, gamma HCH, heptachlor, pp DDE and pp DDT. Figures 2 and 3 show the downward trend of dieldrin and gamma HCH respectively over the past twenty years at the Harmonised Monitoring Sites.

The NRA also monitors and reports on substances entering the North Sea as part of the Government's commitment to halving the load of certain hazardous substances entering the North Sea by 1995 (Section 3.3).

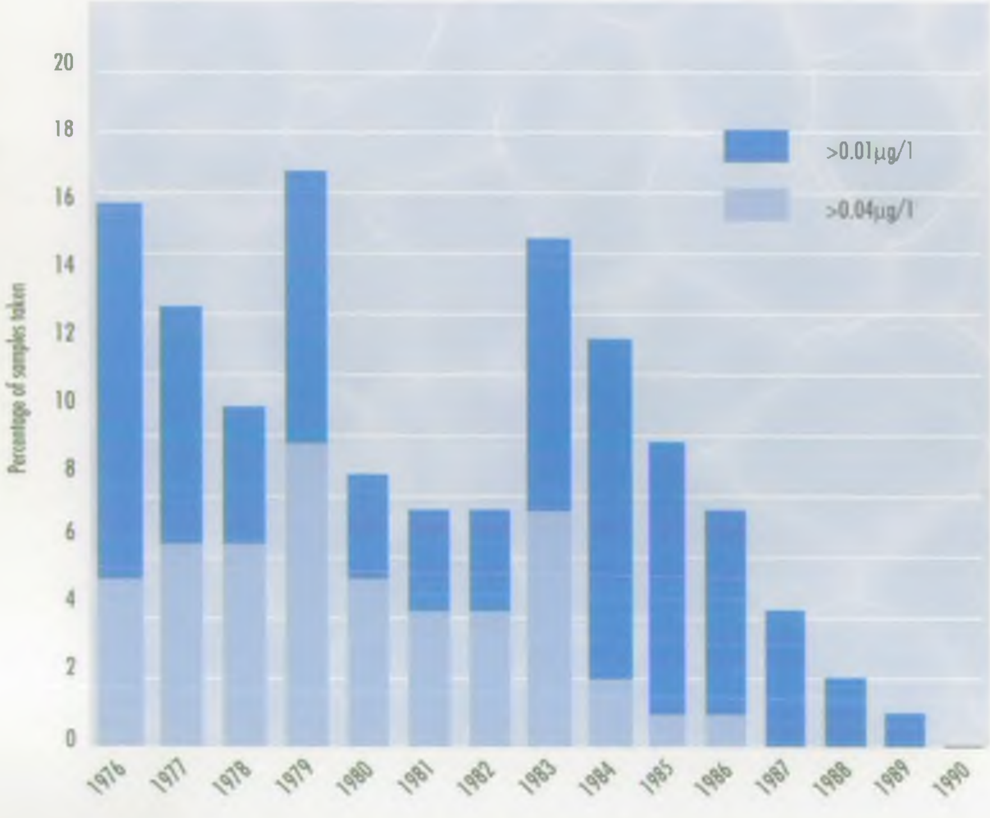
4.5 NON-STATUTORY MONITORING

The NRA carries out monitoring for other pesticides which it considers may be present in the aquatic environment, to ensure no environmental damage is occurring. Monitoring for pesticides is expensive and time consuming and must be carefully planned to ensure value for money. With about 450 different pesticides available, it is not practical or possible to monitor all of them. Therefore, each NRA Region carries out monitoring tailored to known and potential problems associated with the local use of pesticides. This requires detailed information from a number of sources (Section 4.5.1 and 4.5.2).

Many pesticides are used in agriculture and therefore in intensive arable farming areas, monitoring is carried out for some of the most widely used agricultural pesticides. In contrast, upland areas have little arable land but more sheep farming, and monitoring is therefore targeted towards pesticides used in sheep dips. In urban areas, the amenity pesticides used on roads and railways are monitored. However, land use may vary widely even within individual river catchments.

Additional factors which are considered when assessing whether a pesticide is likely to reach water are the physico-chemical properties of the substance, such as solubility, mobility and persistence, along with factors such as time of application, dose rate, soil type and climate. Once the use of a pesticide is known, it is possible to combine this information with these other factors and try to predict those pesticides most likely to be found in surface and groundwaters.

FIGURE 2
Dieldrin in rivers in Great Britain (% distribution of concentrations) (Data from the Harmonised Monitoring Sites)



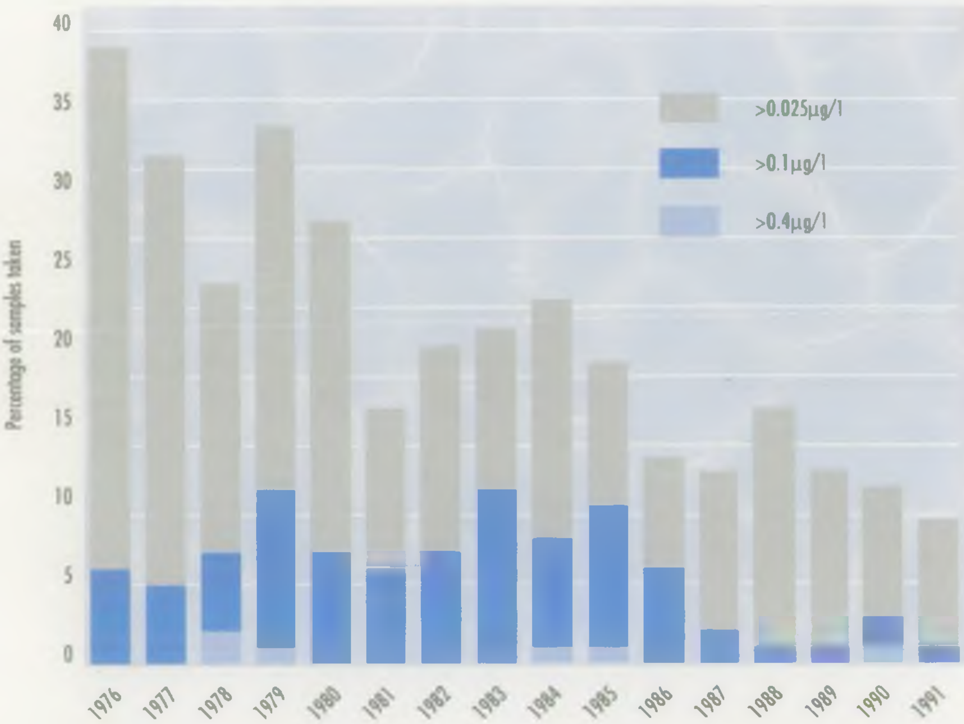


FIGURE 3
Gamma HCH in rivers in Great Britain (% distribution of concentrations)
(Data from the Harmonised Monitioring Sites)

Currently, groundwater monitoring for pesticides has not been formalised by the NRA. Proposals are being considered for a national groundwater quality monitoring programme which will include pesticides. Their relation to current and historic land use will be taken into account.

New pesticides are regularly being approved by MAFF and HSE. This means that monitoring programmes must be continually reviewed and analytical methods developed for those substances.

4.5.1 Pesticide usage information

Information on agricultural pesticide use in Great Britain is produced by MAFF's Pesticide Usage Survey Group. The group provides information on the quantity of individual pesticides used on each crop, a "top 50" of pesticides used in the highest tonnages in Great Britain and also the "top 50" pesticides according to the area to which they are applied. It is therefore possible to determine the pesticides with the highest use, one factor which may affect the likelihood of water contamination.

Information on different catchments is available commercially from Farmstat Ltd in the form of the FARMSTAT Report.
A mathematical model predicts the likely concentrations of pesticides within specific catchments after taking into consideration rainfall, soil type, cropping, pesticide use, timing of application and solubility. The model predicts the expected concentration in surface and groundwater for selected catchments for each month of the year. The NRA is currently developing its own modelling system for the "Prediction Of Pesticide Pollution In the Environment" (POPPIE) (Section 6.2.).

4.5.2 Water company analysis

Another source of information on pesticides occurring in water is the Annual Report of the Drinking Water Inspectorate. The Inspectorate assesses the results of over 1 million tests for pesticides in drinking water carried out by water companies. The report indicates the pesticides detected at concentrations greater than 0.1 µg/l. The information in the report, however, refers only to treated water and is of decreasing value to the NRA because water companies tend now to treat water to remove pesticides.

The water companies are also required to inform the NRA of any exceedences of the pesticide parameter, so that appropriate action can be taken. In addition, they also provide the NRA, on request, with data on pesticides in raw water before treatment. This can be used to develop the NRA's monitoring strategies. The proposed groundwater monitoring programme will rely heavily on water company assistance to avoid duplication of analytical effort.

All of these sources of information are used to set priorities for monitoring and the control of pesticide pollution.

4.6 ANALYSIS OF PESTICIDES

To make the best use of resources, pesticides from similar chemical families are analysed together using the same technique where possible. A group of pesticides is then known as an analytical "suite". Examples include organochlorine insecticides e.g. DDT, gamma HCH and dieldrin; triazines e.g. atrazine, simazine, terbutryn etc; and "urons" e.g. isoproturon, chlorotoluron and diuron. Analysing for a number of pesticides at the same time reduces the cost. However, some pesticides have unique properties and require specific analytical techniques.

The extent of pesticide monitoring has varied significantly within the NRA depending on pesticide use in each Region and also the capability of the laboratories.

Each NRA laboratory has a set of analytical procedures which vary according to the resources available, the nature of the samples and the suites of analysis. In general all the analytical methods include: extraction, concentration, clean-up, analysis, measurement and confirmation. (Details of the analytical procedures can be found in Appendix VIII).

Most pesticides are analysed using chromatographic techniques, which depend on the pesticide's retention time on a chromatographic column under set conditions. This is compared with a known reference standard of the pure pesticide. False positive results can occur because some pesticides may have the same retention time under certain chromatographic conditions. It is therefore important to carry out additional analysis using a different technique to confirm the identity of the substance. (Details of confirmatory techniques can be found in Appendix VIII).

A high priority is placed on analytical quality assurance and each laboratory produces its own Analytical Quality Control (AQC) procedures. Laboratories also participate regularly in AQC collaborative exercises organised externally.

It is the NRA's policy that its laboratories are accredited by the National Measurement and Accreditation Service (NAMAS). This involves external auditing of each laboratory and in particular its AQC system. The NRA also has an internal report detailing the analytical methods used in the organisation.

4.7 ANALYTICAL CONSTRAINTS ON MONITORING

The main difficulties in analysing for trace levels of pesticides in water occur because:

i. the very low levels of detection required introduce problems of accuracy, reproducibility and reliability. The lower the concentrations being measured, the higher the cost, analytical skill required and degree of uncertainty.
ii. many pesticides are very soluble in water, e.g. glyphosate and TCA making extraction and concentration difficult.
iii. it is difficult to identify organic pesticides amongst a wide range of other organic compounds which are present at higher concentrations in environmental samples.

Because of the difficulties and costs associated with analysis, not all pesticides identified as high priority can be included in current monitoring programmes. Analytical methods need to be developed for these pesticides if routine monitoring is to be undertaken. Developing methods can be complex and expensive, and analysis of high priority pesticides may therefore be contracted out to external laboratories so that current environmental concentrations can be established and priorities for future monitoring drawn up.

It is not practical to constantly modify "suites" of analysis, but there is a need to develop new analytical techniques for high priority pesticides which can be incorporated into existing "suites".

4.8 POLLUTION INCIDENTS

The NRA is responsible for investigating pollution incidents including those caused by pesticides. Reports of pollution or suspected pollution are received by the NRA from various sources. These may include manufacturers, users, public, the police or fire service. In addition, unusually high pesticide concentrations are sometimes detected during routine monitoring or are reported by the water companies following a failure of the drinking water parameter. The NRA provides a free emergency telephone hotline (0800 80 70 60) for reporting pollution incidents.

The NRA responds to pollution incidents immediately. The highest priority is to contain the pollution and minimise the environmental impact. This is then followed by identifying the source, cause and, if possible, the pesticide involved. The risk to the aquatic environment is also assessed. Samples are collected for analysis and as evidence in prosecutions. Laboratory analysis is usually required to identify and quantify the pesticides involved.

NRA laboratories have special procedures for identifying pesticides in pollution samples. These include multi-extraction, chromatography and spectrometry. A spectrum (type of fingerprint) of each component in the sample is produced. Sophisticated computer software is then used to search an extensive computer library for matching pesticides. Very low levels of detection (<0.005-0.01 μg/l) are possible for some pesticides so that trace amounts can still be found sometime after the event.

Details of the substantiated pesticide pollution incidents which occurred in 1992 and 1993 can be found in Section 5.4 and Appendix IX.

4.9 BIOLOGICAL MONITORING OF RIVER QUALITY

The biological quality of rivers is assessed to obtain a better understanding of the health of rivers and to measure the impact of pollution not detected by chemical monitoring.

Biological quality is primarily based on monitoring aquatic macroinvertebrates, the small animals which live in rivers. These organisms live in continuous contact with river water and can therefore provide information on the long-term quality of the water. If the water is polluted, even for just a few minutes, some or all of the macro-invertebrates may die. Recovery of the community may take several months, so biological data can provide evidence of pollution which may have been missed by routine chemical monitoring. Because some macroinvertebrates respond differently to different chemicals, biological data can indicate the type of pollution which occurred.

The impact of pesticides on the biology of rivers will probably depend on the type of pesticide involved. For example, biological monitoring may pick up a decline in insect population following pollution by an insecticide, or a lower than expected algae population following herbicide pollution.

The low concentrations of pesticides in surface waters are not generally significant in terms of acute toxicity to aquatic life. Also, biological surveys carried out by the NRA do not indicate a widespread problem with pesticides. However, in certain rivers, point source inputs of the moth proofing agents permethrin and cyfluthrin have caused acute toxicity problems. Generally, the long-term significance of sub-lethal concentrations or of short-term peaks, particularly in headwater streams is unknown. This is being investigated by a research and development project on "The Impact of Pesticides on River Ecology" which aims to distinguish the impact of pesticides from that caused by other pollutants.

5 THE OCCURRENCE OF PESTICIDES IN WATER

5.1 NRA MONITORING - 1992 and 1993 DATA

Over 200,000 pesticide measurements are recorded each year by the NRA at around 3500 sites. The data presented are only those from the monitoring of environmental waters and exclude pesticide data from discharges or pollution incidents. The results therefore reflect the background concentration in Controlled Waters. All data are presented in micrograms/litre (μg/l). However, because of the cost of analysis, some monitoring is targeted at sites where specific pesticides are known to be problematic. Therefore, Regional differences may be artificially biased. The pesticides routinely monitored by the NRA in 1992 and 1993 and their uses are shown in Appendix X. NB. Not all Regions monitor for all of these pesticides.

Because concentrations of pesticides in most river waters are very low, many of the measurements are reported as "less than" (e.g. < 0.01μg/l), which causes difficulty when analysing the results. In order to simplify the vast quantity of data summarised and presented in this report "less than" results have been treated as zero. Therefore, the results presented illustrate the "best case" (lowest concentration) situation. One exception is illustrated in Appendix XI.

The data have been compared against two criteria.

Environmental Quality Standards

The 1993 pesticide data from each site was compared with all the EQSs which were available or proposed at the time i.e. List I, List II, Red List and the NRA proposed standard for diazinon. Not all the sites are downstream of discharges and are therefore not appropriate for Directives monitoring, but they have been used as a comparison of the national distribution of pesticides.

Drinking Water Directive Standard

The 1992 and 1993 data have been compared against the 0.1 μg/l standard specified in the Drinking Water Directive, (the standard which all pesticides must meet in drinking water irrespective of toxicity). Whilst it is appreciated that not all watercourses are abstracted for drinking water, a figure was needed to compare the data against, and 0.1 μg/l was considered appropriate. However, it is important to appreciate that the data presented are from environmental waters and do not reflect the quality of water from the tap. Treated water data are given in the Annual Report of the Drinking Water Inspectorate.

5.2 THE NATIONAL PICTURE

During 1992 and 1993 the NRA monitored 120 different pesticides and reported almost 450,000 results in Controlled Waters.

Compliance with EQSs

In general, the compliance with EQSs is very high. In 1993, over 99% of sites passed the EQSs for List I pesticides and over 96% of sites passed for all the EQSs. HCH was the most frequent failure for List I pesticides. As not all of these sites are associated with discharges, some HCH must be arising from diffuse inputs as a result of its approved use in agriculture, horticulture, forestry or public health. Therefore, the NRA will be pressing MAFF and HSE to impose restrictions on its use in order to comply with the EQS.

The sites where EQSs were exceeded and the pesticides involved are illustrated in Figure 4 for List I, Figure 5 for List II, and Figure 6 for Red List and diazinon. Details of the sites are given in Appendix XI. The percentage of sites failing for individual pesticides is shown in Table 4. The data were compared against all the EQSs. i.e. if an annual average and a maximum EQS were available, both were used for assessment.

FIGURE 4
Sites failing List I pesticide EQS values in England and Wales during 1993

FIGURE 5
Sites failing List II pesticide EQS values in England and Wales during 1993

FIGURE 6
Sites failing Red List and NRA operational EQS values in England and Wales during 1993

ERRATA

Please note - this map replaces Figure 6 on page 26.
The errors are in South Western, Severn-Trent, Welsh and Northumbria & Yorkshire Regions.

FIGURE 6
Sites failing Red List and NRA operational EQS values in England and Wales during 1993

◆ Fenitrothion ◇ Malathion ◆ Total Atrazine/Simazine

★ Azinphos methyl ☆ Diazinon ★ Dichlorvos

TABLE 4
The percentage of sites failing EQSs in 1993

Pesticide	Percentage of sites failing EQS
All pesticides	3.8
Diazinon	1.25
PCSD/Eulan	0.92
Permethrin	0.81
HCH	0.66
Dichlorvos	0.34
Cyfluthrin	0.33
Total drins	0.26
Total DDT	0.14
Pentachlorophenol	0.09
Azinphos methyl	0.06
Malathion	0.06
Total atrazine/simazine	0.06
pp DDT	0.06
Fenitrothion	0.03
Hexachlorobenzene	0.03

Some sites failed EQSs due to the historic use of pesticides. For example, DDT and the drins have been banned for many years, but there are still a number of sites which fail the EQS for these compounds. This is because these pesticides are extremely persistent in the environment and have not yet fully broken down.

Just over 1% of sites failed for List II substances, where the moth proofing agents PCSD/eulan and permethrin were the most frequent. These are mainly clustered in Northumbria & Yorkshire Region and are associated with the textile industry. In December 1991 representatives of the textile industry, water companies, NRA, DoE and HMIP agreed a programme of changes to processes and reduced usage, that would allow the EQS for all moth proofing agents to be met throughout England and Wales by the end of 1995. The programme is now being concluded.

Whilst the Dangerous Substances Regulations apply to all waters, DoE currently only require data returns for sites relating to discharges (apart from monitoring at national network sites). The diffuse occurrence of pesticides is largely responsible for the differences in sites reported to DoE and the sites reported in Appendix XI. It is not possible for the NRA to control diffuse inputs to Controlled Waters in the same way as for direct discharges, and a different approach is required to limit such pollution . A cluster of failures for the Red List insecticide, dichlorvos, can be seen along the Gloucestershire and Sharpness Canal and this may be attributed to its use in the warehouses along the docks. This is currently being investigated. The EQS for dichlorvos is extremely low, annual average 0.001 µg/l, so any positive detection usually results in an EQS failure.

It is also interesting that atrazine and simazine, pesticides which frequently exceed 0.1 µg/l, rarely exceed their proposed EQS, with only 2 sites failing (0.06% of sites).

These pesticides and others, are on Annex 1A and the UK Government is committed to halving their load to the North Sea by 1995. The pesticides on this list were chosen because of their toxicity, persistence and bioaccumulation. More information on this can be found in the NRA Water Quality Series Report No 24 “Contaminants Entering the Sea”.

Most EQS failures were associated with the sheep dip insecticide, diazinon, which failed its informal NRA EQS at 1.25% of sites. Exceedences can be seen in clusters around the area of Leeds and Bradford and also around Kidderminster and the upper reaches of the River Severn. These areas are associated with the wool industry, the Northern area with wool washing, scouring and fellmongery and the Midlands with carpet manufacturing. The exceedences, therefore, probably reflect the discharge of this substance to watercourses from trade effluents via the public sewage treatment works. Other more randomly spread exceedences, particularly in Wales, Northumberland and the South West are probably associated with sheep dipping.

Unfortunately most pesticides could not be assessed in this way because EQSs have not been developed. Preliminary examination of the 1992 and 1993 data for the 25 pesticides commonly found in environmental waters for which the NRA has now proposed operational EQSs, indicates that there are very few exceedences of these proposed standards. EQSs for the other commonly occurring pesticides are needed so that the environmental significance of the pesticide concentrations detected can be assessed in future.

Exceedences 0.1 µg/l

Of the pesticides analysed, just over half were detected above 0.1 µg/l, a quarter were sometimes detected,

TABLE 5
Summary of the pesticides most frequently exceeding 0.1 µg/l in Controlled Waters in 1992 and 1993.

1992			1993		
Pesticide	Total number of samples	% samples >0.1 µg/l	Pesticide	Total number of samples	% samples >0.1 µg/l
Atrazine	4716	16	† Chlorpropham	28	43
Mecoprop	1519	15	Diuron	1873	19
Diuron	838	13	Mecoprop	2265	17
Simazine	4862	12	Atrazine	5145	13
*2,4 D	505	11	† Carbendazim	40	10
Isoproturon	2256	9	Bentazone	230	10
Pentachlorophenol	7176	7	2,4 DCPA	684	8
Permethrin	860	6	Simazine	5133	8
Sulcofuron	364	5	MCPA	2261	7
Chlorotoluron	2355	5	PCSD/eulan	1454	6
Dicamba	481	4	Isoproturon	3319	6
2,4 DCPA	687	4	*2,4 D	1763	6
MCPA	1476	4	Pentachlorophenol	6513	6
*Terbutryn	565	4	Chlorotoluron	2729	5
*Dichlobenil	685	4	Trietazine	403	5
Diazinon	2332	3	Propyzamide	222	4
Trietazine	609	3	Permethrin	1029	4
			Linuron	2621	4
			Metazachlor	222	3
			2,4 DB	603	3
			2,3,6 TBA	262	3
			Ethofumesate	228	3

* These pesticides are approved for use in or near water and their application rates are such that they would exceed 0.1 µg/l. However, the NRA has to agree to the application of a herbicide to water and would not permit applications immediately upstream of a water abstraction point.

† These pesticides were detected as the result of a special investigation.

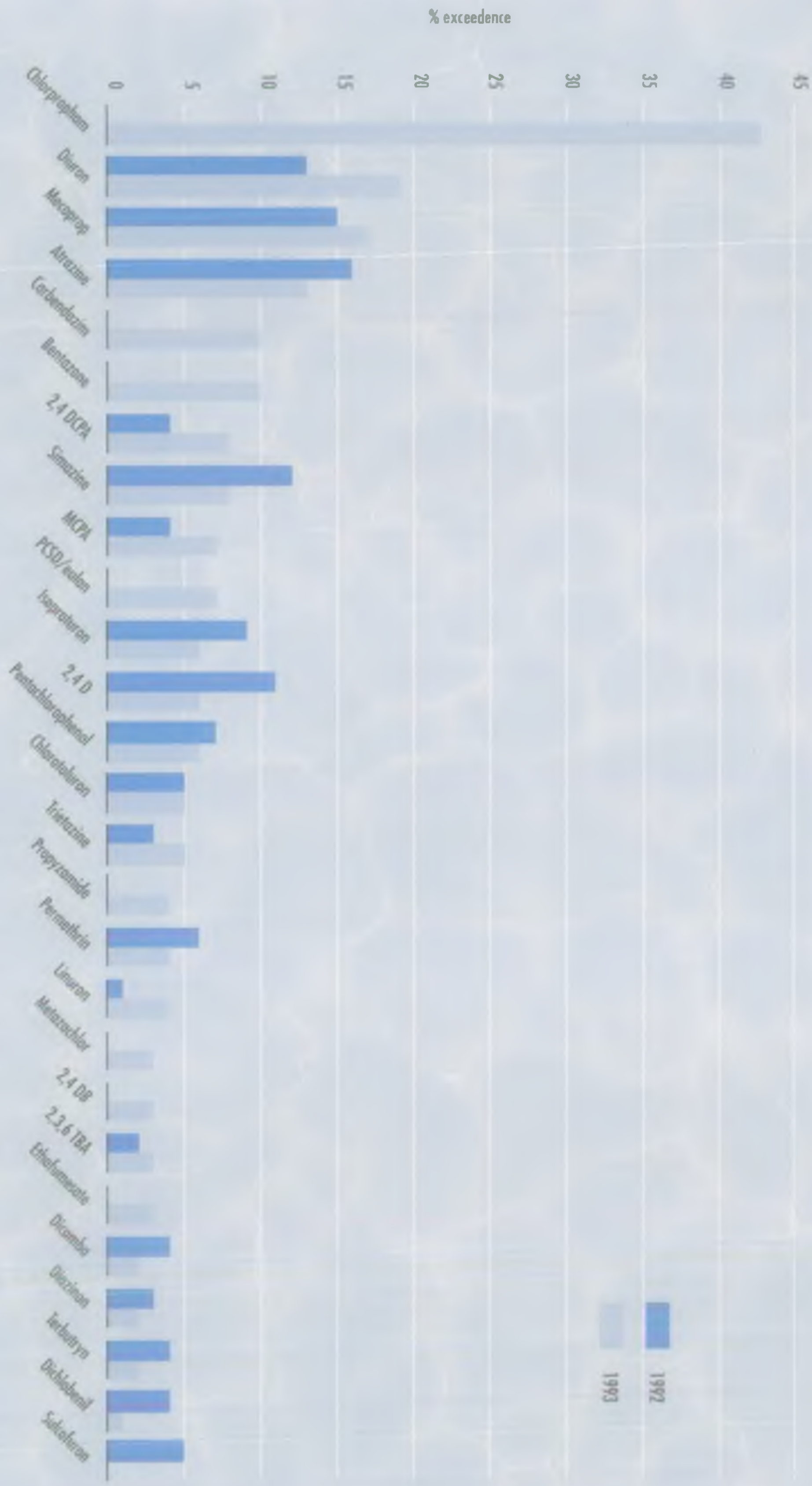


FIGURE 7
Pesticides most frequently exceeding 0.1 µgl in Controlled Waters in 1992 and 1993

but did not exceed 0.1 µg/l and approximately a fifth were never found above the limit of detection. Detailed information on all pesticides can be found in Appendix XII. A summary is shown in Table 5 and Figure 7.

The herbicides used primarily on non-agricultural land, diuron and atrazine, and the agricultural herbicide mecoprop exceeded 0.1 µg/l most frequently in 1992 and 1993. The number of exceedences for diuron increased from 13% of samples in 1992 to 19% in 1993. Atrazine exceedences fell from 16% to 13% in the same period. These differences may be associated with the ban on the use of atrazine and simazine on non-agricultural land, which came into force in September 1993. It appears that users pre-empted the ban and started to use alternative products, such as diuron, before the ban was implemented, thus reducing atrazine levels, and increasing those of diuron.

Chlorpropham, an anti-sprouting agent for potatoes in store, was also detected regularly in 1993. However, this was a special investigation immediately downstream of potato washing sites and is not indicative of Controlled Waters generally.

Other pesticides which frequently exceeded 0.1 µg/l are carbendazim and bentazone. Bentazone was added to the monitoring suite in Anglian Region, following predictions by FARMSTAT that it would be found in concentrations above 0.1 µg/l and this is seen to be the case. Results for carbendazim came from a special investigation which involved targeting monitoring at the time of year and at the specific areas where the pesticide was likely to be detected, and hence probably reflects the worst case situation.

Other agricultural pesticides that are frequently found are the group of herbicides known as the "urons" e.g. isoproturon, chlorotoluron and linuron and the phenoxy group of herbicides e.g. mecoprop, 2,4 D and MCPA. Non-statutory EQSs are currently being developed for these pesticides by the NRA.

In addition, pesticides used in industry, such as the moth proofing agents PCSD/eulan and permethrin, and the timber preservative, pentachlorophenol are also found as a result of point source inputs.

5.2.1 Surface freshwater monitoring

The majority of NRA monitoring is carried out in surface freshwaters (rivers, lakes, canals). Between 1992 and 1993 a total of 117 different pesticides were analysed in freshwater and over 350,000 results obtained. Sites where the EQS was exceeded are shown in Figures 4-6. Detailed information on all pesticides which exceeded 0.1 µg/l can be found in Appendix XII. A summary is shown in Table 6 and illustrated in Figure 8.

The pesticides most frequently detected in freshwaters are similar to those reported for all Controlled Waters. This is because surface freshwaters contribute the most significant quantity of the monitoring data.

5.2.2 Estuary and coastal water monitoring

Monitoring of saline waters is less extensive than that for surface freshwaters. Consequently 90 different pesticides were analysed in saline waters and about 61,000 results obtained during 1992 and 1993.

EQS failures are almost all associated with HCH, which are mostly believed to arise from its diffuse use.

Although saline waters are not used for drinking water supplies, the data have been compared with 0.1 µg/l for consistency. Detailed information on all pesticides which exceeded 0.1 µg/l can be found in Appendix XII. A summary is shown in Table 7 and illustrated in Figure 9. Similar pesticides are detected in saline waters as in freshwaters with diuron, isoproturon, chlorotoluron, atrazine and simazine being detected most frequently. However, the percentage exceedence for diuron is

FIGURE 8
Pesticides most frequently exceeding 0.1 µg/l in freshwaters in 1992 and 1993

TABLE 6
Summary of the pesticides most frequently exceeding 0.1 µg/l in freshwaters in 1992 and 1993.

1992			1993		
Pesticide	**Total number of samples**	**% samples >0.1 pg/l**	**Pesticide**	**Total number of samples**	**% samples >0.1 pg/l**
Atrazine	3965	17	Chlorpropham	28	43
Mecoprop	1358	17	Diuron	1598	18
2,4 D	363	15	Mecoprop	2089	18
Diuron	693	14	Atrazine	4100	14
Simazine	4065	13	Carbendazim	40	10
Isoproturon	2041	10	Simazine	4094	9
Permethrin	816	6	Bentazone	196	9
Pentachlorophenol	6299	6	2,4 DCPA	646	9
Dicamba	369	5	MCPA	2085	8
Sulcofuron	363	5	PCSD/eulan	1369	6
			2,4 D	1615	6
			Pentachlorophenol	5478	6
			Isoproturon	2977	6
			Trietazine	310	6
			Chlorotoluron	2389	5
			Propyzamide	197	5

notably higher in saline water than freshwater, which is probably due to its use in antifouling paints. Mecoprop is not monitored in saline waters and therefore is not presented in the table or histogram.
There are significant changes in Anglian and Thames Region over the two years, resulting from changes to monitoring programmes and this probably accounts for most of the national variation (Appendix XIII).

5.2.3 Groundwater monitoring

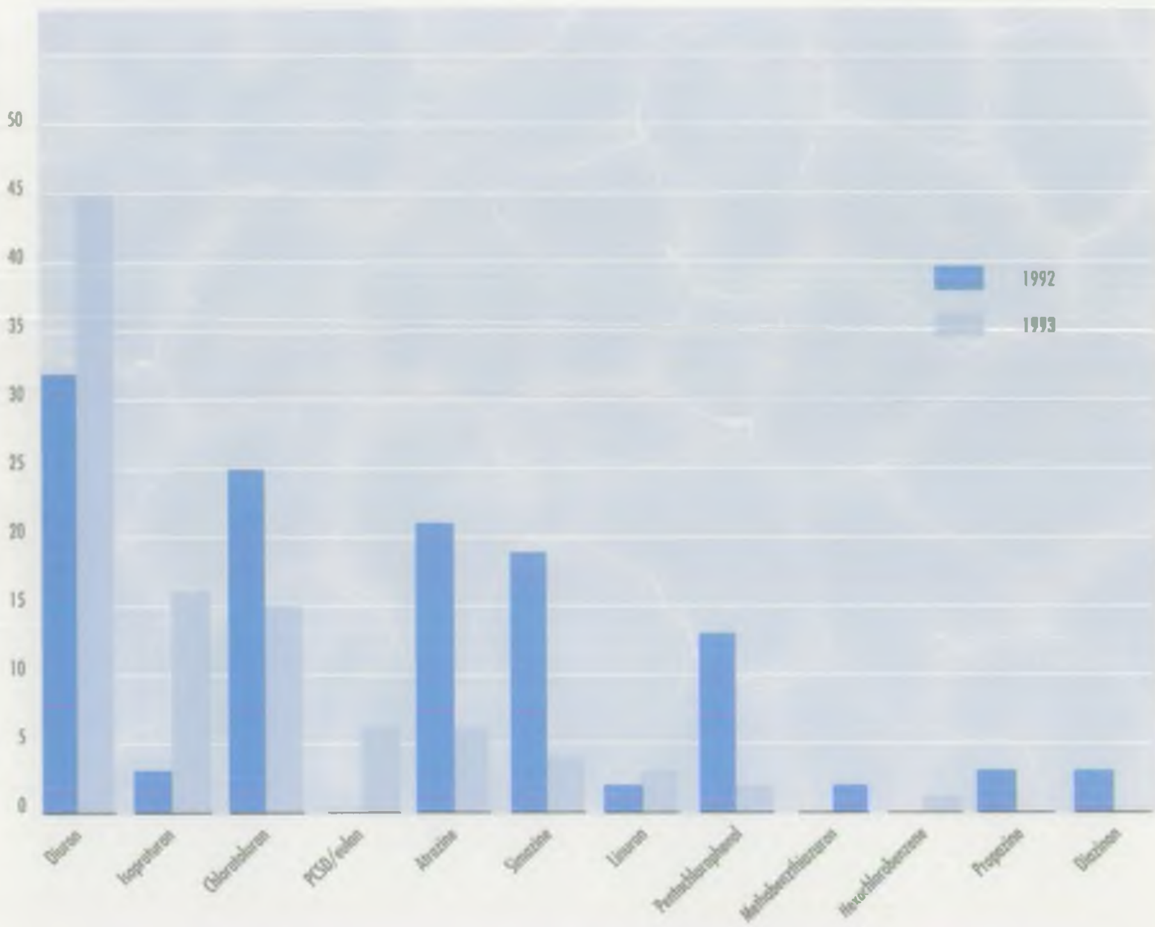
Groundwater is extensively used for drinking water supplies particularly in the southern and eastern areas of England. The major aquifers are the chalk and the Sherwood sandstone. Water supplies derived from groundwater are regularly monitored by water companies. As a result, the NRA currently only carries out a limited amount of groundwater monitoring, resulting in far less groundwater data than that for surface or saline waters. This is being addressed with the development of a national monitoring programme.

However, water companies are required to notify the NRA of any

TABLE 7
Summary of the pesticides most frequently exceeding 0.1 pg/l in estuaries and coastal waters in 1992 and 1993

1992			1993		
Pesticide	**Total number of samples**	**% samples >0.1 pg/l**	**Pesticide**	**Total number of samples**	**% samples >0.1 µg/l**
Diuron	41	32	Diuron	126	45
Chlorotoluron	48	25	Isoproturon	128	16
Atrazine	220	21	Chlorotoluron	128	15
Simazine	275	19	PCSD/eulan	65	6
Pentachlorophenol	871	13	Atrazine	396	6
Propazine	33	3	Simazine	392	4
Isoproturon	37	3	Linuron	127	3
Diazinon	40	3	Pentachlorophenol	947	2
Linuron	48	2	Methabenzthiazuron	49	2

FIGURE 9
Pesticides most frequently exceeding 0.1 µg/l in estuaries and coastal waters in 1992 and 1993



exceedence of the drinking water standard and have agreed to make all their data from groundwater supplies available to the NRA. Because groundwaters are rarely treated, with anything more extensive than chlorine, before entering supply, any contamination by pesticides is significant.
In addition, any restriction on a pesticides use may not have an effect on the quality of water abstracted for many years.

Any pesticide may contaminate groundwater in situations where the attenuation properties of the soil may be by-passed or overcome. Such situations include karstic conditions, fissured aquifers, repetitive pesticide loading over years or where drains or soakaways funnel water from larger areas to one point. Pesticide contamination of the Chalk aquifer is believed to depend largely on preferential flow through fissures within this aquifer.

In 1992 the NRA monitored for 78 different pesticides in groundwaters, and obtained 4,879 results. However, in 1993 this increased to 101 pesticides and 13,343 results. Detailed information on all pesticides which exceeded 0.1 µg/l can be found in Appendix XII. A summary is shown in Table 8 and illustrated in Figure 10.
In 1993, bentazone appeared to be the most frequently detected pesticide in groundwater, but these results should be treated with caution. Bentazone was included in the Anglian monitoring suite in 1993 following FARMSTAT predictions that it may leach to groundwater. Only a small number of samples were taken and these were targeted at high risk sites. The results indicate that bentazone may leach to groundwater in vulnerable areas, but the results presented are not necessarily representative of groundwater generally.
Although atrazine may be declining in surface waters, this is not true for groundwater. This is to be expected, because groundwaters take much longer to recover than surface waters. Groundwater exceedences of

TABLE 8
Summary of the pesticides most frequently exceeding 0.1 μg/l in groundwaters in 1992 and 1993.

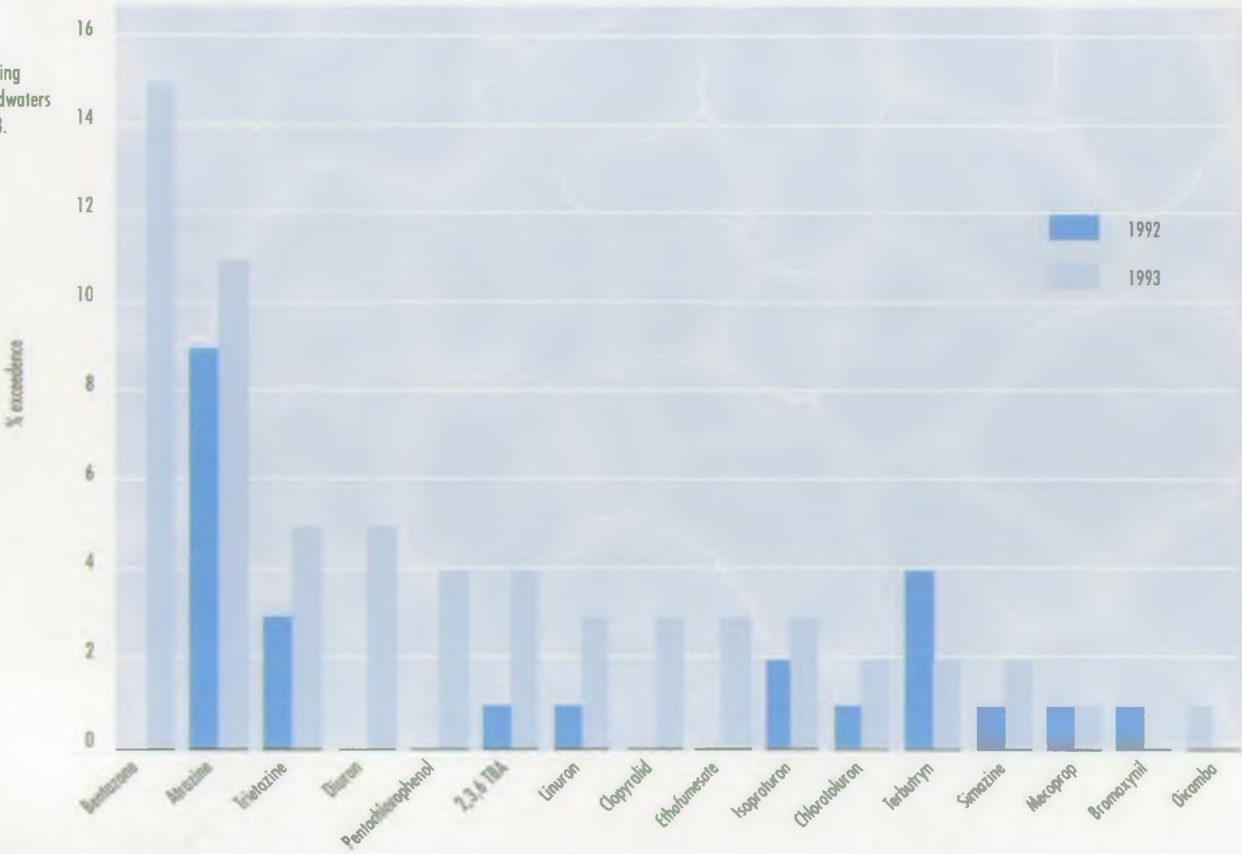
1992			1993		
Pesticide	Total number of samples	% samples >0.1 pg/l	Pesticide	Total number of samples	% samples >0.1 μg/l
Atrazine	531	9	Bentazone	34	15
Terbutryn	106	4	Atrazine	603	11
Trietazine	106	3	Trietazine	42	5
Isoproturon	178	2	Diuron	129	5
Mecoprop	147	1	Pentachlorophenol	78	4
Bromoxynil	102	1	2,3,6 TBA	27	4
2,3,6 TBA	112	1	Linuron	172	3
Dicamba	112	1	Clopyralid	30	3
Simazine	523	1	Ethofumesate	31	3
Linuron	137	1	Isoproturon	181	3
Chlorotoluron	177	1	Chlorotoluron	178	2
			Terbutryn	134	2
			Simazine	603	2
			Mecoprop	138	1

atrazine are mainly found in Anglian, Thames and South Western Regions, which may reflect usage patterns or vulnerability in those areas. Diuron is starting to be detected in groundwaters and it is essential that this is addressed before the problem becomes more widespread. Isoproturon and mecoprop are also of concern.

5.3 THE REGIONAL PICTURE

EQS failures are shown on the maps in Figures 4-6 and described in

FIGURE 10
Pesticides most frequently exceeding 0.1 μg/l in groundwaters in 1992 and 1993.



Section 5.2. The pesticides exceeding 0.1 µg/l most frequently are shown in Appendix XIII as Figures 15-20. (Detailed regional data summaries are contained in a separate appendix and are available on request).

Anglian

Failures of the EQS within the Region are mainly associated with the historic usage of pesticides, such as the drins. At one site, dieldrin is regularly detected, due to its past use in the timber treatment industry. A treatment plant has now been installed to clean up contaminated run off from the site, so the situation is expected to improve.

There are also a few exceedences for HCH which may be as a result of run off from agricultural land or from domestic use.

The herbicides atrazine, simazine, isoproturon, mecoprop and diuron exceed 0.1 µg/l most frequently in surface freshwaters and in saline waters pentachlorophenol is also detected. Isoproturon and mecoprop are major agricultural herbicides and the number of exceedences of 0.1 µg/l reflects the intensive arable farming in the Region. The number of exceedences for atrazine and simazine fell between 1992 and 1993, probably as a result of amenity users turning to alternative products before the ban on their use on non-agricultural land.

A number of pesticides were added to the monitoring programme in 1993, following the 1992 FARMSTAT report, which predicted their presence above 0.1 µg/l in surface waters. Pesticides were added to existing analytical suites where possible. Where this was not possible, special surveys were undertaken to analyse for the other pesticides predicted. The surveys targeted the areas where the pesticides were most likely to be detected e.g. immediately downstream of major conurbations for amenity and industrial pesticides and in the middle of agricultural catchments for agricultural pesticides. The survey also targeted the times of year that the pesticides were most likely to be used. The monitoring results largely reinforced the predictions, and bentazone, benazolin, carbendazim, ethofumesate, metalaxyl and phenmedipham were detected above 0.1 µg/l. Pendimethalin was predicted to exceed 0.1 µg/l, but monitoring data did not confirm this.

Chlorpropham was also detected in 1993 due to a special investigation in the vicinity of potato washing plants. The survey indicated that there are elevated concentrations of chlorpropham; and tecnazene and its metabolites associated with this industry. The NRA has been liaising with the manufacturers of tecnazene who are promoting "best practice" both with the growers and at the washing sites.

Groundwater monitoring indicates that the main exceedences of 0.1 µg/l were primarily due to atrazine, but other triazines, urons and bentazone also exceeded this figure. Bentazone was included at high priority sites following FARMSTAT predictions that it may reach groundwater.

Northumbria & Yorkshire

There are a number of exceedences of the EQSs for the List II moth proofing agents PCSD/eulan and permethrin. These are primarily due to point source discharges associated with the textile industry. Discharges from sewage treatment works contribute to permethrin in the River Calder and several of its tributaries, the worst being the Mag Brook, where the stream biota have been very seriously affected. In order to improve the quality of the Mag Brook, Yorkshire Water Services re-sewered Meltham in September 1993 and the effluent is now being transferred to Huddersfield STW.

There are also a number of exceedences of the NRA's operational EQS for diazinon. The majority of these are in the Leeds/Bradford area and are again primarily due to point source discharges from industries associated with various stages of wool processing. Currently there is little cost-effective treatment capable of removing pesticides from these processes. However, the industries involved are liaising with MAFF, DoE and the NRA to try to find a solution. This is an area where further work and co-operation is required.

Some of the exceedences for diazinon are attributable to its use as a sheep dip, probably resulting from small scale spills or incorrect disposal. In 1992 and 1993 a research project was undertaken to look at the impact of sheep dips on selected water-courses. Catchments were targeted where problems were anticipated and this resulted in higher concentrations than would have been observed under the normal monitoring programme. A campaign to tackle this issue is being initiated.

There were also a few exceedences of the "drins", which is probably due to an historic use on sheep fleeces.

The main exceedences of 0.1 µg/l in the Region are for the "phenoxy" herbicides. This occurs as a result of a pesticide manufacturers consented discharge to three separate sites in the Region. This process is currently under review and consents are being tightened.

Other exceedences of 0.1 µg/l were mainly from atrazine and simazine, the moth proofing agents PCSD/eulan and permethrin, and the timber treatment pesticide pentachlorophenol, which reflects the industrial nature of the Region. Diazinon, propetamphos and chlorfenvinphos were also detected as a result of sheep dipping and the industrial processing of wool.

Pentachlorophenol is also regularly detected in saline waters in the Region, probably resulting from two consented discharges to sewage treatment works.

There were very few exceedences of 0.1 µg/l in groundwater in 1992 and none in 1993.

North West

EQS exceedences are mainly associated with the moth proofing agent cyfluthrin, which arises from point source inputs.

Pentachlorophenol, azinphos methyl, atrazine and permethrin exceeded 0.1 µg/l most frequently in surface freshwaters, but are also quite frequently detected in saline waters. Atrazine is probably detected as a result of its use on non-agricultural land, whilst the others are mainly due to industrial discharges.

Groundwaters have not been monitored historically for pesticides in the Region. The water company would notify the Region if any exceedences of 0.1 µg/l were found, but no confirmed exceedences have been reported for surface waters or groundwaters. Groundwater monitoring will be undertaken in future as part of the national groundwater monitoring programme which is currently being implemented for approximately 90 groundwater supplies.

Severn – Trent

Exceedences of EQSs were mainly seen for diazinon and dichlorvos. The failures for diazinon are primarily due to point source discharges from sewage works receiving effluent from industries associated with various stages of wool processing e.g. fellmongery effluent, wool scouring waste and carpet manufacture. The problem is similar to that in the Northumbria & Yorkshire Region, where lack of a cost-effective and simple method for treating the effluent makes it difficult to meet the EQS. Further work and investigations are continuing to try to find a solution.

The exceedences for dichlorvos on the Gloucester and Sharpness Canal are referred to earlier and may be attributed to its use in warehouses along the docks.

Mecoprop, 2,4 D, atrazine and simazine most frequently exceeded 0.1 µg/l in surface waters. However, it was noticeable that in 1993 there were far fewer exceedences of isoproturon than in 1992 (3% vs 19%). In contrast, there were more exceedences of MCPA in 1993 than 1992 (11% vs 3%). See Appendix XIII Figures 15 and 16. It is extremely difficult to identify the source of diffuse pesticide pollution, but it may be simply a reflection of the different usage during a particular year.

Monitoring of estuaries and coastal waters is extremely limited in the Region, due to the very limited coastal boundary.

No pesticides exceeded 0.1 µg/l in groundwaters except at sites which have been polluted as a result of historic pollution incidents e.g. a fire at a pesticide store.

Southern

One site failed the EQS for total HCH. This site is currently being investigated and appropriate action will be taken.

Atrazine and simazine exceeded 0.1 µg/l most frequently, and there is no indication that the concentrations are declining. The various HCH results reported above 0.1 µg/l are associated with the one site mentioned above and are not the general picture throughout the Region.

There are very few exceedences of 0.1 µg/l for groundwaters.

South Western

Failures of EQSs are primarily for diazinon and the "drins". Diazinon exceedences are probably attributable to sheep dipping, whilst exceedences for the drins may be the result of the historical use of aldrin on daffodil bulbs.

Exceedences of 0.1 µg/l were mainly reported for the herbicides 2,4 D, mecoprop, atrazine, isoproturon and MCPA. Atrazine is detected, as in many other Regions, but it is believed that atrazine is also arising at some sites as a result of its use on maize. The hectarage of maize is rapidly increasing in the South West of England and many of the maize crops are treated with atrazine. Following a number of exceedences of 0.1 µgl for atrazine at a water supply intake in 1993, the NRA instigated a large project to try and tackle the problem. This involved liaising with the manufacturers and visiting farmers. It appears that this achieved some success because there were fewer exceedences in 1994. However, the NRA will keep monitoring the situation, and make recommendations to MAFF for further controls on atrazine if this is appropriate.

Atrazine was also detected in groundwaters in the Region and it is important to establish whether this originated from its historic amenity use or from its current use on maize.

Another pesticide detected in the Region is tecnazene, a potato sprout suppressant. This pesticide is only associated with one site and does not reflect the general picture in the Region. Tecnazene is detected in high concentrations immediately downstream of a farm washing potatoes. The owner has been prosecuted in the past for allowing the lagoon to overflow. The NRA will continue to monitor this site and take the appropriate action where necessary.

Other pesticides detected are the moth proofing agents, sulcofuron, flucofuron and PCSD/eulan.

Thames

Four sites failed the EQS for total HCH. These receive significant discharges of sewage effluent from the major sewage treatment works in London. It is the intention to impose appropriate consent conditions on these discharges. However, Thames Water Utilities Ltd have not identified any specific discharges of HCH to sewer, and it is assumed that any inputs are from diffuse sources.

Atrazine, diuron and simazine regularly exceeded 0.1 µg/l in surface freshwaters, with over half of all diuron results above this figure in 1993. This probably reflects the highly urbanised nature of the Region. Other pesticides which exceeded 0.1 µg/l are the "urons" chlorotoluron, linuron and isoproturon. Chlorotoluron was found more frequently than isoproturon and this is the only Region where this is the case. This was also true in saline waters.

Groundwater monitoring was introduced in 1993 and indicates that by far the most exceedences are associated with atrazine. However, linuron, diuron, isoproturon and chlorotoluron were also detected. This is the only Region where linuron and chlorotoluron have been detected in groundwaters during this period.

Welsh

EQS failures were very limited. Two sites failed for diazinon, which is believed to be as a result of sheep dipping. One site failed for atrazine and simazine, which may have been a spill or direct run off into a drain. To tackle the problem of pollution from sheep dips, local press releases have been made to educate the agricultural community. In addition, farm inspection campaigns are being carried out to identify high risk sites and recommend better pesticide practices.

Exceedences of 0.1 µg/l were relatively infrequent and mainly comprised atrazine, simazine, diazinon and chlorfenvinphos, although some mecoprop, MCPA and MCPB were detected in 1993.

Monitoring of estuaries and coastal waters is undertaken but results from 1992 were unavailable for this report. Results from 1993 do not indicate any exceedences of EQSs or 0.1 µg/l.

The Welsh Region targets its pesticide monitoring at those pesticides expected, from the FARMSTAT reports and extensive dialogue with the water companies. The Region has therefore established a number of standard monitoring suites based on this information. Monitoring is undertaken at appropriate points, normally targeting surface water abstractions. These groups correspond to lowland agriculture, upland agriculture and urban areas.

Groundwater source monitoring is restricted to those emerging as springs and this is reported in the surface water part of the monitoring programme. It is anticipated that specific borehole monitoring will commence in 1996.

5.4 POLLUTION INCIDENTS 1992-1993

A total of 65 pesticide pollution incidents were reported to the NRA in 1992 and 52 in 1993. Further detailed investigation for the purposes of this report substantiated 40 and 47 of these respectively.

Pesticide pollution incidents only account for a very small proportion of the total pollution incidents reported to the NRA and in 1992 and 1993 comprised about 0.2% of all incidents. However, when they do occur they can be very serious, so it is important to try to reduce their number. The NRA continually highlights the risk of pesticide pollution and enforces the pollution prevention message, by producing leaflets, videos and giving advice on farms.

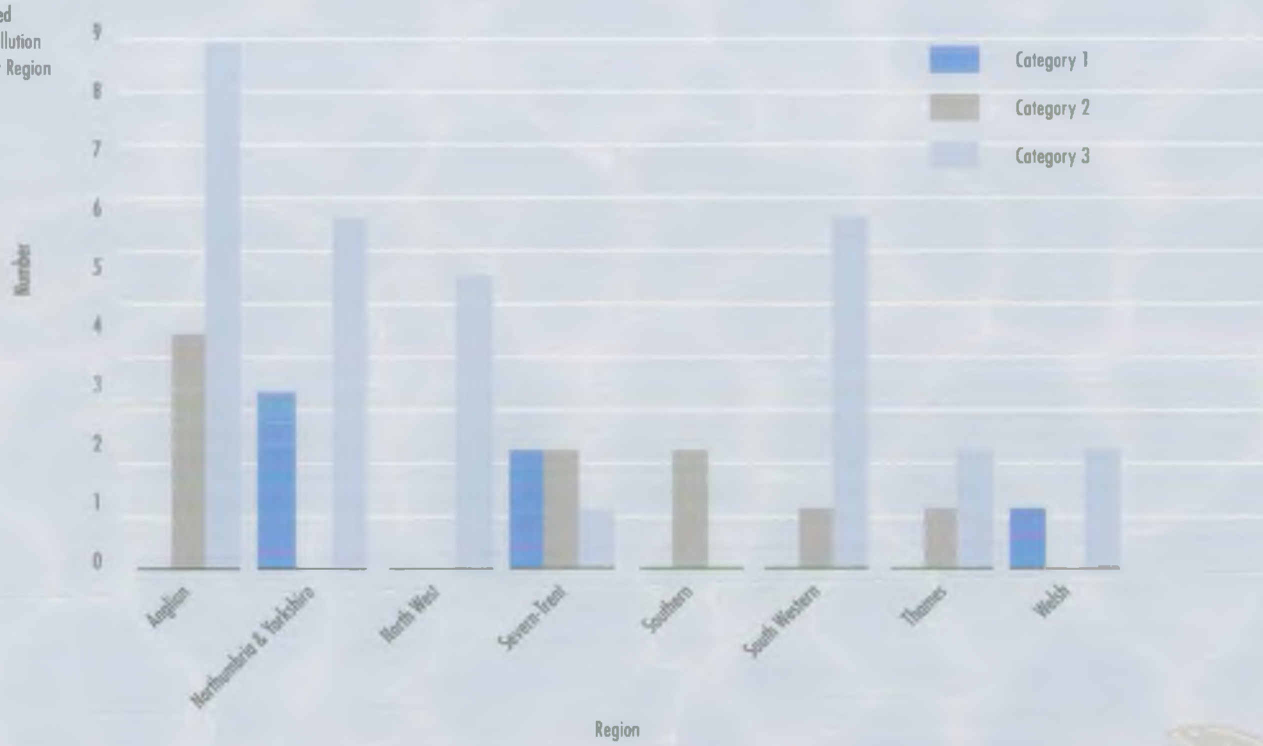
The NRA has a standard pollution incident classification system throughout its Regions. Incidents are divided into four categories depending on the environmental impact and are defined as:

- Category 1 - A major incident;
- Category 2 - A significant pollution;
- Category 3 - Minor suspected or probable pollution;
- Category 4 - Unsubstantiated (introduced 1st January 1995).

Further information on pollution incidents can be found in the annual NRA Water Quality Series report "Water Pollution Incidents in England and Wales". There may be slight discrepancies between the number of pesticide pollution incidents reported here and in the "Water Pollution Incidents in England and Wales" reports because of the way pollution incidents are reported to the NRA. Any incident reported to the NRA is logged as a pollution incident and the probable cause noted. In some instances, no pollution can be identified and in these cases, the incidents were omitted from this report.

FIGURE 11
Substantiated pesticide pollution incidents by Region in 1992

FIGURE 12
Substantiated pesticide pollution incidents by Region in 1993



NB: In 1992 Northumbria and Yorkshire Regions, and South West and Wessex Regions were recorded separately. In 1993 the Regions had merged to form Northumbria & Yorkshire Region and South Western Region.

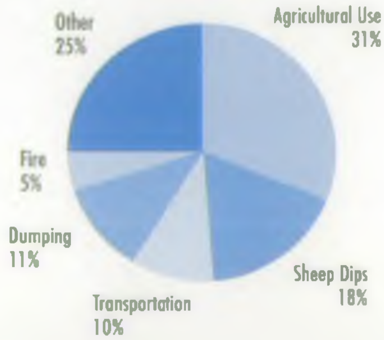


FIGURE 13
Substantiated pesticide pollution incidents by cause in 1992

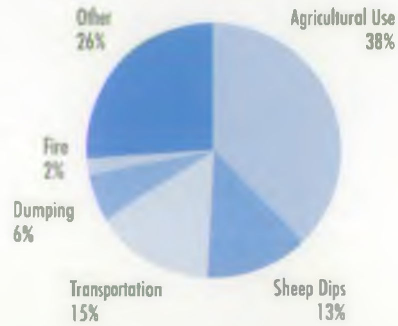


FIGURE 14
Substantiated pesticide pollution incidents by cause in 1993

Tables in Appendix IX describe the substantiated pesticide incidents in 1992 and 1993 and explain the environmental effects. The tables also show the category of incident. This information is summarised in Figures 11 and 12 which display the number of Category 1, 2, and 3 incidents for each Region in 1992 and 1993 (Category 4 was not available in 1992 and 1993). Figures 13 and 14 indicate the reason for the incident in each year.

The NRA is often able to prevent an incident becoming serious and in many cases can prevent water pollution, because of prompt reporting and immediate action. Fifteen of the reported incidents in 1992 and 1993 caused no environmental effects, because the substance was contained.

In 1992, there were two Category 1 incidents. In the first, groundwater used for public water supply was contaminated by sheep dip (chlorfenvinphos) on several occasions, and in the second large numbers of dead fish were found in the Grand Union Canal following spraying with cypermethrin. However, this was never confirmed as the cause. In 1993, there were six Category 1 incidents. One involving sheep dip (propetamphos), where private water supplies were contaminated; three involving gamma HCH which resulted in large numbers of dead fish; one with the bracken herbicide, asulam, which contaminated drinking water supplies; and one where a timber treatment chemical spilt into a watercourse affecting water supplies. None of these incidents resulted in prosecutions due to legal difficulties linking the source with the pollution.

Two Category 2 incidents did result in prosecutions: one in 1992 where sprayer washings from a farmyard entered a stream; and a second in 1993 where drums containing carboxin and thiabendazole (Cerevax) were washed out close to a watercourse killing brown trout.

In 1992, most pesticide pollution incidents arose from agricultural use (31%), sheep dips (18%), dumping (11%), transportation (10%) and fire (5%). In 1993 the number of incidents from agricultural use increased to 38%, sheep dips declined to 13%, transportation rose to 15% and dumping accounted for 6%. There was only one fire involving pesticides (2%). For the remainder of incidents, no reason was given.

The public plays an important role in reporting pesticide pollution incidents and it is essential that this role is maintained so immediate action can be taken and pollution prevented.

6 RESEARCH AND DEVELOPMENT

The aim of the NRA pesticide research and development (R & D) programme is to provide the Authority with the necessary technical knowledge to carry out its duties under the Water Resources Act (1991) and to determine suitable strategies for minimising the pollution of water by pesticides. The NRA also aims to complement R & D work funded by Government Departments, research organisations and the pesticide industry.

There is a need to:

i. quantify the sources of pesticide inputs to the aquatic environment;
ii. determine the rates of movement and pathways to surface and groundwater;
iii. determine pesticide fate and behaviour after entering Controlled Waters;
iv. establish the significance of the concentrations found in Controlled Waters;
v. evaluate the importance of river morphology, including dead zones, as an influence on the availability of sediment bound pesticides.

Approximately £6.5m is spent annually by the NRA on research and development, of which about £250,000 is spent specifically on pesticide research.

Information on completed projects can be found in Appendix XIV.

6.1 PROJECTS COMPLETED IN 1994/95

i. Pesticides in Major Aquifers - R & D Report 17 (HMSO ISBN 011 8858424)

The objectives of the project were to determine the transport and fate of selected priority pesticides in groundwaters; to relate measured levels of pesticides to their patterns of use and physico-chemical properties and to develop predictive models of pesticide transport and fate.

A multi-residue method for the analysis of up to twenty common pesticides in water samples has been developed and also methods of analysis for the "urons", "carbamates" and "acid herbicides" in chalk and sandstone; and for triazines in sandstone.

The project found that under normal agricultural usage, most acid herbicides, urons and carbamates appear to be attenuated in the soil and unsaturated aquifer, and are rarely detected below 3 m from the surface. They are believed to present little threat to groundwater quality. Triazines are more persistent beneath crops and do present a distinct threat to groundwater quality. Mecoprop appears to be persistent in the sandstone but there is no evidence of deep penetration.

Any pesticide may contaminate groundwater where the attenuation properties of the soil may be by-passed or overcome. Contamination of the Chalk Aquifer is believed to largely depend on by-passing the zone of attenuation through fissures within this aquifer.

Future research is aimed at examining the movement of atrazine, and isoproturon and their metabolites in the unsaturated zone of the chalk aquifer.

ii. Impact of Pesticides on River Ecology (R & D Note 269)

Due to the demands of the EC Drinking Water Directive, research on pesticides in the environment is currently focused on the pesticides that are most likely to be found at high concentrations in public water supplies. However, these pesticides are not necessarily the most hazardous to organisms living in the river.

The objectives of the project were to investigate the impact of currently used agricultural pesticides on river communities. The first phase was to assess the extent of current knowledge. The study found that few relevant studies have been conducted, but that for a few pesticides, significant ecological effects have been detected at concentrations likely to arise from normal use.

Future research will identify areas at highest risk from pesticide pollution, both regionally and nationally and will use risk assessment tools to try to identify the effects on riverine communities.

iii. Total Impact Assessment of Pollutants in Rivers - Pesticide Impact Modelling (R & D Note 404)

This project is a continuation of the Rosemaund study and aims to investigate the pollution of streams draining from agricultural catchments and specifically to develop a simple model of the movements of pesticides from the point of application to streams.

The study has established that the use of pesticides, even when applied according to normal agricultural practice, will probably lead to the contamination of surface waters in the sub-catchments to which they drain.

A model for estimating pesticide run-off at Rosemaund has been developed and tested. It performs well in estimating peak concentrations, although the timing of the predicted peak is usually in advance of that observed. The limitations and assumptions of the model are discussed and it is recommended that the Rosemaund and other models are further validated on other catchments of varying soil types. A possible approach to the extension of modelling to large catchments is proposed and the use of such models in setting Environmental Quality Standards for diffuse inputs of pesticides is discussed.

iv. Land Management Techniques (R & D Note 320)

The project aimed to outline practical land management techniques for controlling pesticide pollution from diffuse source inputs. Soil conservation measures, application practices, buffer zones and Integrated Pest Management were reviewed.

The project concluded that much could be done to reduce the risk through the implementation of these low risk practices, but that there appeared to be difficulty communicating the findings of research to the farmer. Also, that there was a reluctance on the part of the farmer to forego established modern practices in favour of unknown techniques that may result in lost revenue. Buffer zones are likely to be effective in reducing run-off, but should be regarded as a preventitive measure, rather than a minimisation of input.

Non point source models developed in the UK and abroad were reviewed to evaluate their usefulness to the NRA. Recommendations for future work include diffuse pollution risk assessment, and optimum buffer zone design.

v. Moth Proofing Agents and Water Quality Management (Project 319 Final Draft September 1995)

The project developed analytical methods, including ELISA immunoassays and examined the fate of moth proofing pesticides in the water environment. It also assessed the significance of the materials when discharged to the aquatic environment and traced sources of contaminations in complex drainage systems in urban areas.

6.2 CURRENT PROJECTS

i. FARMSTAT Pesticides (Project 527 Started July 1994)

This project involves developing analytical methods based on solid phase extraction and High Performance Liquid Chromatography/Mass Spectrometry (HPLC/MS) to monitor for high priority pesticides identified by FARMSTAT.

ii. Small Point Source Discharges of Pesticides (Project A07(94)4)

The project is investigating the importance of small point source discharges of pesticides in relation to true diffuse inputs and developing a methodology for predicting likely river concentrations

iii. New Analytical Techniques for Pesticides and Metabolites (Project 533)

The project is developing techniques for the determination of low concentrations of pesticides and their transformation products in the subsurface aquatic environment (groundwater and aquifer material). This is a joint funded international project. The project will also provide a database of significant metabolites and adjuvants for the NRA.

iv. POPPIE (Prediction Of Pesticide Pollution In the Environment)

Although not strictly an R & D project, the development of the risk assessment tool POPPIE is central to the TAPS National Centre guidance on pesticide impacts in the aquatic environment. POPPIE comprises an integrated computer system of relational databases, pesticide environmental fate and behaviour models and Geographical Information Systems (GIS). The POPPIE system is currently under development and should be fully functional by March 1996. The system will integrate databases of factors affecting pesticide fate in the environment to produce catchment and sub-catchment scale predictions of pesticide transport.

The main uses of POPPIE are the:

a. Prediction of ground and surface water quality with respect to pesticides;
b. Guidance of monitoring programmes - targeting specific compounds;
c. Identification of potential problem compounds;
d. National scale vulnerability assessments;
e. Assessment of leaching potential for new pesticides.

POPPIE uses component databases of pesticide usage (agricultural/non-agricultural/sheep dip), land use, soils, climate and pesticide physico-chemical properties to provide input for ground and surface water models. It also includes vulnerability indices to enable both national, regional and catchment scale predictions to be made. Extensive graphical and statistical capabilities enable detailed investigation and presentation of measured pesticide concentrations and predicted environmental concentrations.

POPPIE will be central to NRA pesticide policy and monitoring strategy both nationally and regionally. POPPIE will also be used to provide advice and guidance to water companies and other organisations with regard to pesticide monitoring strategy.

POPPIE functionality is to be supplemented by current and future NRA R & D projects including a point source catchment based model.

6.3 PROPOSED NEW PROJECTS

i. The Application of Pesticide Run-Off Models to Larger Catchments

To extend the work of the Rosemaund project to river catchments.

ii. Development of Pesticide Usage and Risk Assessment Databases

Future development of POPPIE.

iii. Development of Analytical Methods for Pesticides

To continue to develop analytical techniques for high priority pesticides.

iv. EQS Development for Pesticides and other Toxic Substances

To develop NRA standards for further high priority pesticides and toxic substances.

v. Impact of Pesticides on River Ecology - Phase 2

To investigate the impact of pesticides in headwater streams.

vi. Alternative Farming Methods (Arable)

To demonstrate the viable ways of reducing the levels of certain agrochemicals reaching Controlled Waters which can be promoted by the NRA as best practice.

vii. Collaborative projects with external organisations

7 RECOMMENDATIONS FOR PRIORITY ACTIONS TO MINIMISE WATER POLLUTION BY PESTICIDES

7.1 A national strategy aimed at minimising pollution of the water environment by pesticides should be produced and implemented. The strategy should consider the results of pesticide monitoring in environmental waters and address a range of pollution prevention measures, define clear roles and responsibilities and draw upon latest scientific knowledge and best practices. The task will require the active participation of Government Departments, regulatory organisations, pesticides producers and distributors, the farming industry and other pesticide users.

The NRA does not have the full range of statutory powers and responsibilities to control pesticide pollution. Some of the more important areas that will need to be taken forward as priority within this strategy have been outlined below.

7.2 The current Government review of the use of the List I pesticide gamma HCH (lindane) should consider its impact on the aquatic environment. Possible causes of EQS failures should be identified and appropriate action taken to ensure that the standard is met.

The data for 1992 and 1993 showEQSs for List I substances were exceeded primarily for total HCH and the "drins". As the "drins" are now banned from use in the UK, exceedences of EQSs arise from their past use. Dieldrin is very persistent and environmental waters polluted historically will take time to improve. Gamma HCH, on the other hand, still has many approved uses in agriculture, horticulture, forestry and in human health products, such as for treating head lice, despite monitoring indicating that it is found in fresh and saline waters. Because of the tight controls on discharging this substance from industries under the EC Dangerous Substances Directive, it is likely that much gamma HCH is entering watercourses from diffuse sources. It is therefore important to establish the most likely cause of its EQS failures, so appropriate action can be taken.

7.3 The Government should review ways to meet its commitments under the 1990 North Sea Conference Declarations for those pesticides where the 1995 reduction target is unlikely to be met. The review should look at ways of achieving the targets for those pesticides which arise principally from diffuse sources. The review should also consider new requirements for other pesticides identified at the 1995 Conference.

A number of pesticides are on Annex 1A and the UK Government is committed to halving their load to the North Sea between 1985 and 1995. Restrictions on the use of some of these pesticides may be required if the Government is to be successful in meeting its reduction targets. Further information on discharges to the North Sea can be found in the NRA Water Quality Series Report No 24 "Contaminants Entering the Sea".

7.4 The wool processing and textile industries should continue to improve effluent discharges. The NRA will continue to revise discharge consents as necessary to enable rivers to meet appropriate EQSs. Sewage and industrial discharges containing sheep dip pesticides and moth proofing agents should remain a high priority for pollution control. Solutions involving changing processes or treatment will be sought from industry and the water companies.

Pesticides used in industry e.g. diazinon, permethrin, sulcofuron and PCSD/eulan from the woollen industry and pentachlorophenol from the timber and textile industry are detected in watercourses. These arise principally from point sources and are generally regulated by the NRA with consents. Moth proofing agents are used in the textile industry to treat wool for carpet manufacturing. The waste from these sites is not normally treated to remove pesticides, but is usually discharged to the foul sewer and then to the river via sewage treatment works. The pesticides involved are extremely toxic to aquatic life, particularly the synthetic pyrethroid insecticides, such as permethrin and cyfluthrin and their use has undoubtedly had a detrimental effect on the quality of rivers in the vicinity of these woollen industries.

Exceedences of the EQSs for List II pesticides arise primarily from these sources and include PCSD/eulan and permethrin located mainly in the vicinity of textile manufacturing sites. In December 1991 representatives of the textile industry, water companies, NRA, DoE and HMIP agreed a programme, including changes to processes and reduced use that will allow the EQSs for all moth proofing agents to be met throughout England and Wales by the end of 1995. The NRA will set discharge consents and monitor to ensure that this is achieved.

One of the first non-statutory EQSs proposed by the NRA was for diazinon and data show that this has been exceeded across many areas of England and Wales. Diazinon may enter watercourses as a result of the woollen and related industries. In Northumbria & Yorkshire and Severn-Trent Regions, there are a number of industries discharging diazinon and other sheep dip chemicals as a result of their activities. However, the difficulty of removing the pesticide or treating the waste is still hard to resolve. The problem has been discussed with DoE, MAFF and industry representatives and a solution is being sought. The NRA will continue to ensure that finding a solution remains a high priority and in the meantime will continue monitoring to ensure that the situation does not deteriorate.

7.5 The Ministry of Agriculture, Fisheries and Food (MAFF) and the Health and Safety Executive (HSE) should ensure that appropriate data are available to the NRA from the approval and review process, so that informal standards can be established. The NRA will continue to develop non-statutory EQSs for pesticides which are commonly detected in environmental waters and may present a risk to the aquatic environment. Future EQS development should also focus on the possible impact when a mixture of pesticides arise and on pesticide breakdown products.

Currently, only about 50 of the 450 pesticides available have had EQSs proposed. As a consequence, it is not easy to determine whether the pesticide concentrations in waters are posing a risk to the aquatic environment. However, if informal EQSs were available, this could be assessed. Exceedences of the standards would then indicate that remedial action should be taken.

7.6 As part of the EC reviews of the triazine herbicides, bentazone and diuron, specific consideration should be given to the consequences of their use in groundwater catchments used for drinking water supply.

The pesticides which exceed the 0.1 µg/l standard specified in the EC Drinking Water Directive are of concern because not many groundwater drinking water supply sources have treatment facilities to remove pesticides. Pesticides found in groundwaters are primarily from three different herbicide groups: the "triazines", the "urons", and the "phenoxy acid" herbicides.

Atrazine exceeds 0.1 µg/l in many more samples than any other pesticide (11%). This will hopefully start to decrease following the ban on its use on non-agricultural land imposed from September 1993, but its continued use on maize grown near potable water supply boreholes is still of concern. Currently the maize hectarage is increasing rapidly and consequently the use of atrazine is also rising. The NRA is monitoring the concentrations in this area and targeting farmers to remind them to use and dispose of pesticides safely. If the NRA is unsuccessful in achieving voluntary restraints on the use of atrazine in the potable groundwater public water supplies, it may be necessary to ask the Government to introduce Regulations or Water Protection Zones, prohibiting the use of atrazine in these areas.

Bentazone was also reported above 0.1 µg/l in over 14% of groundwater samples in 1993. This was monitored in Anglian Region following predictions that it would leach to groundwater, which now appears to be the case. The NRA informed the water companies and the manufacturer of the exceedences so that they could take action and will continue to investigate this to establish the extent of groundwater contamination.

Diuron is also starting to be detected in groundwaters (5% in 1993) and it is essential that this is addressed before the problem becomes more widespread. The manufacturers of diuron have set up a working group and are targeting local authorities and other users to try to reduce the problem. In addition, Severn Trent Water initiated a "Spray Safe" Campaign highlighting the problem and is confident that this has had a good response. The NRA will continue to monitor for diuron and liaise with manufacturers and water companies on the current position.

7.7 Pesticide distributors and agronomists should always consider water protection issues when recommending pesticides. Wherever possible they should advise the use of improved formulations with lower dose rates. The NRA will liaise with the British Agrochemicals Association (BAA) to look at ways to try to ensure this approach is understood and adopted by advisors.

Only a few agricultural pesticides commonly exceed 0.1 µg/l. Mecoprop is found most frequently in surface freshwaters and MAFF have realised this and taken action. Mecoprop is a mixture of two different forms; only one of which has herbicidal activity. Historically, products contained a mixture of both forms, resulting in high doses to achieve the effect. However, it is now possible to separate the herbicidally active form "mecoprop p" and MAFF's review concluded that only products containing the active form will be allowed. This halves the dose required and will hopefully reduce concentrations in watercourses. However, manufacturers have until December 1997 to submit data for new formulations and NRA data indicate that earlier action is needed. Farmers should be made aware of this and encouraged to use mecoprop "p" formulations whenever possible.

Isoproturon was recently reviewed by MAFF and a few restrictions on its use were imposed. However, the NRA does not believe that these restrictions will be sufficient to reduce pesticide contamination of water. Farmers should be made aware of the problem of pollution with isoproturon and encouraged to use a mixture of pesticides, where possible, and not to rely solely on isoproturon. Again, this relies on the co-operation of farmers, distributors and agronomists.

Bentazone was monitored in Anglian Region in 1993 following predictions that it would be found at concentrations above 0.1 µg/l. Monitoring was undertaken and the results confirmed that bentazone is regularly detected above this concentration in surface and groundwaters. Currently, there are no restrictions on its use, but bentazone is due to be reviewed under the Authorisations Directive and the issue of water pollution will be raised.

7.8 Amenity pesticide users, such as local authorities, Railtrack and public utilities should continue to be targeted by the regulators, manufacturers and the BAA to alert them to the risk of contamination from the amenity use of pesticides.

Herbicides used on non-agricultural land are particularly significant in relation to exceedences of the 0.1 µg/l drinking water standard. This highlights the risk associated with applying herbicides to hard surfaces, where run-off can easily occur. The NRA will encourage the use of non-chemical methods of weed control and where this is not possible, will promote contact herbicides in preference to residual products.

Atrazine exceeded 0.1 µg/l most frequently both in surface freshwater and groundwater in 1992. Because of the regular exceedences of atrazine and the closely related simazine in drinking water supplies Government Ministers prohibited their use on non-agricultural land from September 1993 in an attempt to reduce the problem. Unpublished NRA data collected since 1993 suggest that the concentrations are starting to decline in surface freshwaters. Concentrations in groundwaters will take longer to decline. It is hoped that banning the use on non-agricultural land will be sufficient to reduce the concentrations in surface and groundwaters to acceptable levels. However, as both pesticides still have limited agricultural approval, the NRA will continue to monitor for atrazine and simazine and report the findings to DoE and MAFF.

Once it became evident that the use of atrazine and simazine was likely to be restricted, the amenity sector started looking for alternative herbicides. Diuron became widely used as an alternative and is already being detected in watercourses and groundwaters, particularly in highly urbanised areas. The data indicate that diuron exceedences may have increased between 1992 and 1993. The NRA will continue to monitor for diuron and liaise with the manufacturers and users to minimise diuron exceedences.

7.9 Arrangements for the disposal of sheep dip should be reviewed by the Government. The NRA's task of protecting Controlled Waters would be helped if the Authority was notified of the location of sheep dips and the method of disposal of spent solution. The development of an effective treatment process to make spent sheep dip solution harmless should be a priority for the industry.

Diazinon is found to exceed its NRA standard and also the 0.1 µg/l drinking water standard. It is a component of some sheep dips and may be detected in watercourses as a result of dipping sheep i.e. as a result of incorrect use or disposal of sheep dip. Disposal of used sheep dip needs careful planning to ensure it does not contaminate watercourses. Knowledge of the sites of dips and current disposal methods would enable the NRA to target advice to sheep farmers on the safe use and disposal of sheep dips. Further information and recommendations are detailed in the NRA R & D Report 11 "The Disposal of Sheep Dip Waste - Effects on Water Quality". This research indicated that groundwaters are particularly at risk when sheep dips are disposed of via soakaways. Therefore, the NRA no longer considers soakaways acceptable for the disposal of sheep dip or pesticide waste.

Sheep dip operators are now required to have a Certificate of Competence in order to buy organophosphorus dips, so this will hopefully improve operating practices and reduce the risk of water pollution.

It may be that disposal of sheep dip, either directly on farms, or as the waste of an industrial process, could benefit significantly from treatment plants such as the "Sentinel" treatment system. Currently, these systems are not available because insufficient development work has been undertaken. If the method was successful, farmers, contractors and industry could be encouraged to dispose of sheep dips by the use of this type of treatment plant.

7.10 The Government should seek improved information on the use of pesticides on non-agricultural land, in sheep dips and other veterinary medicines, and as industrial biocides. This information should be published routinely.

To undertake a cost-effective monitoring programme, the NRA needs accurate information on pesticide use. Currently, information is available on pesticides used in agriculture and horticulture, but there is very little detailed information on pesticide usage on non-agricultural land, despite this being an area where contamination by pesticides is a recognised problem. The DoE undertook a survey of pesticide use on non-agricultural land in 1989, but this is now out of date. A new survey is planned for 1996. There is also insufficient information on the usage of sheep dips and other veterinary medicines, and industrial biocides.

To obtain value for money the NRA reviews national monitoring programmes annually and includes pesticides most likely to be present in the aquatic environment. In future, this will be achieved by developing POPPIE (Prediction of Pesticide Pollution In the Environment), a computer based risk assessment tool incorporating geographical information systems (GIS) and using available information on the physico-chemical properties of pesticides, pesticide usage, land use, hydrology and soil type to predict likely pesticide concentrations in environmental waters in catchments. More information on POPPIE is given in Section 6.2. A Guidance note on "Targeting Pesticide Monitoring" will be produced to help target the monitoring of specific pesticides in the areas and at times of the year when they are most likely to be present.

7.11 Analytical techniques which could be adopted by the water industry should be developed for agricultural fungicides and pyrethroid insecticides at detection limits required by their EQSs. Pesticide manufacturers should assist with the development of practical analytical methods for pesticides in common use. The NRA will work with the pesticide manufacturers and Standing Committee of Analysts to help with this process.

Pesticide analysis is difficult and expensive, so to ensure cost-effective monitoring programmes, resources must be targeted at those pesticides most likely to be present in the aquatic environment. This is being addressed by the development of POPPIE, which will assess the risk of pesticide pollution in surface and groundwaters. Once the pesticides have been prioritised, monitoring programmes can be undertaken. One difficulty arises though due to the lack of adequate analytical techniques. Of the 450 pesticides currently approved for use, less than half have analytical techniques to detect adequately levels in the water environment.

Analytical techniques are particulary lacking for fungicides. Very little fungicide monitoring is carried out by the NRA, despite predictions from FARMSTAT that some of the most widely used fungicides may leach to water. This is due to the lack of analytical techniques and the fact that previously these fungicides were not perceived as high risk.

There is also a need to develop improved methods of analysis for the pyrethroid insecticides, with limits of detection sufficiently low to enable failures of the EQSs to be accurately detected.

The pesticide approval process now requires a method capable of measuring the pesticide at 0.1 µg/l. However, it still may not be practical or possible for the NRA to use this routinely for large numbers of samples. The difficulty is that most pesticide analysis is completed in "suites" (Section 4.6). Therefore, if a pesticide cannot be added to an existing suite, but requires unique analysis, the cost for routine analysis may be prohibitive. If a method is very time consuming or requires very specialised analytical equipment it may not be suitable for routine use by the NRA.

The NRA needs more assistance from industry with analytical method development for pesticides. Where there are shortfalls in available methods, the NRA will address these through its own R & D programme. This currently involves undertaking an R & D project to develop practical cost-effective analytical techniques for about fifteen pesticides which are predicted to reach surface waters.

In addition, there is also a need for separate "confirmatory" techniques. To be confident in the accuracy of pesticide data, all positive results should be confirmed using a different technique. Confirmatory techniques are therefore required for all pesticides and the NRA will liaise with the Standing Committee of Analysts and pesticide manufacturers to achieve this.

Also, there is currently very little information on the concentrations of pesticide breakdown products in the environment or the adjuvants used in pesticide formulations. The potential significance of these need investigating and then monitoring can be undertaken if appropriate. An NRA R & D project is currently producing a database of significant pesticide metabolites and common adjuvants used in pesticide formulations and monitoring will be undertaken for those identified as of potential concern.

7.12 To avoid duplication of monitoring programmes water companies should be encouraged to continue to exchange and review pesticide data with the NRA. The NRA will provide water companies with pollution risk information on individual pesticides to assist them to target their monitoring.

Currently, an NRA national network of groundwater sites is being developed which will allow a more structured approach to groundwater monitoring. This framework is likely to be based on pesticide use and leaching potential within the catchments of groundwater sample points. Water companies will be encouraged to participate in the strategy, by harmonising their groundwater analyses with those of the NRA. Since the water companies have a large number of abstraction wells, combining these data with NRA information would provide valuable additional information on which to base management plans.

7.13 Further assessment of the economic case for Water Protection Zones to control pesticide pollution in public water supply catchments should be considered by the Government, water companies and the NRA, so that the full costs of catchment control versus those of water treatment can be fully evaluated.

There is a major cost implication to the Water Industry and consequently their customers, the public, of removing pesticides from river and groundwater sources to ensure compliance with the EC Drinking Water Directive standard. It has been estimated that capital costs arising from the installation of the necessary treatment facilities may amount to £1 billion (Water Services Association, 1994) and is generally accepted that continuing substantial operating costs of 5-10% (£50-100 million) per annum will arise.

The main direct control mechanism available to the NRA is to recommend the introduction of statutory Water Protection Zones by the Secretary of State for the Environment, in order to restrict or prohibit problem pesticides in some catchments. In practice, introduction of Water Protection Zones will be difficult, as they may require individual public enquiries. An alternative approach may be to introduce Regulations to make general restrictions on the use of problem pesticides in the catchments of public water supplies.

The economics of using Water Protection Zones or Regulations to limit pesticide exceedences of the Drinking Water Directive against the use of treatment plants have been considered in a recent study commissioned by the DoE. The study found that in the Water Supply catchments considered, restricting the use of pesticides was more economic than treatment at the water supply source (Water Research Centre, DoE 3555/P May 1995). However, due to the complexity of the analysis, these findings need substantiating and therefore the study needs repeating on other sites so the apparent benefits can be further assessed.

7.14 The Government should, as a priority, examine the case for "no spray" zones of appropriate width adjacent to all watercourses to prevent overspray, and to minimise spray drift and run-off (except for those pesticides approved for use in or near water). The NRA believes that these should be a minimum of six metres for all pesticides. Larger zones may be necessary for highly toxic pesticides and for application techniques likely to cause increased drift e.g. aerial or orchard application.

Contamination of non-target areas adjacent to crops can occur by direct overspray, drift and run-off. The most practical way of reducing contamination of areas from unwanted transport of applied pesticides is to adopt a strategy of prohibiting the application within a boundary (buffer zone) adjacent to a watercourse. Currently, MAFF have adopted this strategy and during the approvals and review process are implementing "no spray" zones (normally of 6 m) for certain pesticides depending on their toxicity. However, many pesticides have not been assessed in this way, because they have not been reviewed since the policy was implemented. This results in inconsistencies and difficulties in enforcing the requirement. It also causes management problems for farmers. The NRA believes that adopting 6 m "no spray" zones adjacent to watercourses for all pesticides (except for those approved for use in or near water) would help reduce pesticide contamination of water and be easier to manage and enforce. A German study recently found that 4% of spray drifted 1 m and 0.6% drifted 5 m . (Ganzelmeier *et al*, 1995). Also a 6 m wide vegetated strip has been shown to reduce pesticide losses by run-off by more than 95% . (Patty and Gril, 1995). The NRA will be undertaking its own research on the effectiveness of buffer strips.

7.15 To help offset the cost of "no spray" zones, more effective use should be made of set-aside to create buffer zones along watercourses and this should be a priority for MAFF. The optimum solution would be to change the existing rules to allow a six metre vegetated strip to qualify for the set-aside payment. This change would need to be negotiated through the European Union.

Currently, 20 m is the minimum width on which set-aside payments are made. However, if this was reduced to 6 m, many farmers would be amenable to siting set-aside strips adjacent to watercourses. Even greater benefits could be achieved if properly managed vegetated strips were established, which provide enhanced environmental habitats as well as reducing water pollution. In addition, managed herbage rich strips can act as a barrier to prevent unwanted weeds, such as sterile brome and cleavers migrating into a crop from field margins. These strips would also be effective in reducing erosion of soil and the consequent siltation of watercourses, and in reducing loss of nitrate and phosphate from agricultural land.

7.16 Future opportunities arising from the Common Agricultural Policy and land use change should be taken to reduce the risk of pesticide pollution from agriculture.

Agricultural policy is continually being developed and modified. When changes are being discussed, any potential environmental benefits or drawbacks should be considered. Advantage should be taken of proposed changes which could benefit the aquatic environment.

7.17 The independent registration scheme for the pesticide industry - BASIS - should continue to inspect distributors' pesticide stores. The extension of BASIS inspection and certification to all large pesticide stores (e.g. manufacturing plants, large farm stores and other user stores such as local authorities and spraying contractors) should be encouraged. A similar scheme advocating minimum pollution prevention requirements for all pesticide stores should be developed and introduced.

Proper and careful storage of pesticides can reduce the risk of pesticide contamination of water. New and improved methods of pesticide storage should be promoted and the BASIS inspection and certification scheme could be used to encourage these.

7.18 The pesticide industry should further improve formulations and techniques for handling pesticides to reduce the risk of environmental contamination from spillages and disposal e.g. tablet formulations and refillable containers. In addition, machinery manufacturers should be encouraged to continue developing improved spraying techniques, such as direct injection systems, self-cleaning sprayers and container rinsing systems and the NRA will encourage their use.

Improved pesticide formulations, refillable containers, improved mixing and application techniques and automatic tank and container rinsing machines can help reduce pesticide pollution and their development and use will be encouraged by the NRA.

7.19 Pesticide manufacturers, distributors and representative groups (National Farmers Union and Country Landowners Association etc.) should inform their members of current pesticide pollution issues and provide advice on pollution prevention and "best practice". The NRA will assist by publishing pesticide data, providing leaflets, attending agricultural shows and holding seminars.

Recent research indicates that pollution resulting from small scale spillages from mixing, tank washings and incorrect disposal may be significant. If these sources could be eliminated, short-term pesticide peaks would be much reduced. There is a considerable amount of literature available on "best practice" for storage, use and disposal of pesticides, and if this was adopted universally and more rigorously enforced, it is expected that there would be a considerable reduction in pesticide pollution. Effort is needed by regulators and industry to ensure that farmers have all the available literature and that they continually improve their practices. Some work is already being done by the NRA, attending agricultural shows and producing leaflets, but a more proactive approach is needed to enforce the simple pollution prevention message. To achieve this the NRA will continue to liaise with organisations involved with pesticide regulation, manufacture, storage, use and disposal and promote the use of "best practice". Pollution control measures used in Europe and elsewhere should also be investigated and incorporated where appropriate.

The NRA will work closely with DoE on pesticide registration, reviews and other issues referred to it by the ACP, SCP and VPC and advise on matters relating to prevention of pesticide pollution of the aquatic environment. The NRA will also compile information on aquatic pesticide pollution incidents and report to the Advisory Committee on Pesticides (ACP).

7.20 Current research on less intensive farming systems should be extended and the findings implemented by the farming industry. Particular emphasis should be placed on systems which require lower pesticide inputs such as Integrated Crop Management, biological control and insect resistant crops.

Reducing the use of pesticides should continue to be an important issue. Moving towards better targeted applications and the use of "thresholds" to trigger pesticide applications will go some way towards reducing pesticide use. New developments in plant breeding will also allow reductions in pesticide use. For example insect resistant crops and potatoes which are resistant to sprouting.

In addition, the NRA will continue to implement the recommendations in the earlier NRA reports "The Influence of Agriculture on the Quality of Natural Waters in England and Wales", "The Policy and Practice for the Protection of Groundwater" and the sixteenth report of the "Royal Commission on Environmental Pollution". (The recommendations from the Royal Commission Report are given in Appendix XV).

8 GLOSSARY

Acaricide - A pesticide used for controlling mites.
ACP - Advisory Committee on Pesticides.
Active ingredient - The component of a pesticide, with the pesticidal activity.
Acute - Short-term.
ADAS - Agricultural Development and Advisory Service.
Adjuvant - Substance other than water without significant pesticidal properties used in conjunction with a pesticide to enhance its effectiveness.
Annex 1A - The list of 36 priority dangerous substances, agreed at the North Sea Conference for load reductions.
BAA - British Agrochemicals Association.
BASIS - The independent registration scheme for the pesticide industry.
Bioaccumulation - The build up of substances within the tissues of organisms.
Biocide - A substance which is intended to destroy, deter, render harmless, prevent the action of or otherwise exert a controlling effect on an harmful organism.
CLA - Country Landowners Association.
Contact herbicide - A herbicide which kills weeds when it comes into contact with the foliage, rather than acting through the soil.
Controlled Waters - Waters defined in the Water Resources Act (1991) and includes all rivers, lakes, groundwaters, estuaries and coastal waters.
Chronic - Long-term.
COPR - Control of Pesticide Regulations.
DoE - Department of the Environment.
Diffuse source - A non specific release of a substance to the aquatic environment.
ELISA - Enzyme Linked Immunosorbent Assay.
Environmental Quality Standard (EQS) - The concentration of a substance which must not be exceeded within the aquatic environment in order to protect it for its recognised uses.
FEPA - Food and Environment Protection Act.
Fungicide - A pesticide used for controlling fungal diseases.
Growth regulator - A pesticide used to control the growth rate of plants.
Herbicide - A pesticide used for controlling weeds.
HMIP - Her Majesty's Inspectorate of Pollution.
HPLC - High Performance Liquid Chromatography.
HSE - Health and Safety Executive.
Insecticide - A pesticide used for controlling insects.
Karstic – Limestone with underground streams and cavities.
MAFF - Ministry of Agriculture, Fisheries and Food.
MS - Mass Spectrometry.
Nematicide - A pesticide used for controlling nematodes.
NFU - National Farmers Union.
NOAH - National Office of Animal Health Ltd.
Pesticide - Any substance, preparation or organism prepared or used for destroying any pest.
Point source - A specific identifiable release of a substance to the aquatic environment.
POPPIE - A risk assessment tool for the Prediction Of Pesticide Pollution In the Environment.
PSD - Pesticides Safety Directorate.
Red List - The UK's initial priority list which preceded Annex 1A.
Residual herbicide - A herbicide which acts through the soil and therefore is persistent in the soil.
SCP - Sub-Committee on Pesticides.
Toxicity - The relative poisoning effect of a chemical.
VMD - Veterinary Medicines Directorate.
VPC - Veterinary Products Committee.
WRc - Water Research Council.

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APPENDIX I

PESTICIDE APPROVALS PROCESS FOR MAFF APPROVED PESTICIDES

Manufacturers submit their data package which is evaluated by a group of scientists and a summary document passed to the Sub-Committee on Pesticides (SCP). The SCP considers the information and then decides to recommend to the Advisory Committee on Pesticides (ACP) approval or rejection of the application, or to require that the company provide more data before the application can proceed.

The ACP's independent panel of experts then consider the SCP's recommendation and on the basis of the information presented to it make recommendations to the Ministers for Health, Employment, Environment, Scotland, Wales and MAFF. The pesticide is approved once all six Ministers are satisfied that the pesticide can be used without unacceptable risk to people, animals and the environment.

Under The Council Directive of 15th July 1991 Concerning the Placing of Plant Protection Products on the Market (commonly referred to as the Authorisations Directive), which came into force on 25th July 1993, agricultural pesticide approval is being harmonised across Europe. Active ingredients are being approved at Community level using Uniform Principles across each member state and once approval is given the pesticide will be placed on a list known as Annex 1.

This Directive also requires MAFF to review all existing pesticides over a number of years, and those which continue to meet the requirements will be included in Annex 1. The EC is committed to reviewing all active ingredients over the next fifteen years at a rate of 90 a year and each individual member state will be assigned a pre-agreed number, which for the UK is 11. In order to meet the review, manufacturers may have to provide additional toxicological data for older products. This may lead to the withdrawal of a number of these pesticides which are no longer commercially viable.

The Authorisations Directive allows for a pesticide to be approved if it is not predicted to exceed 0.1 μg/l in groundwater. It also allows for Member States to grant "conditional approval" for a pesticide where modelling predicts the possibility that the 0.1 μg/l may be exceeded. Monitoring will then be required over the following five years to show that this is not the case. It is not yet clear which Member States will take up this option.

APPENDIX II

SUBSTANCES GOVERNED BY THE DANGEROUS SUBSTANCES DIRECTIVE (76/464/EEC)

LIST I substances (also known as the 'Black List')

1. Mercury
2. Cadmium
3. Hexachlorocyclohexane (HCH)
4. DDT
5. Pentachlorophenol (PCP)
6. Carbon tetrachloride
7. Aldrin
8. Dieldrin
9. Endrin
10. Isodrin
11. Hexachlorobenzene (HCB)
12. Hexachlorobutadiene (HCBD)
13. Chloroform ($CHCl_3$)
14. Trichloroethylene (TRI)
15. Tetrachloroethylene (PER)
16. Trichlorobenzene (TCB)
17. 1,2-Dichloroethane (EDC)

LIST II substances (also known as the 'Grey List')

<table>
<tr><td>1.</td><td>Lead</td><td></td></tr>
<tr><td>2.</td><td>Chromium</td><td></td></tr>
<tr><td>3.</td><td>Zinc</td><td></td></tr>
<tr><td>4.</td><td>Copper</td><td></td></tr>
<tr><td>5.</td><td>Nickel</td><td></td></tr>
<tr><td>6.</td><td>Arsenic</td><td></td></tr>
<tr><td>7.</td><td>Boron</td><td></td></tr>
<tr><td>8.</td><td>Iron</td><td></td></tr>
<tr><td>9.</td><td>pH</td><td></td></tr>
<tr><td>10.</td><td>Vanadium</td><td></td></tr>
<tr><td>11.</td><td>Tributyltin</td><td rowspan="2">Triorganotin Compounds</td></tr>
<tr><td>12.</td><td>Triphenyltin</td></tr>
<tr><td>13.</td><td>PCSDs</td><td rowspan="5">Mothproofing Agents</td></tr>
<tr><td>14.</td><td>Cyfluthrin</td></tr>
<tr><td>15.</td><td>Sulcofuron</td></tr>
<tr><td>16.</td><td>Flucofuron</td></tr>
<tr><td>17.</td><td>Permethrin</td></tr>
</table>

APPENDIX III

SUBSTANCES GOVERNED BY THE GROUNDWATER DIRECTIVE (80/68/EEC)

The EC Directive on Protection of Groundwater against pollution caused by certain Dangerous Substances contains two lists of families and groups of substances in the Annex to the Directive.

List I of families and groups of substances

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment
2. Organophosphorus compounds
3. Organotin compounds
4. Substances which possess carcinogenic, mutagenic, or teratogenic properties in or via the aquatic environment
5. Mercury and its compounds
6. Cadmium and its compounds
7. Mineral oils and hydrocarbons
8. Cyanides

List II of families and groups of substances

1. The following metalloids, metals and their compounds:

Zinc	Copper	Nickel
Chromium	Lead	Selenium
Arsenic	Antimony	Molybdenum
Titanium	Tin	Barium
Beryllium	Boron	Uranium
Vanadium	Cobalt	Thallium
Tellerium	Silver	

2. Biocides and their derivatives not appearing in List I
3. Substances which have a deleterious effect on the taste and/or odour of groundwater, and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption
4. Toxic or persistent organic compounds of silicon, and substances which may cause the formation of such compounds in such water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances
5. Inorganic compounds of phosphorus and elemental phosphorus
6. Fluorides
7. Ammonia and nitrites

APPENDIX IV

ANNEX 1A – SUBSTANCES AND TARGET REDUCTIONS

The following list of 36 substances comprises Annex 1A of the Final Declaration of the 3rd North Sea Conference.

Substance	Target reduction
Mercury	70%
Cadmium	70%
Copper	50%
Zinc	50%
Lead	70%
Arsenic	50%
Chromium	50%
Nickel	50%
Drins	50%
HCH	50%
DDT	50%
Pentachlorophenol	50%
Hexachlorobenzene	50%
Hexachlorobutadiene	50%
Carbon tetrachloride	50%
Chloroform	50%
Trifluralin	50%
Endosulfan	50%
Simazine	50%
Atrazine	50%
Tributyltin compounds	50%
Triphenyltin compounds	50%
Azinphos ethyl	50%
Azinphos methyl	50%
Fenitrothion	50%
Fenthion	50%
Malathion	50%
Parathion	50%
Parathion methyl	50%
Dichlorvos	50%
Trichloroethylene	50%
Tetrachloroethylene	50%
Trichlorobenzene	50%
1,2-Dichloroethane	50%
Trichloroethane	50%
Dioxins	70%

APPENDIX V

ANNEX 1B

In addition to the commitment regarding the 36 substances in Annex 1A of the 3rd North Sea Conference Declaration, further common actions were agreed with respect to the reduction of inputs of specific substances and groups of substances.

1. **Pesticides** - to aim for a substantial reduction in the quantities of pesticides reaching the North Sea and thus, by 31/12/92, to strictly control their use and application and reduce, where necessary, emissions to the environment. Annex 1B part (c) lists 18 substances, employed as pesticides, the use of which must be strictly prohibited or banned:
   Aldrin
   Atrazine
   Carbon tetrachloride
   Chlordane
   Chlorpicrin
   1,2-Dibromoethane
   1,2-Dichloroethane
   Dieldrin
   Endrin
   Fluoroacetic acid (and derivatives)
   Heptachlor
   Hexachlorobenzene
   Hexachlorocyclohexane
   Mercury compounds
   Nitrofen
   Pentachlorophenol
   Polychlorinated terpenes
   Quintozene

2. **PCBs** - to prevent PCBs and hazardous PCB substitutes from entering the marine environment including the phasing out of and destruction of all identifiable PCBs as soon as possible.

3. **Nutrients** - in applying the precautionary principle, to co-ordinate initiatives to reduce nutrient inputs, in order to meet the aim of a reduction of around 50% for inputs between 1985 and 1995 into areas where they are likely to cause pollution.

APPENDIX VI

LEGISLATION GOVERNING STORAGE, USE AND DISPOSAL

Storage

Pesticide stores involved in the sale and supply of professional products are required to meet the standards in the MAFF Code of Practice for Suppliers of Pesticides (Yellow Code), which details the storage requirements of COPR. Separate guidance is available for retailers of garden products. The HSE generally enforce COPR for wholesalers and local authorities for retail premises, such as garden centres.

Guidance on the safe storage of pesticides in farm stores is given in the HSE Guidance Note CS19, *Storage of approved pesticides: guidance for farmers and other professional users.*

The Control of Industrial Major Accident Hazards Regulations (1984) (CIMAH) implement the European Communities "Seveso" Directive. Their aim is to prevent industrial accidents and to limit the consequences of any which do occur. They apply to hazardous activities at fixed sites. These are defined in the Regulations in terms of process and storage activities involving specified Dangerous Substances, including a number of pesticides e.g. chlorfenvinphos and parathion.

The dangers associated with pesticide storage were illustrated in November 1986, when a fire swept through a warehouse at the Sandoz pesticide manufacturing plant on the banks of the River Rhine. Approximately 15,000 m3 of water used to fight the fire flowed into the River Rhine via the drains from the factory. Substantial amounts of insecticides were washed into the Rhine with the fire water. The river suffered ecological damage along 250 km, the most noticeable sign of which was thousands of dead fish. This accident, however, has lead to improvements in store design and an appreciation of the importance of the Fire Services in preventing water pollution. The NRA is carrying out R & D work with the Fire Services in relation to the control of water pollution including work on firewater retention.

In the UK, a suspected arson attack occurred at Harcros Timber Yard, in Woking in 1990. This resulted in a spillage of timber preservative containing tributyltin oxide and gamma HCH to the River Bourne, a tributary of the River Thames. Fish and wildlife in the river were affected and 15,000 fish died. Also, some of the water supply abstractions on the River Thames were closed for up to seven days, and contamination was detected as far away as the Thames Estuary.

Use

Under COPR pesticide users are required to take all reasonable precautions to protect the health of humans, creatures and plants, safeguard the environment and avoid polluting water. Additionally, all users of agricultural and amenity pesticides must have received instruction and guidance in the efficient and humane use of pesticides and be competent in their duties. In order to comply, some sprayer operators, notably those born after 31 December 1964, or those applying pesticides to land or water which is not their property, are required to have obtained National Proficiency Testing Council (NPTC) Certificates of Competence. The MAFF/HSE Code of Practice for the Safe Use of Pesticides on Farms and Holdings is the main source of guidance on the use of pesticides in agriculture.

Additional requirements are made under COPR for applications of herbicides in or near water and for aerial application.

Sheep dip operators are also required to have passed a Certificate of

Competence and since 1st April 1995, organophosphorus sheep dips can only be sold to people holding the Certificate.

Anyone selling, storing or supplying pesticides must also have demonstrated their knowledge and to have passed the BASIS Certificate of Competence. This is also an appropriate certificate for advisors, such as ADAS or NRA staff who give advice on the use of pesticides.

The Code of Practice for the Safe Design and Operation of Timber Treatment Plants is available for guidance from the British Wood Preserving and Damp Proofing Association to those involved in using pesticides for timber treatment.

Disposal

The incorrect or careless disposal of pesticides can be a major cause of water pollution and can cause pollution incidents resulting in fish kills and the closure of water abstraction points.

Disposal of dilute agricultural pesticides is covered in the Code of Practice for the Safe Use of Pesticides on Farms and Holdings and for non-agricultural pesticides in the Approved Code of Practice for the Disposal of Non-Agricultural Pesticides. Disposal of concentrated pesticides is controlled by the Waste Regulation Authorities.

APPENDIX VII

UK PRIORITY RED LIST SUBSTANCES

1. Mercury and its compounds
2. Cadmium and its compounds
3. Gamma Hexachlorocyclohexane
4. DDT
5. Pentachlorophenol
6. Hexachlorobenzene
7. Hexachlorobutadiene
8. Aldrin
9. Dieldrin
10. Endrin
11. Polychlorinated Biphenyls
12. Dichlorvos
13. 1,2-Dichloroethane
14. Trichlorobenzene
15. Atrazine
16. Simazine
17. Tributyltin compounds
18. Triphenyltin compounds
19. Trifluralin
20. Fenitrothion
21. Azinphos methyl
22. Malathion
23. Endosulfan

APPENDIX VIII

ANALYTICAL AND CONFIRMATORY TECHNIQUES

A. ANALYTICAL TECHNIQUES

Each laboratory has a set of analytical procedures which vary according to the resources available, the nature of the samples to be analysed and the suites of analysis selected for determination. However, in general all the analytical methods include extraction, separation, concentration and clean up.

Extraction: removes the small amount of pesticide from the water sample. This is achieved by adding a small amount of an immiscible organic solvent to the sample into which the pesticide dissolves.

Separation: The solvent containing the pesticide is then separated from the water.

Concentration: removes the solvent by evaporation, leaving the pesticide.
Clean-up: removes, as far as possible, any interfering organic compounds.

These steps are essential to enable the detection of extremely low concentrations of pesticides.

Analysis and Detection (Separation, Identification and Quantification)
Most analytical procedures rely on a chromatographic separation process linked to either a non- specific (detects a number of different pesticide types) or specific detector system (detects specific pesticide types, such as chlorinated insecticides).

Sometimes it is beneficial to modify the pesticide by chemical means to make it easier to detect and to take advantage of:

a. improved separation and efficiency;
b. the use of a more selective chromatographic process;
c. the use of a specific detector;
d. lower limits of detection.

The identification of a pesticide using a chromatographic procedure depends on its relative retention time on a chromatographic column under set conditions. This is compared with a known reference standard of the pure pesticide. However, despite the detailed preparation outlined, false positive results can occur because some pesticides may have the same retention time under certain chromatographic conditions. Therefore it is essential to carry out additional analysis to confirm the identity of the substance.

B. CONFIRMATORY TECHNIQUES

Confirmation can be achieved by two methods. Either by using chromatography linked to a mass spectrometer (the detector). The mass spectrometer fragments the pesticide into unique pieces and these can then be used to positively identify the pesticide. Alternatively the analysis can be carried out using two (or more) different types of chromatography columns. This can be done simultaneously or sequentially, but the confirmation will not be so reliable if the same non-specific detector system is used for both sets of results.

APPENDIX IX

SUBSTANTIATED PESTICIDE POLLUTION INCIDENTS 1992

* indicates no environmental effects because the pollution was contained

NB: In 1992 Northumbria and Yorkshire Regions, and South West and Wessex Regions were recorded separately. In 1993 the Regions had merged to form Northumbria & Yorkshire Region and South Western Region

	Incident and Environmental Effect	Pesticide (\$) denotes trace levels only	Category
	ANGLIAN REGION		
1	Wash out from sprayer discharged to stream. Discolouration and chemical odour in stream.	Fenoxaprop ethyl Isoproturon	2
2	Tractor spray tank washed into road drain which flowed into river. No known effect	Isoproturon (\$) Chlorotoluron (\$)	2
3	Sample of borehole water found to contain a range of pesticides. No environmental effect known.	Various	2
4	Suspected tractor spill entering river. 25+ dead fish. 1000+ dead invertebrates.	Atrazine (\$) Ethofumesate (\$) Fenpropimorph (\$) Oxadiazon (\$) Simazine (\$)	2
5	Dumping of pesticides into chalk pit. Suspected contamination of stream and spring.	DNOC	2
6	Spray drift into fish pond. Dead goldfish and carp.	Simazine (\$)	2
7	Mobile sheep dip collapsed and spilt 200 g of contents. Dead fish and invertebrates.	Organophosphorus	2
8	Suspected spillage from sprayer filling. 100 dead fish in river.	Atrazine Chlorfenvinphos Propetamphos Terbuthylazine	2
9	Tanker emptied into chalk pit. No known effect.	Chlorothalonil Dimethoate Ethofumesate Fenoxaprop ethyl Pirimicarb Terbutryn Metribuzin	3
10	Suspected contamination of spring as 4 ewes had died. Grass around spring turned brown, no other effects.	Not known	3
11	Slug pellets spilt into drain from spreader. No known effects.	Methiocarb	3
12 *	Rusty containers carried by lorry leaking onto road. Contained, no known effect.	Dimethoate	3
13 *	Road accident resulted in spillage of herbicide. Contained, no environmental effects.	Diquat	3
14 *	50 g of dilute Birlane 24 spilt onto road from leaking sprayer. Contained, no environmental effect.	Chlorfenvinphos	3
15 *	Spraying vehicle in ditch resulting from sheared axle. Contained, no known effects.	Quinalphos Triadimenol	3
	NORTHUMBRIA REGION		
16	Sheep dip contamination of water supply. Groundwater pollution.	Chlorfenvinphos	1
17 *	Drum of weed killer found in river. No pollution or fish mortality.	Mecoprop	3
	NORTH WEST REGION		
18	Pollution of a pond. Dead fish.	Mecoprop MCPA	2

	Incident and Environmental Effect	Pesticide (S) denotes trace levels only	Category
	SEVERN-TRENT REGION		
19	Trailer burst open releasing 100-140 gallons of Fusilade into river. Affected wildlife and amenity.	Fluazifop	2
20	Farm discharge containing trifluralin polluting river. No environmental effects.	Trifluralin	2
21	Catch pits found to be contaminated by pesticides. No environmental effect, potable supply contaminated.	Trifluralin	3
	SOUTHERN REGION		
22	25 litres of PVA glue/biocide washed down drain.	None identified	3
	SOUTH WEST REGION		
23	High levels of pesticide recorded in routine sample. No known effect.	Soil disinfectant	2
24	Pesticide drum found in stream. Stream contaminated. No other known effects.	Dichlorprop	3
25	Run off from sheep dipping operation causing possible pollution of spring. Risk of groundwater contamination.	Not known	3
	THAMES REGION		
26	Suspected spray drift entering canal. More than 1000 dead fish.	Cypermethrin	1
27	Suspected tipping of pesticide into brook. Hundreds of small dead fish.	Not known	2
28	Report of member of public pouring Verdone into river. No known effect.	2,4 D Mecoprop	3
29	Panacide M used by contractor to remove moss from roof drained to pond. Dead fish in pond.	Dichlorophen	3
30	Report of chemicals being dumped in watercourse. No known effect.	Gamma HCH Aldrin	3
31	Half a litre of pyrethroid insecticide spilt and washed into drain. No known effect.	Deltamethrin	3
32*	Arson attack on fire where Gramoxone stored. Contained, no known effect.	Paraquat	3
33*	Trailer axle sheared resulting in spill of 150 litres of fungicide onto road. Contained, no known effect.	Fungicide	3
34*	Fire in insecticide can packaging plant. 1000 cans exploded. Contained, no known effect.	Bioallethrin Permethrin	3
35*	Spillage of pesticides following overflow of steam heated vessel on industrial site. Contained, no known effect.	Cypermethrin Dimethoate	3
36*	Fork lift truck punctured 25 litre container. Spillage contained. No known effect.	Parathion	3
	WELSH REGION		
37	Disposal to ground of sheep dip which entered pond. No effects known.	Propetamphos Diazinon	2
38	Overflowing sheep dip. No effect known.	Not identified	2
39	Syphoning of sheep dip resulted in run off entering road drains. No impact on river.	Propetamphos	3
40	Sheep dip causing discoloration and odour to watercourse. No environmental effects.	Not known.	3
	WESSEX - No substantiated pollution incidents related to pesticides.		
	YORKSHIRE - No substantiated pollution incidents related to pesticides.		

SUBSTANTIATED PESTICIDE POLLUTION INCIDENTS 1993

* indicates no environmental effects occurred because pollution was contained

	Incident and Environmental Effect	Pesticide ($) denotes trace levels only	Category
	ANGLIAN REGION		
1	Contents of drums used in raft race leaked into river. Drums removed. Oily film on water. No environmental effects known.	Diquat ($) Bitumen	2
2	Foam in watercourse resulting from spraying activity. 100 dace killed.	Unknown	2
3	Spray drift into lake. 2 carp, 1 eel and approx 4000 small rudd killed.	Thiovit ($)	2
4	River turned bright blue as result of discharge from fish farm.	Malachite Green	2
5	Spray tank fell off tractor when pin sheared. Dilute pesticide spilt on ground and soaked away. No environmental effects known.	Diquat	3
6	Vandals discharged 13,000 litres 77% sulphuric acid onto land. Neutralised with 60 tonnes of lime. No environmental effects known.	Sulphuric acid	3
7	Stream turned white, strong smell of agro-chemicals. No environmental effects known.	Unidentified	3
8	Herbicide applied to grass round pond. Grass turned brown. No environmental effects known.	Unidentified	3
9	Spray drift on river bank. No environmental effects known.	MCPA	3
10	Crop damage from spraying on railway. No effect on watercourse.	Unknown	3
11	Fire in farm chemical store. Watercourse not affected.	Unknown	3
12*	Seven 5.5kg bags of slug pellets dumped in drain. Removed. No environmental effects known.	Methiocarb	3
13*	Vehicle spillage to road. Contained. No environmental effects known.	Pendimethalin	3
	NORTHUMBRIA & YORKSHIRE REGION		
14	Private spring water contaminated by sheep dip. Water unusable for 1 week.	Propetamphos	1
15	3,000 litres of timber chemicals spilt into watercourse. Water supply contaminated, but downstream pumps turned off minimised effects. No environmental effects known.	Bitumen in white spirit	1
16	Stream contaminated with bracken control herbicide. Drinking water supply contaminated.	Asulam ($)	1
17	Sheep dip containers dumped in quarry pond. No environmental effects known.	Chlorfenvinphos Propetamphos	3
18	Accidental spillage of wool scour to watercourse. No environmental effects known.	Unknown	3
19	Long-term leakage from pipe, discolouring stream occasionally. Ongoing investigation.	Unknown	3
20	Vandals emptied wool scour into watercourse. No environmental effects known.	Unknown	3
21*	Crop sprayer overturned in roadside ditch. 30 litres of 'Cheetah' weedkiller lost. Contained and pumped to crop. No environmental effects known.	Fenoxaprop-P- Ethyl	3
22*	Accidental spillage of wood chemicals to roadside. Contained. No environmental effects known.	P-Creosote	3
	NORTH WEST REGION		
23	Herbicide and oil entered the watercourse in farm run off. No environmental effects known.	Unknown	3
24	Sheep dip entered watercourse in farm run off. No environmental effects known.	Unknown	3
25	Sheep dip entered watercourse in farm run off. No environmental effects known.	Unknown	3

	Incident and Environmental Effect	Pesticide (\$) denotes trace levels only	Category
	North West Region - continued		
26	Sheep dip entered watercourse in farm run off. No environmental effects known.	Unknown	3
27	A mixture of pesticides entered watercourse in farm run off. No environmental effects known.	Unknown	3
	SEVERN-TRENT REGION		
28	Lindane entered brook from farm run off. 67 dead trout, all stream life killed.	Gamma HCH	1
29	Lindane detected in watercourse. 700 bullheads and brown trout killed. Farm not positively identified as source.	Gamma HCH	1
30	Water supply reservoir contaminated.	MCPA	2
31	Pesticide drums washed out close to watercourse. Brown trout killed.	Carboxin and thiabendazole (Cerevax)	2
32	Agricultural vehicle crashed spilling 4.5 litres of herbicide onto verge. No environmental effects known.	Unknown	3
	SOUTHERN REGION		
33	700 litres of pesticide spilt into storm sewer overflow. No environmental effects known.	Unknown	2
34	6 litres of Mecoprop spilt on road. Diluted and washed down storm drain. No environmental effects known.	Mecoprop	2
	SOUTH WESTERN REGION		
35	Water supply contaminated. Source not found. No environmental effects known.	Dieldrin	2
36	High levels of herbicide detected in routine sample. No environmental effects known.	Propachlor	3
37	Formaldehyde drum in culvert. No environmental effects known.	Formaldehyde	3
38	River turned blue-green due to discharge from trout farm.	Malachite Green	3
39	Contents of sprayer emptied into river. No environmental effects known.	Unknown	3
40	Water supply contaminated with mixture of pesticides.	Unknown	3
41	River green resulting from discharge from aquaculture centre discharge.	Malachite Green	3
	THAMES REGION		
42	Ditch appeared green. No environmental effects known.	Unknown	2
43	9 litres of diluted pesticide emptied into road gulley. No environmental effects known.	Dimethoate	3
44*	16 litres of pesticide spilt from lorry on road. Isolated and removed by fire service. 1 litre dilute pesticide washed down road drain. Brook turned pink.	Emazolol(\$)	3
	WELSH REGION		
45	Pesticides discharge to Brook from farm drain. Estimated 1066 trout and 4 salmon killed.	Gamma HCH Atrazine	1
46	Elevated pesticide levels detected in routine sample. No environmental effects known.	Atrazine	3
47	Spray drift into watercourse. Water company informed. No environmental effects known.	Glyphosate	3

APPENDIX X

PESTICIDES MONITORED BY THE NRA IN 1992 AND 1993 AND THEIR USES

Pesticide	Type	Use in 1992 and 1993
2,3,5 T	H	Not approved
2,3,6 TBA	H	Amateur
2,4 D	H	Aq, C, G
2,4 DB	H	C, G
2,4 DCPA	H	NA
A HCH	I	See gamma HCH
Aldicarb	I	A, H
Aldrin	I	A, F, H, V
Atrazine	H	M, NA
Azinphos ethyl	I, A	Not approved
Azinphos methyl	I, A	F, V
B HCH	I	See gamma HCH
Benazolin	H	B, C, G
Bendiocarb	I	H, M, SB
Bentazone	H	B
Bromoxynil	H	C, G
Carbaryl	I	G, T
Carbendazim	F	B, C, G, F, H
Carbetamide	H	B
Carbofenothion	I	ST
Carbofuran	I, N	H, V
Chlordane	I	Not approved
Chlorfenvinphos	I	A, H, S
Chloridazon	H	SB
Chlorofen	I	Not approved
Chlorothalonil	F	B, C, F, V
Chlorotoluron	H	C
Chloroxuron	H	Not approved
Chlorpropham	H, SS	H, P
Chlorpyrifos	I	C, F, G
Chlorpyrifos methyl	I	GS
Clopyralid	H	C, G, H, SB
Cyfluthrin	I	C, F, Mo, V
Cypermethrin	I	B, C, F,S, V
D HCH	I	See gamma HCH
DDE op	I	Not approved
DDE pp	I	Not approved
DDT op	I	Not approved
DDT pp	I	Not approved
Demeton S methyl	I, A	B, C, F, H, V
Desmetryn	H	K
Diazinon	I	H, S, V
Dicamba	H	C, G, NA
Dichlobenil	H	Aq, F, NA, T
Dichlorprop	H	C, G
Dichlorvos	I	Fly, FF
Dieldrin	I	Not approved
Dimethoate	I, A	C, F, V
Disulfoton	I, A	F, V
Diuron	H	NA, T
E HCH	I	See gamma HCH
Endosulfan a	I	Not approved
Endosulfan b	I	Not approved
Endrin	I	Not approved
EPTC	H	Not approved
Ethiofencarb	I	Not approved
Ethofumesate	H	G, SB
Eulan	I	Mo
Fenitrothion	I	C, F, GS
Fenpropimorph	F	B, C
Fenthion	I	VM
Flucofuron	I	Mo
Fluroxypyr	H	C, G
Fonofos	I	C
Gamma HCH	I	A, H, W
Glyphosate	H	A, Aq, H, NA, T
Heptachlor	I	Not approved
Heptachlor epoxide	I	Not approved
Hexachlorobenzene	F	Not approved
Ioxynil	H	C, G
Isodrin	I	Not approved
Isoproturon	H	C
Imazapyr	H	NA
Linuron	H	B, V
Malathion	I	GS, V
Maneb	F	C, P, SB
MCPA	H	C, G
MCPB	H	C
Mecoprop	H	C, G
Metalaxyl	F	ST
Methabenzthiazuron	H	C, G
Metazachlor	H	B, H
Methiocarb	I, M	A, H
Methomyl	I	Fly

Pesticide	Type	Use in 1992 and 1993	Pesticide	Type	Use in 1992 and 1993
Methoxychlor	I	Not approved	Propazine	H	Not approved
Mevinphos	I	Not approved	Propetamphos	I	S
Monolinuron	H	P	Propoxur	I	H
Monuron	H	Not approved	Propyzamide	H	B, F
Napropamide	H	B, F	Simazine	H	B, F, NA
Oxamyl	I, N	B	Sulcofuron	I	Mo
Parathion	I, A	Not approved	TDE op	I	Not approved
Parathion methyl	I, A	Not approved	TDE pp	I	Not approved
PCSD	I	Mo	Tecnazene	F	P
Pendimethalin	H	B, C, F, H, P	Terbutryn	H	Aq, C
Pentachlorophenol	I	W	Tetrachloroaniline		Metabolite of tecnazene
Permethrin	I	F, Fly, GS, Mo, V	Tetrachlorothioanisole		Metabolite of tecnazene
Phenmedipham	H	SB	Tri-allate	H	B, C
Phorate	I	B	Triazophos	I	C, G, V
Phosalone	I, A	K	Triclopyr	H	G, NA
Pirimicarb	I	B, C, F, H, M,P	Trietazine	H	B
Pirimiphos methyl	I	C, GS, Fly	Trifluralin	H	C, F, V
Prochloraz	F	B, C			
Prometryn	H	B			

NB There may be a few additional pesticides monitored occasionally

Key to Type

A = Acaricide
F = Fungicide
H = Herbicide
I = Insecticide
N = Nematicide
M = Molluscicide
SS = Sprout suppressant

Key to Use

A = Agriculture
B = Broad leaved crops
F = Fruit
Fly = Fly control
GS = Grain stores
K = Kale (and related crops)
Mo = Moth proofing
P = Potato storage
SB = Sugar beet (beets)
T = Trees (fruit)
W = Wood preservative
Aq = Aquatic
C = Cereals
FF = Fish farms
G = Grass
H = Horticulture
M = Maize
NA = Non- agricultural
S = Sheep dip
ST = Seed treatment
V = Vegetables
VM = Veterinary medicine

APPENDIX XI

SITES WHICH EXCEEDED EQSs FOR LIST I, II, RED LIST OR DIAZINON IN 1993

List I

Location	Water type	NGR	Pesticide
ANGLIAN REGION			
Greetwell Beck Culvert D/S All	FW	TF0025071500	HCH
Calders Town Drain D/S Confluence *	FW	TF3120042300	HCH Total Drins
Calders London Road Dyke	FW	TF3185042000	HCH Total Drins
Salary Brook. N Tributary Blue Barns Farm	FW	TM0276030170	pp DDT
NORTHUMBRIA & YORKSHIRE REGION			
Capperley Brook U/S Taylors	FW	SE0750033800	Total Drins
Mag Brook at Cocking Step	FW	SE1259012390	Total Drins
Mag Brook *	FW	SE1360012300	Total Drins
River Holme at Queens	FW	SE1420015700	Total Drins
River Calder at Mirfield (Battyford) *	FW	SE1890020500	HCH
Clough Beck	FW	SE2043023750	Total Drins
Aire and Calder Navigation Whitly Bridge	FW	SE5560022700	HCH
River Calder Methley *	FW	SE4090025800	HCH
NORTH WEST REGION			
Wyre Estuary at Windy Harbour	MW	SD3892740469	Total DDT
River Weaver Frodsham Road Bridge *	FW	SJ5301778474	HCH
River Douglas Wanes Blade *	FW	SD4758912612	HCH
SEVERN-TRENT REGION			
2 Km SW Cox Chemicals Bell Brook	FW	SJ5910009240	Diazinon Total HCH
Highway Drainage 1Km W Coxs Chemicals	FW	SJ5973010560	pp DDT Total DDT
Uppington 1.5Km SW Coxs Chemicals	FW	SJ6028009440	Diazinon HCH Total DDT
Leaton Quarry 1Km NE Coxs Chemicals	FW	SJ6142011440	HCH
Teme Tributary B4203 D/S Forest Fen	FW	SO7112066000	Pentachlorophenol
River Leam at Willes Meadow	FW	SP3310065700	Diazinon Total DDT
Cubbington Brook D/S Metcalfe Ltd	FW	SP3485068920	Total Drins
SOUTHERN REGION			
River Medway Allington Sluices *	FW	TQ7490058150	HCH

Location	Water type	NGR	Pesticide
SOUTH WESTERN REGION			
Spires Lake at Spires Cross	FW	SS6461000650	Total Drins
Newton Abbott (Buckland) STW	MW	SX8835072150	HCH
Teign Estuary - Newton Abbot (100m D/S STW) *	MW	SX8845072150	HCH
Teign Estuary - Newton Abbot (250m D/S STW) *	MW	SX8865072150	HCH
Taw Estuary 100m D/S STW *	MW	SS5310023100	HCH
Taw Estuary 250m D/S STW *	MW	SS5285034300	HCH
River Parrett D/S Bridgewater STW *	MW	ST3030038800	HCH
KWR Mixed Severn Estuary (Upper)	FW	ST5130079800	Total HCH Hexachlorobenzene
THAMES REGION			
Lee U/S Lea Bridge Weir *	FW	TQ3570086600	HCH
Lee at Carpenters Road *	FW	TQ3770084500	HCH
Hogsmill U/S Thames *	FW	TQ1780069100	HCH
Wandle The Causeway Wandsworth *	FW	TQ2558074840	HCH

* Sites reported to DOE as part of the Dangerous Substances List I returns. In line with DoE guidance, when reportingEQS failures, all less than results were taken as half the value. In line with the rest of the report for all other sites, less thans were taken as zero.

FW = Freshwaters MW = Estuary and coastal waters

List II

Location	Water type	NGR	Pesticide
NORTH WEST REGION			
Irwell at Stubbins Bridge *	FW	SD7934518090	Permethrin Cyfluthrin
Cowpe Brook PTC Irwell	FW	SD8341621660	Permethrin Cyfluthrin
Tame at Manchester Road Bridge*	FW	SD9856904030	Permethrin Cyfluthrin
Tame PTC Diggle Brook	FW	SD9938106220	Permethrin Cyfluthrin
SOUTH WESTERN REGION			
Colesmill stream above Holsworth	FW	SS3405000320	Cyfluthrin
Severn Estuary, Kings Western Rhyne	MW	ST5100080250	PCSD/eulan
Severn Estuary, Holesmouth	MW	ST5135080900	PCSD/eulan
Severn Estuary, Stipp Pill	MW	ST5160082300	PCSD/eulan
Severn Estuary, ICI pipe	MW	ST5210084100	PCSD/eulan
River Camel at Polbrock	FW	SX0138069490	Cyfluthrin
River Camel below Bodmin	FW	SX0410067340	Cyfluthrin PCSD/eulan
River Par above St Austell	FW	SX0440058000	Cyfluthrin
River Camel above Scarlett SW	FW	SX0449067450	PCSD/eulan
Haye Valley Stream	FW	SX3403068900	PCSD/eulan
River Dart at Totnes Weir	FW	SX8010061220	Cyfluthrin
River Bovey above Heathfield	FW	SX8383076430	Cyfluthrin
River Teign above Chudleigh St	FW	SX8559079330	Cyfluthrin
Teignmouth Long Sea Outfall	FW	SX8830072100	PCSD/eulan
THAMES REGION			
A4 Bridge, Twyford	FW	SU7790076600	Permethrin
Lock 100, Brentford	FW	TQ1715077650	Permethrin
NORTHUMBRIA & YORKSHIRE REGION			
Brearley Weir (River Calder)	FW	SE0270025900	Permethrin
Wessenden Brook	FW	SE0480011550	Cyfluthrin
CrossFlats - River Aire	FW	SE0840022400	Permethrin PCSD/eulan
North Dean (River Calder)	FW	SE0970021900	PCSD/eulan
Hall Dyke above WPCW	FW	SE1105011470	Permethrin PCSD/eulan
Hall Dyke at Healey House	FW	SE1181012110	Permethrin
Mag Brook at Cocking Step	FW	SE1259012390	Permethrin PCSD/eulan
Mag Brook	FW	SE1360012300	Permethrin PCSD/eulan
Salts weir - River Aire	FW	SE1390038200	Permethrin
Queens (River Holme)	FW	SE1420015700	Permethrin PCSD/eulan
Kings (River Colne)	FW	SE1480016000	Permethrin
Bradley Brook at Shipley Weir	FW	SE1510037600	Permethrin
Buck Bridge - River Aire	FW	SE1690039200	Permethrin

Location	Water type	NGR	Pesticide
Colne Bridge (River Colne)	FW	SE1760020200	Permethrin PCSD/eulan
Cooper Bridge (River Calder)	FW	SE1760020600	PCSD/eulan
Hunsworth Beck U/S NBSW	FW	SE1800027800	Permethrin
River Calder at Mirfield (Battyford)	FW	SE1890020500	Permethrin PCSD/eulan
Apperley Bridge - River Aire	FW	SE1950037900	Permethrin PCSD/eulan
SPEN (A644)	FW	SE2310020500	Permethrin PCSD/eulan
Dewsbury (River Calder)	FW	SE2410020300	Permethrin PCSD/eulan
Dearne at Common Lane	FW	SE2510010500	PCSD/eulan
Dearne U/S Clayton West SW	FW	SE2660011900	PCSD/eulan
Dearne at Litherop Lane	FW	SE2710012200	PCSD/eulan
Calder at Horbury Bridge	FW	SE2900017900	Permethrin PCSD/eulan
Aire at Leeds Bridge	FW	SE3030033200	PCSD/eulan
Lupsett Brook at golf course	FW	SE3050018800	PCSD/eulan
Calder at Kirkgate	FW	SE3360020000	Permethrin PCSD/eulan
Aire at Fleet Weir	FW	SE3810028500	PCSD/eulan
Calder at Methley Bridge	FW	SE4090025800	Permethrin PCSD/eulan
Aire at Allerton Bywater	FW	SE4180027300	PCSD/eulan
Aire U/S Hickson Fine Ch.	FW	SE4320026300	Permethrin PCSD/eulan
Aire D/S Hickson & Welch	FW	SE4360026900	PCSD/eulan
Aire at Airedale	FW	SE4690027100	Permethrin PCSD/eulan
Aire at Beal	FW	SE5320025500	Permethrin

* Sites reported to DoE

FW = Freshwaters MW = Estuary and coastal waters

Red List and Diazinon

Location	Water type	NGR	Pesticide
NORTHUMBRIA & YORKSHIRE REGION			
East Allen at Sinderhope	FW	NY8430052200	Dichlorvos
North Tyne at Chlorford	FW	NY9180070500	Diazinon
Tyne at Wylam Bridge	FW	NZ1190064600	Dichlorvos
Derwent at Cockburn Drift	FW	NZ1860060400	Diazinon
Wansbeck at Sheepwash	FW	NZ2570085700	Diazinon
Tees at Low Worsall	FW	NZ3910010200	Diazinon Dichlorvos
Esk at Ruswarp	FW	NZ8870009100	Diazinon
River Colne at Slaithwaite F/B	FW	SE0838014050	Diazinon
River Colne D/S Penine Chemicals	FW	SE0960014600	Diazinon
Aire at Fleet Weir	FW	SE3810028500	Diazinon Dichlorvos Fenitrothion Malathion
River Nidd at Skipp Bridge	FW	SE4820056000	Diazinon
Aire at Beal	FW	SE5320025500	Diazinon
Ouse at Nether Poppleton	FW	SE5580055100	Diazinon
Don at North Bridge	FW	SE5680003800	Diazinon
Ouse at Naburn Lock	FW	SE5940044500	Diazinon
River Don at Kirk Bramwith	FW	SE6210011500	Diazinon
River Don at Halfpenny Bridge	FW	SK4000091400	Azinphos methyl Diazinon
River Hull at Inlet Croda University	FW	TA0950031800	Diazinon
NORTH WEST REGION			
River Darwen A6 Road Bridge	FW	SD5570927969	Diazinon Dichlorvos
SEVERN-TRENT REGION			
Llandrino (Severn)	FW	SJ2980016900	Diazinon
DW Directive Intake (Shelton WTW)	FW	SJ4648013480	Diazinon
Leaton Brook	FW	SJ4730018000	Total atrazine/simazine
Yoxall Bridge River Trent	FW	SK1310017700	Diazinon
At Bawtry (River Idle)	FW	SK6560092700	Diazinon
Dunham River Trent Fishery	FW	SK8190074400	Diazinon
Patch Bridge (Gloucester & Sharpness Canal)	FW	SO7275004250	Dichlorvos
Splatt Bridge (Gloucester & Sharpness Canal)	FW	SO7425006750	Dichlorvos
Newhouse Farm (Cam)	FW	SO7455004350	Diazinon
Park End (Gloucester & Sharpness Canal)	FW	SO7775010650	Dichlorvos
Stourport (Stour)	FW	SO8135070950	Diazinon
DS Lincombe Island (Mid)	FW	SO8205069110	Diazinon
Severn Avon Tid Llanthony Bridge	FW	SO8235018250	Dichlorvos
Gloucester and Sharpness Canal LlanthonyBridge	FW	SO8265018150	Diazinon Dichlorvos
Haw Bridge Severn Avon	FW	SO8455027850	Diazinon Dichlorvos
Chelt Wainlodes	FW	SO8505026150	Diazinon Dichlorvos
Upton on Severn	FW	SO8515040750	Diazinon
Tewkesbury (Avon)	FW	SO8935033250	Diazinon

Location	Water type	NGR	Pesticide
Severn-Trent Region- continued			
Defford Bridge Bow Brook	FW	SO9245043650	Diazinon
Besford Bridge Bow Brook	FW	SO9275046350	Diazinon
Shell Ford Bow Brook	FW	SO9515059750	Diazinon
Swan Coseley Bridge Tipton	FW	SO9595051250	Diazinon
D/S Chemiculture Bishops Itchin	FW	SP3895056750	Malathion
Clifton Avon Upper	FW	SP5320077200	Diazinon
SOUTH WESTERN REGION			
River Lydd at Greenlanes Bridge	FW	SX4436083250	Diazinon
River Yeo Bideford at Edge	FW	SS4478022810	Diazinon
River Dart below Buckfastleigh	FW	SX7536065310	Diazinon
River Dart at Littlehempston	FW	SX8005061630	Diazinon
River Dart at Totnes Weir	FW	SX8010061220	Diazinon
Barrow Reservoir Colliters Brook	FW	ST5360067500	Azinphos methyl
WELSH REGION			
River Solva at Middle Mile Abstraction	FW	SM8060025600	Diazinon
River Taf at Clog Y Fran	FW	SN2380016060	Diazinon
River Tywi at Manoravan Intake	FW	SN6590024000	Total atrazine / simazine

FW = Freshwaters MW = Estuary and coastal waters

APPENDIX XII

NATIONAL PESTICIDE SUMMARIES

Summary of Pesticides which exceeded 0.1 µg/l in Controlled Waters in 1992 and 1993

1992

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > >0.1 µg/l	95 percentile µg/l
Atrazine	4704	0.001-3	49	16	0.29
Mecoprop	1501	0.02-1	27	15	0.34
Diuron	844	0.01-0.1	21	14	0.39
Simazine	4861	0.001-1.4	35	12	0.18
*2,4 D	507	0.02-1.5	10	10	0.37
Isoproturon	2221	0.01-0.8	14	9	0.20
Pentachlorophenol	7143	0.01-180	10	7	0.16
Permethrin	867	0.001-0.15	15	6	0.08
Sulcofuron	354	0.06-1	5	4	0.17
Chlorotoluron	2320	0.02-0.5	9	4	0.10
Dicamba	483	0.02-0.6	5	4	0.13
2,4 DCPA	687	0.025-1	8	4	0.17
MCPA	1456	0.02-5	8	4	0.13
*Terbutryn	566	0.01-0.25	15	4	0.01
*Dichlobenil	685	0.02-0.25	4	4	0.07
Diazinon	2645	0.003-0.6	12	3	0.05
Trietazine	610	0.02-0.1	10	3	0.08
2,3,6 TBA	461	0.025-0.1	2	2	0.01
Flucofuron	331	0.06-0.6	2	1	0.03
Demeton S methyl	1425	0.008-3	3	1	0.01
Linuron	2221	0.01-0.1	6	1	0.05
Dichlorprop	593	0.025-0.5	3	1	0.02
Propetamphos	2230	0.002-0.1	7	1	0.02
Bromoxynil	1136	0.05-1	2	0.9	0.08
Pirimiphos methyl	533	0.01-0.5	2	0.9	0.01
Chlorfenvinphos	2356	0.002-0.1	3	0.8	0.01
Carbetamide	411	0.05-0.1	0.7	0.7	0.003
Gamma HCH	10052	0.001-0.5	69	0.6	0.03
Propazine	1459	0.01-0.8	3	0.6	0.007
Ioxynil	1131	0.05-1	0.5	0.4	0.02
Methabenzthiazuron	276	0.05-0.1	0.3	0.3	0.003
Trifluralin	3831	0.001-6	6	0.2	0.004
Dieldrin	9757	0.001-0.5	11	0.2	0.007
E HCH	506	0.005	2	0.2	0.003
Propyzamide	450	0.02-0.1	6	0.2	0.01
D HCH	3999	0.001-0.01	1	0.2	0.002
Chlorothalonil	536	0.001-0.01	0.3	0.1	0.003
Cypermethrin	556	0.001-0.1	0.5	0.1	0.003
MCPB	1132	0.025-1	0.2	0.1	0.005
Hexachlorobenzene	8164	0.001-0.5	2	0.1	0.002
Prometryn	745	0.01-0.2	3	0.1	0.004
Azinphos methyl	2816	0.001-0.25	0.2	0.1	0.0009
Dichlorvos	3083	0.001-0.6	0.5	0.1	0.001
Azinphos ethyl	2361	0.001-0.25	0.2	0.1	0.0008

1993

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > >0.1 µg/l	95 percentile µg/l
$ Chlorpropham	28	0.01	68	43	633.04
Diuron	1873	0.02-0.1	26	19	0.57
Mecoprop	2265	0.02-0.2	25	17	1.03
Atrazine	5145	0.005-4	47	13	0.20
$ Carbendazim	40	0.1-0.15	10	10	0.12
Bentazone	230	0.05	24	10	0.25
2,4 DCPA	684	0.025-0.7	22	8	0.11
Simazine	5133	0.004-2	35	8	0.13
MCPA	2261	0.02-0.4	11	7	0.66
PCSD/eulan	1454	0.01-0.41	8	6	0.05
Isoproturon	3319	0.01-0.1	10	6	0.10
*2,4 D	1763	0.02-0.4	11	6	0.26
Pentachlorophenol	6513	0.01-50	10	6	0.28
Chlorotoluron	2729	0.02-0.1	11	5	0.14
Trietazine	403	0.02-0.026	18	5	0.16
Propyzamide	222	0.025	16	4	0.95
Permethrin	1029	0.01-0.5	10	4	0.57
Linuron	2621	0.02-0.1	13	4	0.73
Metazachlor	222	0.025	20	3	0.02
2,4 DB	603	0.025-0.5	3	3	0.19
2,3,6 TBA	262	0.05-0.1	3	3	0.17
Ethofumesate	228	0.025-0.03	14	3	0.34
Dicamba	391	0.02-0.8	3	2	0.32
Benazolin	225	0.05-0.1	8	2	0.26
Dichlorprop	701	0.02-0.2	8	2	0.65
Clopyralid	226	0.05-0.1	3	2	0.13
MCPB	1094	0.02-0.5	2	2	0.12
Diazinon	3929	0.0047-0.3	8	2	0.26
*Terbutryn	1121	0.005-1	6	2	0.78
Tetrachloroaniline	550	0.01-0.5	10	1	0.92
Metalaxyl	222	0.05	5	1	0.21
Flucofuron	816	0.025-1	4	1	0.29
Propetamphos	3249	0.0045-0.2	6	1	0.17
*Dichlobenil	670	0.001-0.25	4	1	0.16
E HCH	442	0.005	2	0.9	0.10
Triallate	222	0.025	9	0.9	0.37
Chlorfenvinphos	3963	0.005-0.15	3	0.8	0.16
Bromoxynil	735	0.025-1	1	0.8	0.14
Propazine	1923	0.005-0.85	3	0.7	0.008
Tecnazene	1637	0.001-0.5	4	0.7	0.2
Gamma HCH	9902	0.0005-0.042	45	0.7	0.27
Phenmedipham	140	0.05	0.7	0.7	0.003
Hexachlorobenzene	5945	0.001-0.052	2	0.5	0.11
Ioxynil	734	0.025-1	0.5	0.4	0.009

1992

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > >0.1 µg/l	95 percentile µg/l
Heptachlor	2982	0.001-1	0.2	0.07	0.006
Fenitrothion	2996	0.001-0.1	0.4	0.07	0.0009
Parathion	3617	0.001-1	0.8	0.06	0.0006
Fenthion	2294	0.005-0.3	0.3	0.04	0.0004
pp DDT	7988	0.001-0.5	1	0.04	0.0004
A HCH	9609	0.001-0.5	3	0.02	0.0008
DDT op	8548	0.001-0.5	0.2	0.01	0.0001
Endrin	9227	0.001-0.5	0.4	0.01	0.0001

1993

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > >0.1 µg/l	95 percentile µg/l
Pirimiphos methyl	247	0.01-0.2	0.8	0.4	0.005
Azinphos methyl	2889	0.005-5.7	0.6	0.4	0.007
Methabenzthiazuron	273	0.05	0.4	0.4	0.002
Chlorpyrifos methyl	276	0.01-0.025	0.7	0.4	0.005
Dieldrin	9451	0.0006-0.06	10	0.3	0.004
Sulcofuron	816	0.025-1	3	0.3	0.15
D HCH	4413	0.0005-0.11	1	0.2	0.006
Dimethoate	1626	0.005-0.9	2	0.2	0.003
Azinphos ethyl	2579	0.001-4.35	0.3	0.2	0.004
Chlorpyrifos	660	0.01-0.8	1	0.2	0.002
Dichlorvos	4014	0.002-1.4	0.8	0.2	0.20
Malathion	4214	0.001-0.75	0.5	0.1	0.51
Trifluralin	7072	0.001-0.082	4	0.1	0.002
A HCH	8925	0.0003-0.054	5	0.08	0.001
Carbofenothion	1332	0.01-0.13	0.2	0.08	0.0003
Cyfluthrin	1304	0.0028-0.1	1	0.08	0.0006
DDT pp	8310	0.0004-0.04	3	0.07	0.001
Fenitrothion	4006	0.005-0.4	0.4	0.07	0.001
DDT op	8686	0.0009-0.065	0.3	0.02	0.0002
TDE pp	8003	0.0005-0.03	0.6	0.02	0.0003
Aldrin	9075	0.0005-0.042	0.5	0.01	0.0002
B HCH	7560	0.001-0.159	1	0.01	0.0003

* These pesticides are approved for use in water and their application rates are such that they would exceed 0.1 µg/l. However, the NRA has to agree to the application of a herbicide to water and would not permit applications immediately upstream of a water abstraction point.

$ These pesticides were detected as the result of a special investigation.

The following pesticides were detected, but did not exceed 0.1 µg/l. The number in brackets denotes the number of samples analysed.

1992

aldicarb (274); aldrin (9111); b HCH (6193); chlorofen (10); chlorpyrifos (302); chlorpyrifos methyl (139); cyfluthrin (584); 2,4 DB (274); op DDE (3110); pp DDE (7377); desmetryn (382); e HCH (504); endosulfan a (2921); endosulfan b (2267); heptachlor (2677); heptachlor epoxide (2407); isodrin (7233); malathion (2954); methoxychlor (372); 2,4,5 T (682), op TDE (4187); pp TDE (6603); tecnazene (1290).

1993

bendiocarb (222), tetrachlorothioanisole (27), chloroxuron (275), cypermethrin (481), DDE op (4820), DDE pp (7627), demeton s methyl (1099), desmetryn (494), endosulfan a (5455), endosulfan b (4644), endrin (8783), fenpropimorph (222), fenthion (2363), fluroxypyr (610), fonofos (224), heptachlor (3907), heptachlor epoxide (1516), isodrin (8221), mevinphos (990), monuron (272), parathion (3757), pendimethalin (523), phorate (295), prochloraz (40), prometryn (979), TDE op (5750), triazophos (649), triclopyr (225), 2,4,5 T (826)

The following pesticides were monitored but were not detected.

1992

carbofenothion (686); carbofuran (274); chlordane (369); dimethoate (890); disulfoton (153); fluroxypyr (528); methiocarb (274); methomyl (274); mevinphos (305); oxamyl (274); parathion methyl (915); PCSD/eulan (719); phorate (154); phosalone (150); propoxur (274); triazophos (245)

1993

aldicarb (474), carbaryl (274), carbetamide (274), carbofuran (274), chlordane (12), chlorothalonil (604), chloridazon (275), EPTC (222), ethiofencarb (274), glyphosate (42), imazapyr (44), maneb (37), methiocarb (275), methomyl (274),methoxychlor (13), monolinuron (275), napropamide (222), oxamyl (300), parathion methyl (236), pirimicarb (222), propoxur (274),

Summary of Pesticides which exceeded 0.1 µg/l in Freshwaters in 1992 and 1993

1992

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > > 0.1 µg/l	95 percentile µg/l
Atrazine	3939	0.008-3	52	17	0.31
Mecoprop	1339	0.02-1	30	17	0.38
Diuron	699	0.01-0.1	22	15	0.46
2,4 D	365	0.02-1	15	15	0.5
Simazine	4051	0.001-1.4	38	13	0.2
Isoproturon	2009	0.01-0.8	13	10	0.21
Permethrin	823	0.001-0.15	15	7	0.08
Pentachlorophenol	6288	0.01-180	8	6	0.15
Dicamba	371	0.02-0.6	6	5	0.17
Sulcofuron	353	0.06-1	5	4	0.17
Chlorotoluron	2098	0.02-0.5	8	4	0.10
2,4 DCPA	673	0.025-1	9	4	0.18
MCPA	1284	0.02-5	10	4	0.15
Dichlobenil	648	0.02-0.25	5	4	0.08
Terbutryn	447	0.01-0.25	17	4	0.07
Diazinon	2280	0.003-0.6	14	3	0.05
Trietazine	490	0.02-0.1	11	3	0.07
2,3,6 TBA	349	0.025-0.1	2	2	0.01
Demeton S methyl	1101	0.008-0.5	3	2	0.02
Flucofuron	330	0.06-0.6	2	2	0.03
Dichlorprop	481	0.025-0.5	4	1	0.02
Propetamphos	1894	0.002-0.1	8	1	0.03
Linuron	2039	0.01-0.1	6	1	0.05
Chlorfenvinphos	2010	0.002-0.1	3	1	0.01
Bromoxynil	1020	0.05-1	2	0.9	0.09
Carbetamide	307	0.1	0.9	0.9	0.004
Pirimiphos methyl	524	0.01-0.5	2	0.9	0.01
Gamma HCH	8156	0.001-0.5	42	0.7	0.03
Propazine	1290	0.01-0.8	3	0.6	0.007
Methabenzthiazuron	190	0.1	0.5	0.5	0.004
Ioxynil	1014	0.05-1	0.5	0.4	0.02
E HCH	229	0.005	4	0.4	0.006
Trifluralin	2946	0.001-0.5	7	0.3	0.005
Dieldrin	7871	0.001-0.5	11	0.3	0.008
Propyzamide	345	0.02-0.1	8	0.2	0.02
Chlorothalonil	406	0.001-0.01	0.4	0.2	0.004
D HCH	2941	0.001-0.01	2	0.3	0.003
MCPB	1009	0.025-1	0.3	0.2	0.006
Cypermethrin	556	0.001-0.1	0.5	0.1	0.003
Prometryn	602	0.01-0.2	3	0.1	0.004
Hexachlorobenzene	6381	0.001-0.5	1	0.1	0.002
Dichlorvos	2457	0.001-0.6	0.5	0.1	0.001
Heptachlor	1986	0.001-1	0.2	0.1	0.01
Azinphos methyl	2165	0.004-0.25	0.2	0.09	0.0005
Fenitrothion	2380	0.001-0.1	0.2	0.08	0.0007
Fenthion	1905	0.005-0.3	0.3	0.05	0.0005
Azinphos ethyl	1967	0.001-0.25	0.1	0.05	0.0004

1993

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > > 0.1 µg/l	95 percentile µg/l
Chlorpropham	28	0.01	68	43	633.04
Diuron	1598	0.02-0.1	24	18	0.58
Mecoprop	2089	0.025-0.2	26	18	1.11
Atrazine	4100	0.005-4	51	14	0.22
Carbendazim	40	0.1-0.15	10	10	0.12
Simazine	4094	0.0047-2	39	9	0.15
Bentazone	196	0.05	25	9	0.26
2,4DCPA	646	0.025-0.7	23	9	0.11
MCPA	2085	0.025-0.4	12	8	0.72
PCSD/eulan	1369	0.01-4.1	8	6	0.05
2,4 D	1615	0.025-0.4	12	6	0.25
Pentachlorophenol	5478	0.01-50	10	6	0.23
Isoproturon	2977	0.01-0.1	9	6	0.99
Trietazine	310	0.02-0.026	20	6	0.16
Chlorotoluron	2389	0.02-0.1	91	5	0.14
Propyzamide	197	0.025	18	5	0.11
Permethrin	958	0.01-0.5	10	4	0.06
Linuron	2276	0.02-0.1	11	4	0.07
Metazachlor	197	0.025	22	4	0.06
2,4 DB	569	0.025-0.5	4	3	0.21
Benazolin	196	0.05-0.1	9	3	0.03
2,3,6 TBA	235	0.05-0.1	3	3	0.02
Dicamba	315	0.05-0.8	3	3	0.03
Ethofumesate	197	0.025	16	3	0.03
E HCH	162	0.0005	7	3	0.03
Dichlorprop	581	0.025-0.2	10	2	0.08
Tetrachloroaniline	366	0.01-0.5	13	2	0.14
MCPB	940	0.025-0.5	2	2	0.14
Diazinon	3462	0.0047-0.3	9	2	0.03
Terbutryn	936	0.005-1	6	2	0.02
Clopyralid	196	0.05-0.1	3	2	0.01
Metalaxyl	197	0.05	6	2	0.02
Flucofuron	767	0.025-1	4	1	0.03
Propetamphos	2950	0.0045-0.2	6	1	0.02
Dichlobenil	541	0.02-0.25	5	1	0.02
Triallate	197	0.025	10	1	0.04
Phenmedipham	106	0.05	0.9	0.9	0.004
Chlorfenvinphos	3498	0.005-0.15	3	0.9	0.01
Tecnazene	1275	0.001-0.5	5	0.9	0.16
Bromoxynil	663	0.025-1	1	0.8	0.01
Gamma HCH	7793	0.0005-0.042	43	0.7	0.03
Propazine	1676	0.0005-0.3	3	0.7	0.008
Chlorpyrifos methyl	204	0.01-0.025	1	0.5	0.007
Pirimiphos methyl	222	0.01-0.2	0.9	0.5	0.006
Azinphos methyl	2319	0.005-5.7	0.7	0.4	0.004
Hexachlorobenzene	4422	0.0001-0.051	2	0.3	0.009
Ioxynil	660	0.025-1	0.5	0.3	0.009

1992

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > > 0.1 µg/l	95 percentile µg/l
ppDDT	6445	0.001-0.5	1	0.05	0.0004
Parathion	2926	0.002-1	0.4	0.03	0.0005
A HCH	7755	0.001-0.5	4	0.03	0.001
op DDT	6722	0.001-0.5	0.2	0.01	0.0001
Endrin	7365	0.001-0.5	0.5	0.01	0.0001

1993

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > > 0.1 µg/l	95 percentile µg/l
Dieldrin	7371	0.0006-0.06	10	0.3	0.005
Sulcofuron	767	0.025-1	4	0.3	0.02
D HCH	3203	0.0005-0.11	0.9	0.3	0.008
Dimethoate	1380	0.005-0.15	2	0.1	0.003
Azinphos ethyl	2227	0.001-4.35	0.3	0.1	0.0009
Dichlorvos	3435	0.002-0.8	0.8	0.1	0.0002
Cyfluthrin	1300	0.0028-0.1	1	0.08	0.0005
Malathion	3618	0.001-0.75	0.5	0.08	0.0006
Trifluralin	5688	0.001-0.082	4	0.07	0.002
A HCH	7089	0.0003-0.051	4	0.06	0.001
Fenitrothion	3430	0.0005-0.4	0.3	0.03	0.0002
B HCH	5676	0.001-0.159	1	0.02	0.0003

The following pesticides were detected, but did not exceed 0.1 µgl. The number in brackets denotes the number of samples analysed.

1992

aldrin (7547); b HCH (4989): chlorofen (10); chlorpyrifos methyl (90); cyfluthrin (584); 2,4 DB (274); op DDE (2327); pp DDE (5879); desmetryn (288); e HCH (229); endosulfan a (2324); endosulfan b (1717); heptachlor (1977); heptachlor epoxide (1877); isodrin (5974); malathion (2618); methoxychlor (317); 2,4,5 T (567); op TDE (3211); pp TDE (5119); tecnazene (1052).

1993

aldrin (7025); bendiocarb (197); chlorpyrifos methyl (566); cypermethrin (481); op DDE (3566); pp DDE (5823); op DDT (6727); endosulfan a (4374) endosulfan b (3641); endrin (6813); fenthion (2020); fluroxypyr (410); fonofos (198); heptachlor (2892); heptachlor epoxide (1012); isodrin (6585); monuron (196); parathion (3183); pendimethalin (339); phorate (279); pp DDT (6347); prochloraz (40); prometryn (794); op TDE (4459); pp TDE (6058); tetrachlorothioanisole (27); triazophos (606); triclopyr (196); 2,4,5 T (747).

The following pesticides were monitored but were not detected.

1992

aldicarb (190); carbofenothion (629); carbofuran (190); chlordane (315); chlorpyrifos (235); dimethoate (650); disulfoton (135); fluroxypyr (398); methiocarb (190); methomyl (190); mevinphos (305); oxamyl (190); oxamyl (190); parathion methyl (805); PCSD/eulan (696); phorate (136); phosalone (132); propoxur (190); triazophos (245).

1993

aldicarb (389); carbaryl (197); carbetamide (197); carbofenothion (926); chlortoxuron (197); demeton-s-methyl (828); desmetryn (401); EPTC (197); ethiofencarb (197); fenpropimorph (197); glyphosate (42); imazapyr (44); maneb (37); methabenzthiazuron (1971); methiocarb (197); methomyl (197); methoxychlor (13); mevinphos (744); monolinuron (197); napropamide (197); oxamyl (223); parathion methyl (805); pirimicarb (197); propoxur (197).

Summary of Pesticides which exceeded 0.1 µg/l in Saline Waters in 1992 and 1993

1992

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > > 0.1 µg/l	95 percentile µg/l
Diuron	41	0.02-0.1	59	32	0.29
Chlorotoluron	48	0.02-0.1	38	25	0.48
Atrazine	222	0.01-1	42	21	0.25
Simazine	276	0.001-1	33	20	0.22
Pentachlorophenol	842	0.01-1	28	14	0.35
Propazine	35	0.02-0.1	9	3	0.03
Isoproturon	37	0.03-0.1	32	3	0.30
Diazinon	40	0.02-0.1	5	3	0.02
Linuron	48	0.02-0.1	35	2	0.08
Gamma HCH	1532	0.001-0.008	56	0.3	0.02
Azinphos methyl	355	0.001-0.25	0.2	0.2	0.002
Parathion	395	0.001-0.1	5	0.2	0.002
Hexachlorobenzene	1422	0.001-0.05	5	0.2	0.003

1993

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > > 0.1 µg/l	95 percentile µg/l
Diuron	126	0.02 - 0.1	64	45	0.82
Isoproturon	128	0.02 - 0.1	29	16	0.23
Chlorotoluron	128	0.02 - 0.1	31	15	0.2
PCSD/eulan	65	0.05-0.36	6	6	0.12
Atrazine	396	0.009 - 1	25	6	0.07
Simazine	392	0.005-1	24	4	0.08
Linuron	127	0.02 - 0.1	25	3	0.1
Pentachlorophenol	947	0.01-1	10	2	1.34
Methabenzthiazuron	49	0.05	2	2	0.01
Hexachlorobenzene	1180	0.001-0.052	3	1	0.01
Gamma HCH	1617	0.0005-0.026	65	0.6	0.03
Azinphos methyl	297	0.01 - 0.4	0.3	0.3	0.002
Trifluralin	1076	0.001-0.025	2	0.2	0.002
A HCH	1492	0.0003-0.054	9	0.1	0.002
Dieldrin	1622	0.006-0.011	14	0.1	0.002
Aldrin	1595	0.0005-0.013	0.6	0.06	0.0005
DDT op	1603	0.009-0.02	0.4	0.06	0.0002
DDT pp	1603	0.0004-0.017	10	0.06	0.003

The following pesticides were detected, but did not exceed 0.1 µgl. The number in brackets denotes the number of samples analysed.

1992

a HCH (1496); aldrin (1518); b HCH (1168); chlorpyrifos (47); chlorpyrifos methyl (47); d HCH (1030); pp DDE (1486); op DDT (1495); dichlorvos (298); dieldrin (1520); endrin (1514); fenitrothion (300); heptachlor (698); isodrin (1255); malathion (300); mecoprop (14); methoxychlor (55); pp DDT (1511); prometryn (19); propetamphos (12); trifluralin (601); op TDE (973); pp TDE (1472); tecnazene (235).

1993

b HCH (1594); chlorpyrifos (47); 2,4 DCPA (9); op DDE (1155); pp DDE (1456); diazinon (80); 2,4-D (9); d HCH (1131); endosulfan a (807); endosulfan b (733); endrin (1612); heptachlor (752); isodrin (1279); mecoprop(9); tetrachlorothioanisole (12); op TDE (978); pp TDE (1597); terbutryn (51); triazophos (8); trietazine (51).

The following pesticides were monitored but were not detected.

1992

aldicarb (6); azinphos ethyl (122); bromoxynil (14); carbetamide (6); carbofenothion (55); carbofuran (6); chlordane (54); chlorothalonil (127); chlorfenvinphos (40); 2,4 D (24); 2,4 DCPA (14); op DDE (780); demeton S methyl (12); desmetryn (13); dichlobenil (12); dimethoate (203); e HCH (275); endosulfan a (593); endosulfan b (547); fenthion (94); flucofuron (1); fluroxypyr (127); heptachlor epoxide (510); ioxynil (14); MCPA (12); MCPB (12); methabenzthiazuron (6); methiocarb (6); methomyl (6); oxamyl (6); parathion methyl (107); PCSD/eulan (21); permethrin (28); pirimiphos methyl (7); propoxur (6); propyzamide (3); sulcofuron (1); 2,4,5 T (3); terbutryn (13); trietazine (14).

1993

aldicarb (50); azinphos ethyl (75); bromoxynil (9); carbaryl (50); carbetamide (50); carbofenothion (1); carbofuran (50); chlorpyrifos methyl (47); chlorothalonil (168); chlorfenvinphos (80); chloridazon (51); chlortoxuron (51); demeton-s-methyl (11); desmetryn (51); dichlobenil (10); dichlorvos (294); dimethoate (186); ethiofencarb (50); e HCH (263); fenitrothion (298); fenthion (80); flucofuron (48); fonofos (1); heptachlor epoxide (251); ioxynil (9); malathion (297); MCPA (9); MCPB (9); methiocarb (51); methomyl (50); mevinphos (8); monolinuron (51); monuron (49); oxamyl (50); parathion (311); parathion methyl (5); pendimethalin (158); permethrin (71); phenmedipham (22); phorate (7); pirimiphos (1); prometryn (55); propazine (69); propetamphos (11); propoxur (50); sulcofuron (48); tecnazene (239); 2,4,5,-T (9).

Summary of Pesticides which exceeded 0.1 µg/l in Groundwaters in 1992 and 1993

1992

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > >0.1 µg/l	95 percentile µg/l
Atrazine	543	0.001-0.04	29	9	0.12
Terbutryn	106	0.02-0.04	7	4	0.29
Trietazine	106	0.02-0.04	5	3	0.14
Isoproturon	175	0.02-0.1	19	2	0.05
Mecoprop	148	0.025-0.2	1	1	0.01
Bromoxynil	102	0.05-1	0.9	0.9	0.04
Diazinon	325	0.005-0.05	2	0.9	0.007
2,3,6 TBA	112	0.025-0.1	0.8	0.8	0.02
Dicamba	112	0.02-0.1	2	0.8	0.01
Simazine	534	0.004-0.04	14	0.7	0.02
Linuron	134	0.02-0.1	0.7	0.7	0.007
Azinphos ethyl	272	0.01-0.08	1	0.7	0.005
Chlorotoluron	174	0.02-0.1	11	0.5	0.02
Azinphos methyl	296	0.02-0.08	0.6	0.3	0.003
Dichlorvos	326	0.002-0.05	0.6	0.3	0.002

1993

Pesticide	Total number of samples	Range of LOD µg/l	% of samples > LOD µg/l	% samples > >0.1 µg/l	95 percentile µg/l
Bentazone	34	0.05	18	15	0.1
Atrazine	603	0.0085-0.052	32	11	0.13
Trietazine	42	0.025	10	5	0.33
Diuron	129	0.02-0.1	12	5	0.1
Pentachlorophenol	78	1-10	4	4	0.1
2,3,6 TBA	27	0.05-0.1	4	4	0.0
Linuron	172	0.02-0.05	35	3	0.1
Clopyralid	30	0.05-0.1	3	3	0.02
Ethofumesate	31	0.025-0.03	6	3	0.04
Isoproturon	181	0.02-0.08	12	3	0.03
Chlorotoluron	178	0.02-0.05	19	2	0.09
Terbutryn	134	0.005-0.025	4	2	0.67
Simazine	603	0.0044-0.057	19	2	0.05
Mecoprop	138	0.02-0.2	4	1	0.02
DDT pp	292	0.001-0.04	0.3	0.3	0.004
DDT op	291	0.001-0.01	0.3	0.3	0.001
TDE pp	290	0.001-0.01	0.3	0.3	0.002
Gamma HCH	422	0.0005-0.025	9	0.2	0.007

The following pesticides were detected, but did not exceed 0.1 µg/l. The number in brackets denotes the number of samples analysed.

1992

a HCH (39); b HCH (36); diuron (104); gamma HCH (48); trifluralin (4)

1993

aldrin (387), B HCH (260), tetrachloroaniline (26), carbofenothion (378), chlortoxuron (27), DDE pp (290), demeton s methyl (222), desmetryn (42), dieldrin (391), dimethoate (54), 2,4 D (113), fenitrothion (238), fenpropimorph (25), hexachlorobenzene (291), MCPA (138), mevinphos (221), parathion (225), prometryn (112), propazine (129), propetamphos (239),TDE op (272), tecnazene (121), triazophos (26),

The following pesticides were monitored but were not detected in 1992.

1992

aldicarb (78); aldrin (46); azinphos ethyl (2); azinphos methyl (2); carbetamide (98); carbofenothion (2); carbofuran (78); chlorpyrifos (20); chlorpyrifos methyl (2); chlorothalonil (3); chlorfenvinphos (3); 2,4 D (118); d HCH (3); 2,4 DB (25); op DDE (3); pp DDE (12); op DDT (12); demeton S methyl (18); desmetryn (81); diazinon (21); dichlobenil (25); dichlorprop (112); dichlorvos (21); dieldrin (48); dimethoate (37); disulfoton (18); endosulfan a (4); endosulfan b (3); endrin (29); fenitrothion (20); fenthion (2); fluroxypyr (30); hexachlorobenzene (46); heptachlor (3); heptachlor epoxide (20); ioxynil (103); isodrin (4); malathion (36); MCPA (159); MCPB (111); methabenzthiazuron (80); methiocarb (78); methomyl (78); mevinphos (2); oxamyl (78); parathion (18); parathion methyl (3); pentachlorophenol (6); permethrin (16); phorate (18); phosalone (18); pirimiphos methyl (2); pp DDT (15); prometryn (122); propazine (123); propetamphos (19); propoxur (78); propyzamide (102); 2,4,5 T (112); op TDE (3); pp TDE (12); tecnazene (3)

1993

aldicarb (27), azinphos ethyl (237), azinphos methyl (233), A HCH (277), benazolin (29), bendiocarb (25), bromoxynil (31), B HCH (260), carbaryl (27), carbetamide (27), carbofuran (27), chlorpyrifos (39), chlorpyrifos methyl (25), chlorothalonil (26), chlorfenvinphos (224), chloridazon (27), cyfluthrin (3), 2,4 DB (25), 2,4,DCPA (1), DDE op (75), diazinon (336), dicamba (74), dichlobenil (96), dichlorprop (111), dichlorvos (239), D HCH (64), endosulfan a (242), endosulfan b (238), endrin (292), EPTC (25), ethiofencarb (27), E HCH (17), fenthion (225), fluroxypyr (26), fonofos (25), heptachlor (233), heptachlor epoxide (238), ioxynil (32), isodrin (291), malathion (254), MCPB (120), metalaxyl (25), metazachlor (25), methabenzthiazuron (27), methiocarb (27), methomyl (27), monolinuron (27), monuron (27), napropamide (25), oxamyl (27), parathion methyl (26), pendimethalin (26), phenmedipham (12), pirimicarb (25), pirimiphos methyl (24), propoxur (27), propyzamide (25), triallate (25), triclopyr (29), 2,4,5 T (44), trifluralin (241).

APPENDIX XIII REGIONAL PESTICIDE SUMMARIES

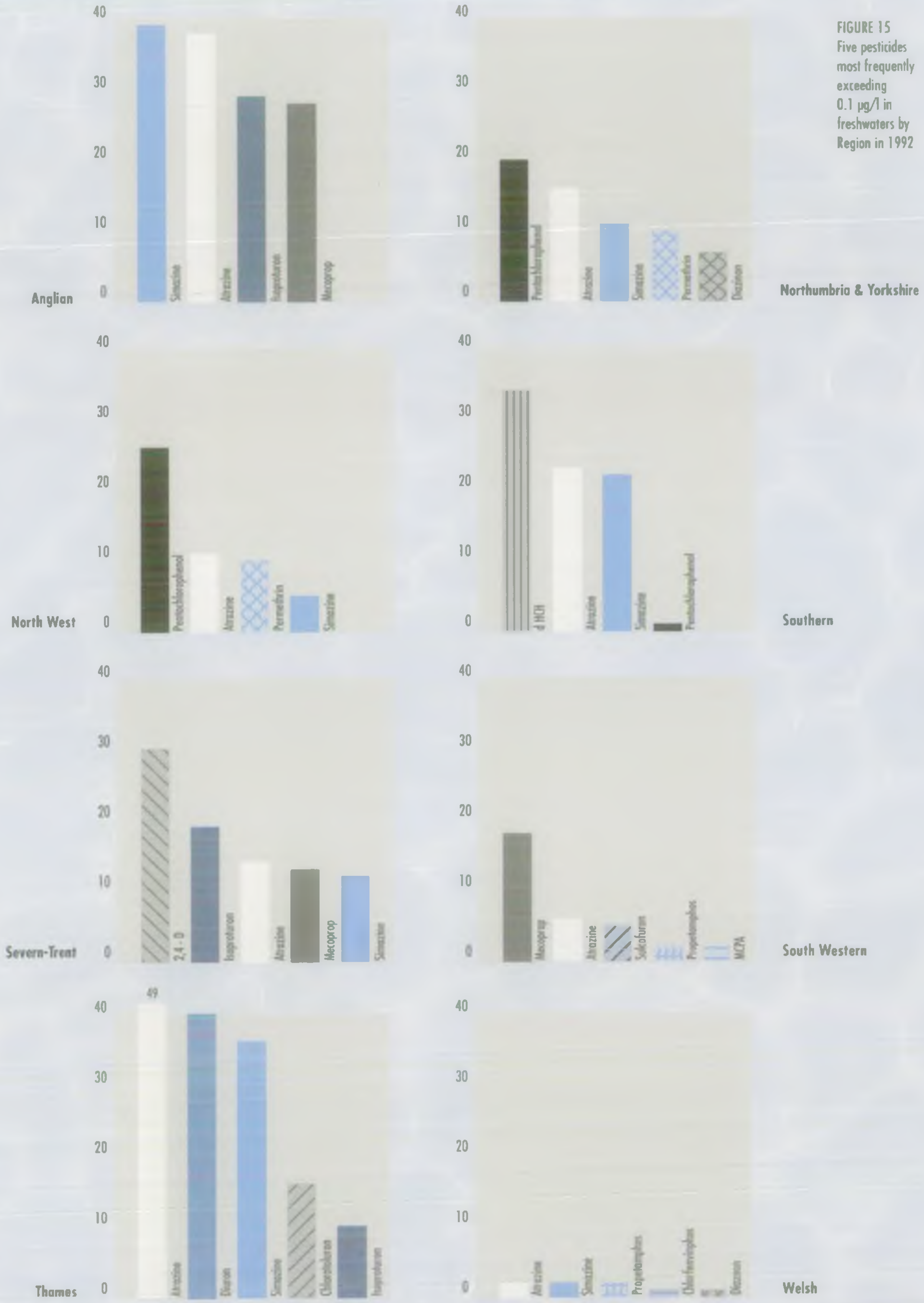
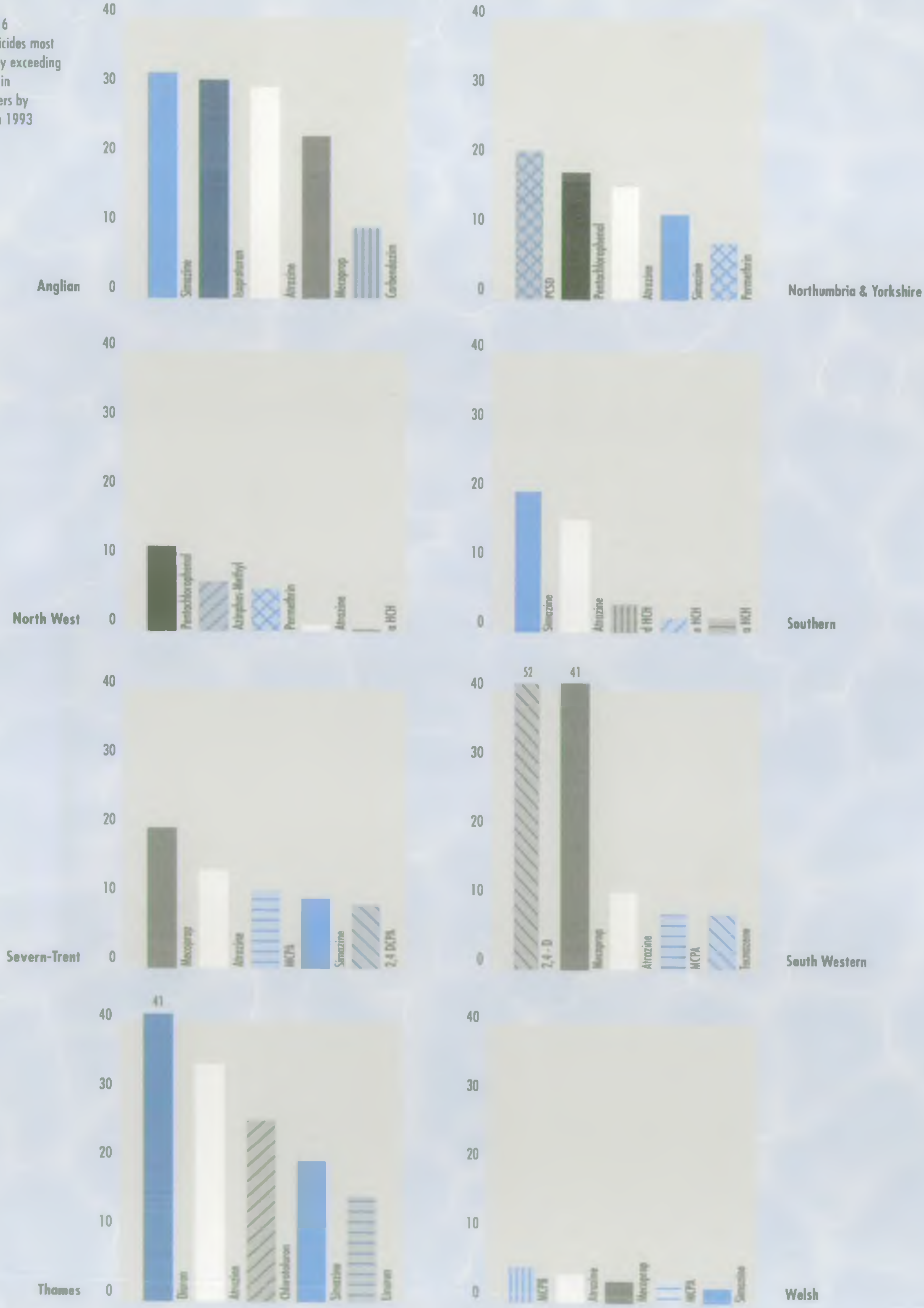


FIGURE 15
Five pesticides most frequently exceeding 0.1 μg/l in freshwaters by Region in 1992

y scale: % samples > 0.1 μg/l

Data not presented where number of samples < 30

FIGURE 16
Five pesticides most frequently exceeding 0.1 µg/l in freshwaters by Region in 1993

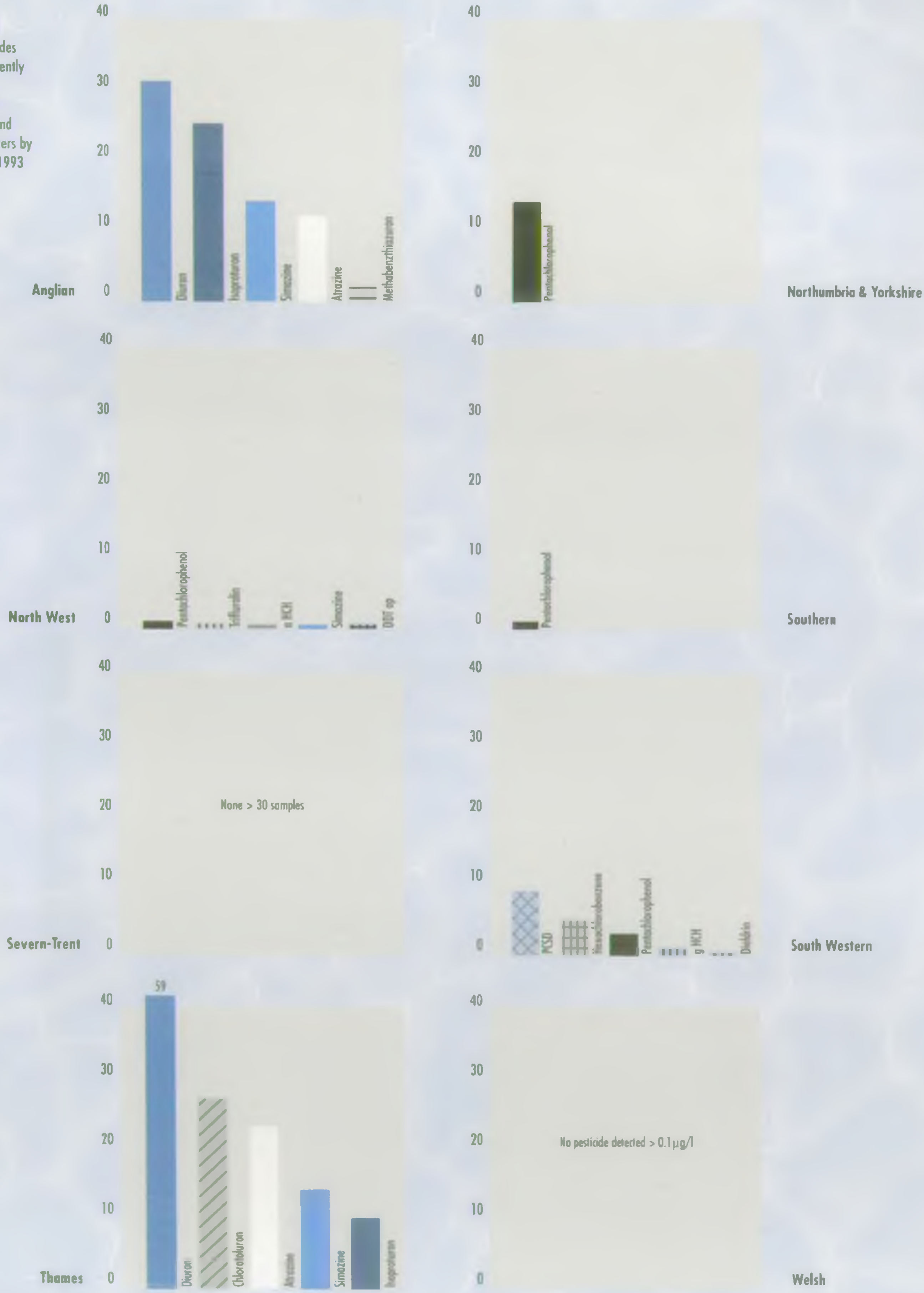


y scale: % samples > 0.1 µg/l

Data not presented where number of samples < 30

FIGURE 17
Five pesticides most frequently exceeding 0.1 µg/l in estuaries and coastal waters by Region in 1992

FIGURE 18
Five pesticides most frequently exceeding 0.1 pg/l in estuaries and coastal waters by Region in 1993



y scale: % samples > 0.1 µg/l

Data not presented where number of samples < 30

FIGURE 19
Five pesticides most frequently exceeding 0.1 pg/l in groundwaters by Region in 1992

y scale: % samples > 0.1 μg/l

Data not presented where number of samples < 30

FIGURE 20
Five pesticides most frequently exceeding 0.1 µg/l in groundwaters by Region in 1993

y scale: % samples > 0.1 µg/l

Data not presented where number of samples < 30

APPENDIX XIV

SUMMARIES OF COMPLETED RESEARCH AND DEVELOPMENT PROJECTS

i. The Disposal of Sheep Dip Waste - Effects on Water Quality (R & D Report 11)
The project investigated the impact of the disposal of sheep dip waste, principally on groundwater quality, but also with regard to disposal onto shallow soils overlying impermeable bedrock. A number of catchment based studies were carried out in Devon, Sussex, Northern Ireland and Scotland. A total of six dip disposal sites in these areas were investigated. The study found evidence of pollution of the unsaturated zone, and groundwater sites on aquifers where dip was disposed of at high loading rates and that pollution of surface water and soil contamination is likely at sites on shallow soils and impermeable bedrock where disposal is to soakaway.

ii. Investigation of Pesticide Transport at Rosemaund Farm (co-funded by NRA)
The study investigated the environmental concentrations of pesticides which can occur as a result of their normal agricultural use in a surface water catchment. This information was then used to develop a model which predicts mean pesticide concentrations during rainfall events. The study found that almost all the pesticides tested appear transiently in the stream after rain, generally at maximum concentrations in excess of 0.5 µg/l. Peak concentrations for some pesticides reached 50 µg/l and above, but concentration generally return to baseline values, <0.1 µg/l, within 24 hours of the cessation of rain. Some of these transient events showed acutely toxic effects to invertebrates in streams and ditches.

iii. Body Burdens in Fish (R & D Note 193)
The exposure of freshwater fish to high levels of contaminants in water or sediments may result in their accumulation in tissues. The report describes a framework for use by the NRA to identify substances requiring routine monitoring in fish tissues, a procedure to monitor these substances in appropriate fish species and explains how to identify impacted fisheries.

iv. An Investigation of Biological Impact from Pesticides in the Granta and Great Ouse Catchments - March 91 (NR 2743)
The project investigated the impact of pesticides in the Granta and Great Ouse Catchments by identifying pesticides used, reviewing ecotoxicological information on the most significant pesticides and relating this information to the biological status of the two river catchments. The study found that the concentrations of most pesticides are at least two orders of magnitude lower than the lowest recorded toxicity value, however, toxicity data were sparse, especially with respect to chronic exposure. One pesticide, atrazine, exhibited only a small safety margin between river concentrations and toxicity.

v. Pesticides in Major Aquifers - Phase I (R & D Note 72)
The study examined the transport and fate of selected priority pesticides in waters typical of the major UK aquifers, for groundwater protection purposes. Phase I involved undertaking national, regional and catchment scale pesticide usage surveys, developing analytical methods for urons and triazines in aquifer materials and producing a model of pesticide transport in the Granta Catchment.

vi. Control of Nitrate and Pesticides in Seven EC Member States (R & D P-14)
The project summarises the approaches adopted in seven EC countries to meet the EC Drinking Water Directive Standards for pesticides and nitrates.

vii. Variability of Pesticides in River Water and its Effect on Estimation of Load (FR0152)
The study investigated the seasonal variability of concentrations of twelve Red List compounds, mainly pesticides, in the River Thames, and compared the estimates of loads of these substances based on discrete data (grab samples and instantaneous measurements of flow) with those based on continuous monitoring. The study found that strong seasonal variations existed in river flow and pesticide concentrations, and hence in pesticides loads. Estimates of annual load based on weekly grab samples could differ from those achieved by continuous flow proportional sampling by as much as +/-50%.

viii. Review of Research and Development Priorities - Agricultural Impacts on Water Quality (R & D Note 32)
The review covers the principal impacts of agriculture on water quality caused by nutrients, pesticides and constituents of organic waste. It also reviews opportunities for research in the fields of land use policy and longer term trends in agricultural land use.

ix. The Effects of Sediment Metals on Estuarine Benthic Organisms (R & D Note 203)
The study analyses the success of legislation prohibiting the use of TBT paints on boats of less than 25 m length in some of the most heavily TBT polluted areas of the UK. The study found that seawater concentrations of TBT had declined in small boat areas, but by 1992 were, at the more contaminated sites, still at least ten times the EQS of 2 ng/l TBT. In the Test Estuary, where large ships predominate, seawater, sediment and biota levels did not fall significantly.

x. Fucus *and* Enteromorpha *as Monitors of Red List Organochlorines in Marine and Estuarine Ecosystems*
The study contains a method for the sampling, treatment and analysis of organochlorine pesticides in the seaweeds *Fucus* and *Enteromorpha*.

xi. Investigation of Partitioning of Contaminants between Water and Sediments (R & D Note 66)
The study found that partitioning between sediments and water can significantly change under different water quality conditions (e.g. with salinity) and that this affects toxicity. This work has also shown that sample preparation prior to analysis can have a significant affect on the interpretation of the results.

xii. The Effects of Partitioning on Toxicity (R & D Note 201)
The project investigated whether the direct assessment of toxicity in settled and suspended sediments provides useful information, or whether the environmental risk posed by contaminated sediments can be predicted from standard ecotoxicological data alone. The project found that a spiked sediment approach, used to assess the toxicity of gamma HCH, hexachlorobenzene and endosulfan to freshwater and marine animals was practical, accurate and capable of achieving environmentally realistic concentrations. This contrasts with the results from the suspended sediments where results were variable.

xiii. Atmospheric Inputs of Pollution to Surface Waters (R & D Report 015/12/T)
The project examined whether some organic pollutants, including organochlorine pesticides, present in the atmosphere contribute a significant input of these compounds to surface waters. The study found that under certain environmental conditions, it is possible that atmospheric deposition may contribute a significant proportion of the EQS value for some of the pollutants studied.

xiv. Diffuse Pollution from Land Use Practices (R & D Project Record 113/10/ST)

This document, together with the report on R & D Project 002 (R & D Note 72) relates to innovative research on the ability and likelihood of pesticides to contaminate groundwater. It is a preliminary stage to understanding the risks of pesticide application on the surface to groundwater quality and hence any conclusions are purely tentative until further research is undertaken.

APPENDIX XV

RECOMMENDATIONS ON PESTICIDES FROM THE SIXTEENTH REPORT OF THE ROYAL COMMISSION ON ENVIRONMENTAL POLLUTION 'FRESHWATER QUALITY'

1. Recommend further research be carried out in the UK to assess to what extent the long-range transport of pesticides presents an environmental hazard.
2. Recommend that regulatory authorities and the water undertakers should extend and improve their monitoring programmes for pesticides in surface and groundwaters and should periodically analyse and publish the results.
3. Recommend local authorities seek to reduce their application and to use less environmentally harmful formulations.
4. Recommend that periodic surveys of the non-agricultural uses of pesticides should be commissioned by the Government and the results published.
5. Recommend that research on ecotoxicology and the mechanisms governing the distribution and fate of pesticides in the environment should continue.
6. Recommend that manufacturers of pesticides progressively improve their recovery and treatment processes until no effluent leaves their works without having been rendered effectively inert.
7. Recommended that MAFF's guidance on the disposal of pesticides by farmers be further revised.
8. Recommend that the Government seeks ways of encouraging the use of systems for treating pesticide waste on farms.
9. Recommend that the merits of establishing a similar scheme for non-agricultural pesticides and animal health products containing pesticides should be evaluated.
10. Recommend that those non-agricultural employees who apply pesticides (or supervise their application) should be required to hold a certificate of competence.
11. Recommend that a national strategy (including a timetable) for reducing pesticide use should form part of the UK's water quality plan. Targets should be related to individual pesticides taking particular account of their toxicity and persistence in the environment as well as of the results of research aimed at reducing pesticide usage.
12. Recommend that the national strategy should encourage further research and development of pesticides which are specific in their effect, degrade rapidly in the environment and do not harm parts of the environment which they are not intended to control.

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The NRA is committed to the principles of stewardship and sustainability. In addition to pursuing its statutory responsibilities as Guardians of the Water Environment, the NRA will aim to establish and demonstrate wise environmental practice throughout all its functions.

Pesticides in the Aquatic Environment

Monitoring by the National Rivers Authority has shown low concentrations of a wide range of pesticides in many environmental waters. This publication is the first comprehensive report on pesticides in the aquatic environment in England and Wales and indicates the occurrence and distribution of pesticides in surface waters and groundwaters.

A concise analysis of the current position, the report makes 20 recommendations designed to reduce pesticide pollution of environmental waters and to promote action on future work and initiatives.

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