



SID 5 Research Project Final Report

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2. Project title
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5. Project: start date
end date

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Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

The Water Framework Directive (WFD) places a statutory obligation on Member States to ensure that all water bodies are of good chemical and ecological status by 2015. This represents a significant challenge and will require considerable changes to be made to the ways in which we manage land. Agriculture perhaps represents the greatest threat to meeting WFD objectives due to farmland making up 75% of UK landcover, as well as agriculture's significant contribution to water pollution. The use of pesticides in agriculture, in addition to other chemicals such as fertilisers, contributes to this pollution and it can thus be envisaged that changes may be necessary in the ways in which pesticides are used. In light of this, Defra's Pesticides Safety Directorate (PSD) commissioned ADAS to review the potential impacts of the WFD on pesticide use in UK agriculture in 2001 (Armstrong and Carter, 2001). This report updates the 2001 version.

It has been identified that the WFD may have a number of implications for pesticide usage in agriculture. As the Competent Authority, the Environment Agency is likely to seek to reduce concentrations of those pesticides most frequently detected in water bodies and those that have a significant ecological effect. A number of mechanisms have been identified that may be used to do this, including regulatory schemes, incentive schemes, voluntary actions and Programmes of Measures. Existing schemes, such as the Single Farm Payment, Entry Level and Higher Level Schemes and the Voluntary Initiative may form a significant component of these. The possibility of a tax on pesticide use remains a possibility. It has been identified that water quality standards may become stricter and are likely to become more diverse. It is also possible that more pesticides will be added to the Priority Hazardous Substances list over time and so their use will need to be phased out.

It will be essential for PSD to keep abreast of those policies relating to the WFD that will impact upon the usage of pesticides in UK agriculture, such as the development of the National Pesticides Strategy and the production of River Basin Management Plans (RBMPs).

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
- the scientific objectives as set out in the contract;
 - the extent to which the objectives set out in the contract have been met;
 - details of methods used and the results obtained, including statistical analysis (if appropriate);
 - a discussion of the results and their reliability;
 - the main implications of the findings;
 - possible future work; and
 - any action resulting from the research (e.g. IP, Knowledge Transfer).

1. Introduction

The Water Framework Directive (WFD) provides a comprehensive framework for the protection of Europe's water resources. Under the WFD, River Basin Management Plans (RBMPs) will be produced by the competent authority, the Environment Agency (EA) in England and Wales. One of the main aims of RBMPs will be to ensure that surface water bodies achieve good chemical and ecological status. This will require management of chemicals in the environment, including, for example, agricultural chemicals, such as pesticides. Although management strategies currently exist to address pesticide pollution, the WFD may require that these are changed or new strategies are implemented, to achieve higher standards.

The Pesticides Safety Directorate (PSD) therefore needs to determine how regulation of pesticides may change over time due to the WFD. Moreover, it is important that the effects on pesticide usage and agriculture are assessed in order that the agricultural industry can respond to the changing demands placed upon it. In light of this, PSD formerly commissioned ADAS to produce a report on the issue in 2001 (Armstrong and Carter, 2001). It is now timely to update the report, given the changes that have since taken place, such as the passing of the WFD into UK law and further development of strategies aimed at ensuring the good chemical and ecological status of water bodies. PSD has therefore requested that ADAS produces this update. The objectives of the current work were met in full.

1.1 Aim

The overall aim of the work was to consider the issues highlighted in the original ADAS report to PSD, assess how these are being implemented, and produce an updated document to inform PSD how the WFD might affect pesticide regulation, usage and agriculture. The project aimed to address a range of issues, such as the identification of pesticides likely to compromise the goal of good chemical and ecological status and how the 'polluter pays principle' might be enforced, as well as the effect of this on pesticide use and agriculture. The study also looked at how the WFD might operate alongside the current risk assessment procedure carried out under the Plant Protection Products Directive (91/414) (European Union, 1991). Moreover, new pressures that might be placed upon regulators, the agrochemical industry and farmers due to the WFD were identified and possible adaptation strategies discussed.

2. Methodology

The methodology used split the project into three phases, which are detailed below. This strategy ensured full use of research previously funded by PSD and made certain that the implications of the WFD for pesticide usage and agriculture were fully considered. The three phases were:

1. To review the report formerly written for PSD by ADAS, discussing the impacts of the WFD on pesticide usage and agriculture (Armstrong and Carter, 2001).
2. Identify changes in the WFD, other environmental management strategies (e.g. risk assessment at registration), regulatory bodies and scientific understanding of pesticide issues since completion of the first report.
3. Update the report to take into account the changes identified and produce a document to inform PSD how the WFD might affect pesticide regulation, usage and agriculture and how challenges might be met.

3. The main provisions of the Water Framework Directive

Directive 2000/60/EC of the European parliament and of the Council of 23 October 2000 (European Union, 2000) established a framework for the Community in the field of water policy. The Water Framework Directive (WFD) provides for the future development of water protection and sustainable water use throughout the European Union (EU).

The Directive has the force of European law, and includes a requirement that transposition be implemented by each state within the Community via national legislation by December 2003, as has been done in the UK. The WFD aims to maintain and improve the aquatic environment across all EU Member States; promoting sustainable water use, ensuring progressive reduction of pollution of both surface and ground waters and, in doing so, securing the drinking water supply for the population of the Community. Article 1 of the Directive thus states:

Article 1 The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- (a) Prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems.
- (b) Promotes sustainable water use based on a long-term protection of available water resources.

- (c) Aims at enhanced protection and improvement of the aquatic environment inter alia through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances.
- (d) Ensures the progressive reduction of pollution of groundwater and prevents its further pollution.
- (e) Contributes to mitigating the effects of floods and thereby contributes to:

- The provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use.
- A significant reduction in pollution of groundwater.
- The protection of territorial and marine waters.
- Achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by Community action under Article 16(3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

Specific provisions of the Directive require individual Member States to:

- Establish the co-ordination of administrative arrangements within River Basin Districts (Article 3).
- Implement river basin management plans to prevent the deterioration of surface water and groundwater, reducing pollution and aiming to achieve good ecological status of the water bodies and protected areas (Article 4). These plans and their implementation are to be made public (Articles 14 and 15).
- Review the characteristics of each River Basin District, identifying the environmental impact of human activity (Article 5).
- Maintain a register of protected areas and water supplies (Articles 6 and 7).
- Monitor status of surface waters, ground waters and protected areas (Article 8).

Appendix V of the Directive includes a series of "normative definitions of ecological status classification". This includes a general requirement for ecological protection, and a general minimum chemical standard, to cover all surface waters. These are the two elements "good ecological status" and "good chemical status". Good ecological status is defined in Annex V of the Directive, in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics. As no absolute standards for biological quality can be set which apply across the Community, because of ecological variability, the controls are specified as allowing a slight departure from the biological community that would be expected in conditions of minimal anthropogenic impact. The Environment Agency is still to specifically define 'good ecological quality' in the UK, as are other Member States. Boundaries between high/good and good/moderate status are currently being established through an intercalibration exercise facilitated by the European Commission. The information to decide where these boundaries lie will be produced based on the results of the WFD monitoring programs that will begin in 2006 (Environment Agency, 2004a). Draft ecological reference conditions for the UK have been produced by the UK Technical Advisory Group on the Water Framework Directive (UK TAG) (UK TAG, 2005a).

Good chemical status is defined in terms of compliance with all the quality standards established for chemical substances at European level. The Directive also provides a mechanism for renewing these standards and establishing new ones by means of a prioritisation mechanism for hazardous chemicals.

For rivers, the definitions for Specific Synthetic Pollutants are relevant, defining:

- High status: concentrations close to zero and at least below the limits of detection of the most advanced analytical techniques in general use.
- Good status: concentrations not in excess of the standards set, without prejudice to Directives 91/414 (Plant Protection Products) and 98/8 (Biocidal Products).
- Moderate status: conditions consistent with the achievement of the values specified above for the biological quality elements.
- Water achieving a status below moderate shall be classified as poor or bad.

The mechanisms available to achieve these aims include the Plant Protection Products Directive, and Annex VIII of the WFD, Indicative list of the main Pollutants, which includes biocides and plant protection products. Water bodies may also be classified as heavily modified or artificial water bodies where it is unlikely that good status can be attained. Here, lower biological standards can be set, and so less stringent water quality criteria are applicable, although this in no way limits the application of other Directives (e.g. 91/414).

The way in which the Directive approaches groundwater is somewhat different to surface water. No additional chemical quality standards have been set for groundwaters but existing standards established at European level for particular pollutants (including nitrates, pesticides and biocides) must be adhered to (e.g. 0.1µg/l for a single pesticide). The WFD requires the production of a Daughter Directive for Groundwater, which will replace the

current Groundwater Directive (80/68/EEC) (European Union, 1980) in 2013. Threshold values for specific pollutants in groundwater must be reported to the Commission by June 2006 at the latest (European Union, 2003). These may replace the current standard of 0.1µg/l for pesticides. For general protection, there is prohibition of direct discharges to groundwater, and (to cover indirect discharges) a requirement to monitor groundwater bodies so as to detect changes in chemical composition and to reverse any anthropogenically induced upward pollution trend.

3.1 Progress with implementation of the Directive in the UK

The timetable for implementation of the WFD is laid out in the Directive. The Directive itself came into force on 23 October 2000, and required legal implementation by the Member States by 22 December 2003. In England and Wales this was effected when Statutory Instrument 2003 No. 3242 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 came in to force on 2nd Jan 2004. In Scotland, transposition was effected by the Water Environment and Water Services (Scotland) Act 2003, and in Northern Ireland by Statutory Rule 2003 No. 544 The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003.

The United Kingdom Technical Advisory Group (UKTAG) provides technical support for the implementation of the WFD in the UK. It is a partnership of the UK environment and conservation agencies and also includes partners from the Republic of Ireland. Current progress with UK implementation is summarised in Table 1.

The Directive requires that water planning be concentrated in natural, catchment, units, which should, if required, be transnational. For this reason, the RBDs have been developed in collaboration with the Welsh Assembly Government and the Scottish Executive. The Directive places the whole of mainland UK in a single "ecoregion" (WFD Annex XI map A).

Table 1. Timetable of implementation of the Water Framework Directive in the UK and current status (UK TAG, 2005b).

Year	Requirement	Summary Status
Dec. 2000	Directive comes into force (article 22)	
By Dec 2003	<ul style="list-style-type: none"> Transpose requirements to Member State Law (article 24) Identify River Basin Districts (RBD) and Competent Authorities (article 3) 	<ul style="list-style-type: none"> Completed Report on RBD and Competent Authorities to European Commission in 2004
By Dec 2004	Undertake RBD Characterisation (article 5) <ul style="list-style-type: none"> Pressures and Impacts upon water status Economic analysis of water use Identify heavily modified and artificial waters Register of Protected Areas 	<ul style="list-style-type: none"> UKTAG prepared national guidance (being implemented and reviewed as required) Competent Authorities in England And Wales, Scotland and Northern Ireland undertaking review Economic analysis of water use under development/in progress in countries.
By December 2006	<ul style="list-style-type: none"> Monitoring programmes operational to ensure comprehensive view of water quality status within each river basin district (article 8) Publish, for consultation, a work programme for River Basin Management Plan (RBMP) production (article 14) 	<ul style="list-style-type: none"> UKTAG –WFD developing framework for monitoring programme design and priorities (due 2005) Countries identifying RBMP processes. UKTAG identifying common issues across UK (2004-2005)
By December 2007	<ul style="list-style-type: none"> Publish, for consultation, interim overview of significant water management issues for each RBD (article 14) 	Not initiated
By December 2008	<ul style="list-style-type: none"> Publish full draft RBMP's for consultation (article 14) 	

Year	Requirement	Summary Status
By December 2009	<ul style="list-style-type: none"> • Publish final first RBMP for each RBD including environmental objectives for each body of surface or groundwater • Designate heavily modified water bodies • Summaries of programme of measures • Monitoring Networks • (article 13) 	
By 2010	<ul style="list-style-type: none"> • Introduce pricing policies (article 9) 	
By December 2012	<ul style="list-style-type: none"> • Programme of Measures operational (article 11) • Interim progress report on PoM prepared (article 11) 	
By December 2013	Review, for the first RBMP; <ul style="list-style-type: none"> • Characterisation assessments • Economic Analysis • Publish, for consultation, interim overview of significant water management issues for second RBMP (articles 13, 14 and 15) 	
By December 2015	<ul style="list-style-type: none"> • Achieve Environmental Objectives of first RBMP • Publish Second RBMP 	
By December 2021	<ul style="list-style-type: none"> • Achieve Environmental Objectives of second RBMP • Publish Third RBMP 	
By December 2027	<ul style="list-style-type: none"> • Achieve Environmental Objectives of third RBMP • Fourth RBMP 	

3.2 River Basin District locations

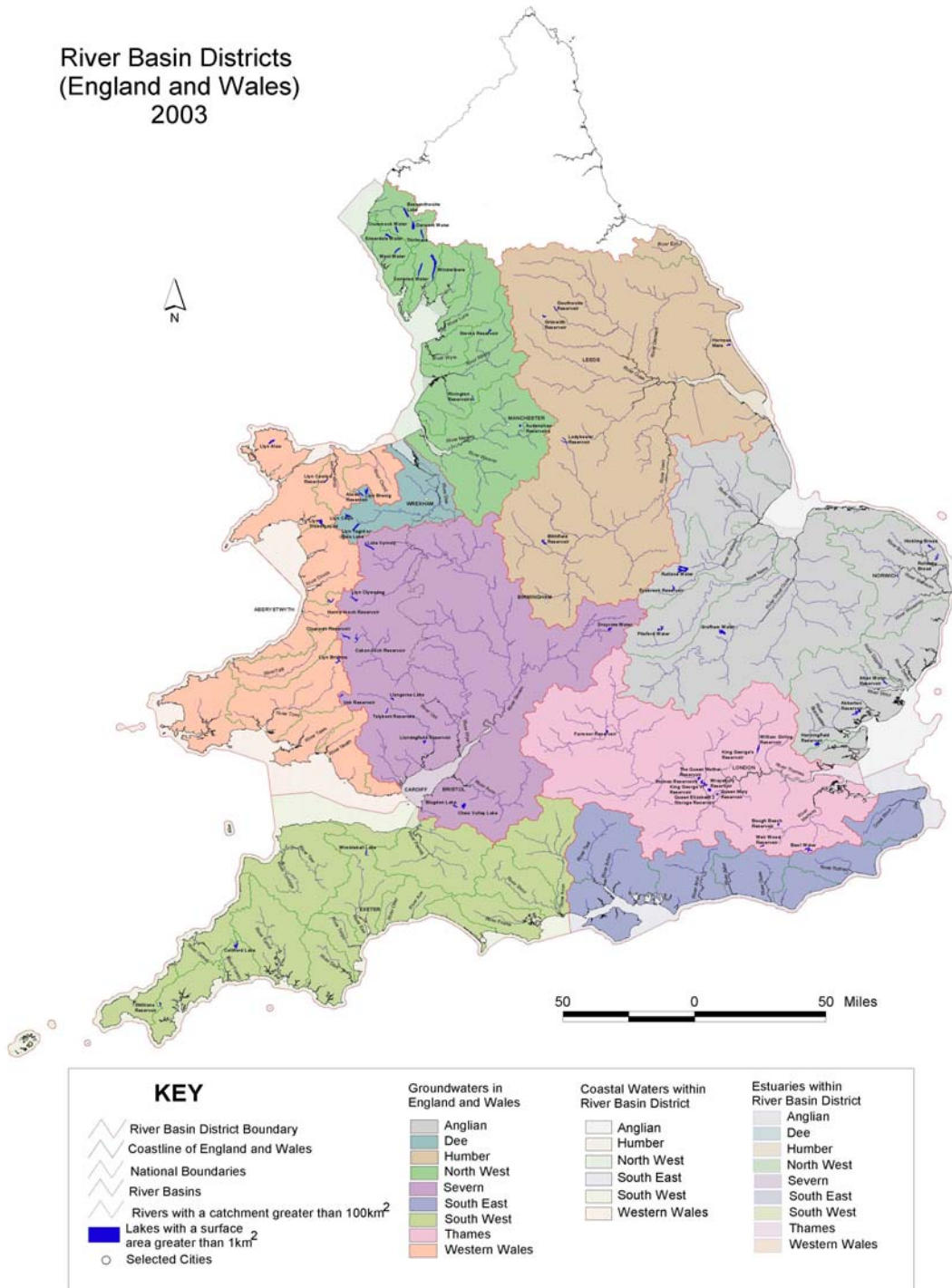
River Basin Districts (RBDs) have now been established for England and Wales (Environment Agency, 2005a) (Figure 1) and the Environment Agency has been designated as the Competent Authority. The Environment Agency, and its predecessor the National Rivers Authority, has many years of experience in managing the water environment on a catchment basis and already has a number of operational tools and techniques needed to implement the Directive in England and Wales. It also has many of the necessary powers under existing domestic legislation. Other Community legislation, such as the Urban Waste Water Treatment Directive and the Nitrates Directive, will help to deliver some of the Directive's requirements. Changes to the regional structure of the EA may, however, be necessary to implement the WFD as some of the RBD boundaries do not match existing EA administrative boundaries.

3.3 Implementation throughout Europe (as of end 2004)

Out of the 15 former Member States, five (Austria, Denmark, Ireland, Greece and Spain) notified the legal instruments to transpose the Water Framework Directive by the set milestone of 22 December 2003. In addition, Germany and Belgium had partially transposed the Directive. By June 2004, the UK (with the exception of Gibraltar), Sweden and France had notified their legal transposition. The remaining states, Finland, Italy, Luxembourg, the Netherlands and Portugal had not notified any information on the transposition.

The 10 new Member States had a requirement to notify the completion of the legal transposition by the time of accession (1st May 2004). Eight of these had notified the completion of this process to the Commission by the deadline. Malta and Slovak confirmed that the transposition had been completed, however, formal notification to the Commission was still pending. In July 2004, the Commission commenced legal action against those Member States that had not completed their transposition.

River Basin Districts
(England and Wales)
2003



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Figure 1. River Basin Districts in England and Wales (cross-border RBD's (Northumbria and Solway Tweed) are not shown) (Environment Agency, 2005a).

4 River Basin Districts and their attitudes to agriculture

4.1 Management of River Basin Districts

The way in which the RBDs are managed is likely to have a significant impact on the implications of the WFD for agriculture. For instance, the level of autonomy that each RBD is given could have a highly significant impact on attitudes to pesticide use in agriculture in the different Districts. The EA is still to decide how it will manage the RBDs, however, and a business implementation project is to be set up by the Agency in 2005 to work on this topic (Dave Martin, Environment Agency, pers. comm.). It is, therefore, still only possible to hypothesise how this may be done. It seems most likely that each RBD will be semi-autonomous and will use the tools available to all RBDs in England and Wales, such as RBMPs and nation-wide risk maps, to address regional issues. It is probable that the structure of the Agency will remain similar to its present form. Some changes may occur,

though, as the present set-up does not mirror the distribution of the RBD boundaries perfectly. For instance, the Humber RBD occupies significant areas of both the North East and Midlands EA regions.

4.2 Stakeholder involvement

It seems highly likely that RBD authorities will make decisions based around the views of a wide range of stakeholders, not just those of the EA. Significant evidence exists from the Ribble Basin Pilot Project that many different stakeholders will all have inputs into river basin management planning. The Ribble Pilot Project is one of fifteen river basin projects being carried out, as part of the WFD Common Implementation Strategy (CIS), to trial the guidance documents developed. The Ribble project began in 2003 and, in addition to testing the guidance developed on the planning process and public participation, will produce a prototype RBMP and Programme of Measures for the Ribble Basin by 2007. This will ultimately feed into the Northwest RBMP. One of the key characteristics of the project has been the interaction between the EA and other key stakeholders (Environment Agency, 2004b). A significant effort has been made to identify all relevant stakeholders, including landowners, farmers, rural communities and industry (Figure 2). It is, therefore, advised that those individuals and organisations with an interest in the agricultural use of pesticides, such as individual farmers, the National Farmers' Union and agrochemical manufacturers, liaise with the relevant EA contacts on a regular basis. This will ensure that they are aware of the mechanisms available to them (e.g. public meetings and written consultations) and that they can contribute to the planning process.

The EA intends to work with stakeholders at a range of scales; national, RBD, catchment and more locally. Stakeholders will formally be able to voice their opinions at a number of points in the catchment planning process, including at the time when significant issues in a RBD have been identified and when the draft RBDP is produced (Environment Agency, 2005c). Whilst the EA clearly envisages that changes in land use and land management will be necessary to achieve the aims of the WFD, it is evident that this will be done in partnership with the farming industry. It is worth noting that the viable farming communities of the Ribble Basin have been noted as an asset of the area and that these should be maintained (Environment Agency, 2004b). This would seem to contradict suggestions of taking land out of production for environmental reasons. Moreover, the EA recognises that the support of farmers is necessary if WFD objectives are to be met (Environment Agency, 2005c) and so the opinions of the farming industry should be listened to carefully. Key to achieving goals will be adoption of changes by the farming community and adherence to pollution advice (Environment Agency, 2004b).

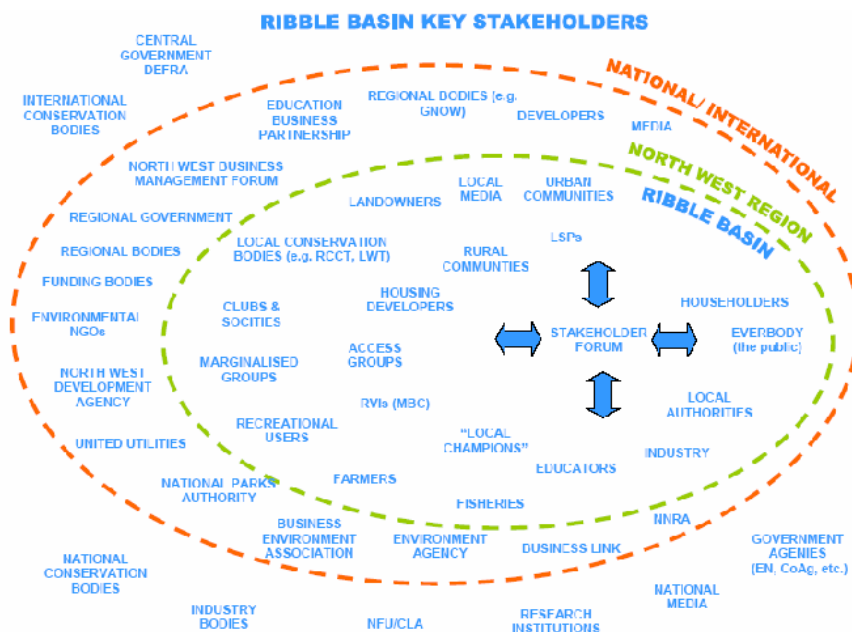


Figure 2. Stakeholder involvement in the river basin management planning process for the Ribble Pilot Project (Environment Agency, 2004b).

4.3 Attitudes of RBD authorities to agriculture and pesticide use

Whilst it cannot be stated with absolute certainty what the attitude of the RBD authorities will be towards agriculture, a range of sources gives a good indication as to how the agriculture sector might have to respond so that the UK can meet the obligations of the Directive.

The EA has outlined how it believes agriculture may be affected by the WFD in the Briefing Note, 'Agriculture and the Water Framework Directive' (Environment Agency, 2004c). Diffuse pollution from agriculture is identified as one of the key issues that RBDs will need to address and pesticides are specified as being a significant agricultural pollutant, presenting a problem in terms of groundwater and surface water chemical quality. Other sources have also identified rural land-use as being one of the key threats to the achievement of WFD goals

(Land Use Consultants, 2004). The 'Catchment Sensitive Farming' (CSF) consultation that was carried out in 2004 confirmed that stakeholders believe that diffuse water pollution from agriculture is a significant problem and that action to combat it is required (Defra, 2004).

Certain pesticides regularly exceed the regulatory standard of 0.1 µg/l in surface waters and it is likely that RBD authorities may take actions to reduce concentrations of these compounds in water in catchments where this is the case. The nine pesticides most frequently detected in water are all relatively mobile and persistent herbicides that are applied to crops at high rates. These are mecoprop, isoproturon, MCPA, diuron, 2,4-D, chlorotoluron, dichlorprop, simazine and atrazine (in order of decreasing frequency) (Environment Agency, 2005b). The Agency has identified a number of routes that it will use to reduce concentrations of agricultural pesticides in water bodies. These can be split into four different categories:

- Regulatory schemes.
- Incentive and grant schemes.
- Voluntary schemes.
- 'Programmes of Measures'.

Programmes of Measures (including basic and supplementary measures) for diffuse pollution control are themselves likely to be a mixture of hard (legislation), medium (spatial planning, codes of practice etc) and soft (voluntary or co-operative) controls.

The main route for regulation of pesticide use in agriculture to reduce environmental impacts is the risk assessment process that is carried out prior to marketing authorisation for individual chemicals under the Plant Protection Products Directive. It is unlikely that this procedure will change in the light of the WFD. It may be the case, however, that RBD authorities recommend to Government that certain compounds do not receive marketing authorisation, or have additional restrictions placed upon them, if they are found to persistently compromise water quality.

The development of the National Pesticides Strategy, currently in draft form (Pesticides Safety Directorate, 2005), will show the direction that the Government wishes to take regarding the use of pesticides in agriculture. The Environment Agency is currently inputting into development of the Strategy and it may be that RBD authorities will contribute to any further updates. Given that other regulations, such as the Control of Pollution Regulations, are unlikely to change due to the WFD it seems unlikely that RBD authorities will use these to bring prosecutions against pesticide users differently to the EA at present.

From the relevant incentive and grant schemes, it is possible that the RBD authorities could encourage farmers to meet the requirements of the Single Farm Payment (SFP) as a means of reducing pesticide pollution of water bodies. For example, cross-compliance demands that buffer strips be maintained alongside ditches, which could limit the transport of pesticides to water bodies in overland flow. Furthermore, RBD authorities may liaise with farmers, through workshops for example, to encourage the uptake of measures in the Entry Level (ELS) and High Level (HLS) Schemes that could reduce pesticide transport to waters. These include larger buffer zones and soil management techniques (Table 2).

Table 2. Measures that could be implemented under the Single Farm Payment and new agri-environment schemes to reduce pollution of water bodies by agricultural pesticides.

Single Farm Payment	Entry Level Scheme	Higher Level Scheme
2m buffer strips	Ditch management	Grass margins
6-10m set-aside strips	2, 4 or 6m buffer strips	Conservation headlands
Soil management plan	Buffering in-field ponds	Overwintered stubble
	Field corner management	Arable reversion to grass
	Over-wintered stubbles	In-field grass areas
	Conservation headlands	Reedbed creation
	Under sown spring cereals	Woodland creation
	Management of high erosion risk cultivated land	
	Management of maize crops to reduce soil erosion	
	Soil management plan	
	Crop protection management plan	

Some stakeholders who were involved in the CSF consultation believed that cross-compliance measures and the ELS and HLS might deliver significant reductions in diffuse pollution (including pesticide pollution) and that further

measures may not be needed. The extent to which these schemes can reduce diffuse pollution from agriculture will be investigated in the Ribble Pilot Project (also using the Yorkshire Derwent catchment to represent an intensive arable catchment). The pilot will run until mid-2007 (Environment Agency, 2005c). However, others (e.g. English Nature (Marsden 2004)), believe that taking this approach will not lead to the improvement in water quality that the WFD requires by 2015 and that further changes in farm inputs and land management must take place in the next few years. Workshops held as part of the Ribble Pilot Project have indicated that bringing about solutions to diffuse agricultural pollution through support schemes such as these is the favoured option. These workshops also highlighted that changes to agriculture will have to be made, with the aim of eliminating poor farming practices that compromise water quality.

Other work has suggested that CAP reform will lead to a reduction in crop production and, subsequently, lower pesticide usage and associated water pollution. This is expected to apply most significantly to the South East, East Midlands, East and Yorkshire and Humberside regions (Silcock et al., 2004).

Very strong support exists amongst stakeholders for taking an approach that works closely with farmers in a supportive way, with good advice being provided by catchment officers who command farmers' respect and have strong local knowledge. It is likely that RBD authorities will use catchment officers as a key means of providing advice to farmers on pesticide management. Economic instruments, such as a pesticide tax, are generally viewed unfavourably and are seen only as a last resort (Defra, 2005).

5. Effectiveness of voluntary schemes and possible alternatives to regulation

The most significant voluntary action that the Environment Agency is currently involved in to reduce pesticide pollution is the Voluntary Initiative (VI), organised by the Crop Protection Association (CPA). RBD authorities may use this scheme, or develop a similar project, in order to encourage actions to result in a reduction in concentrations of pesticides reaching water bodies. Early indications were that VI measures were leading to a significant reduction in levels of agricultural pesticides reaching watercourses. Recent data have, however, indicated that reduced concentrations may simply have been due to seasonal effects, with lower amounts of runoff being generated to transport the chemicals to water bodies in certain years. Concentrations of isoproturon have been elevated during the autumn and winter of 2004. The results of the VI will be reviewed in 2006 and the Government's strategy on how to deal with pesticide pollution will be updated. If the VI fails to achieve its goals then the RBD authorities may push for changes to the scheme and further investigations or further regulation, which could include a pesticide tax. Previous work has concluded that if the VI does fail to meet its objectives then the Government is likely to re-open proposals for a pesticide tax (Land Use Consultants, 2004). Given that the EA hoped that the measures implemented in the VI would lead to significant reductions in pesticide concentrations in water, then the Agency may deem that no option exists other than to attempt to bring about a reduction in pesticide usage via a tax. Integrated crop protection systems may be encouraged, however, as these can lead to a decrease in pesticide use of 40% compared to conventional systems (Environment Agency, 2002, cited in Risk & Policy Analysts Limited, 2003).

It is probable that actions such as those included in the VI will ultimately be incorporated into Environmental Management Systems for Farms (EMSF), which are currently being developed by the EA and the National Farmers' Union (NFU). EMSF will help farmers to evaluate their environmental performance using specifically developed software, some of which will help to develop 'crop protection management plans', examining every aspect of the pesticide application process (Environment Agency, 2004c). Furthermore, RBD authorities may use the 'Catchment Sensitive Farming' (CSF) initiative, managed by Defra, as a means of encouraging farmers to use pesticides in a manner that is less likely to lead to pollution of water bodies.

6. Remedial action - Programmes of Measures

It is likely that any of the actions discussed previously could be included in the Programmes of Measures (PoMs) produced for each RBD.

It is feasible that 'no pesticide zones' or, more likely, zones of restricted pesticide usage could be formed, although a strategy such as this has, to date, not been developed. PoMs can be focused at the national scale, RBD or individual catchment. The Agency will publish RBD Significant Issues Reports in December 2007, and these will show which Districts might be targeted for action to reduce pesticide concentrations in water bodies. They will also work with stakeholders at the catchment and local levels to agree priorities for action. Whilst RBD level PoMs will be identified by 2009 and implemented by the end of 2012, a time-scale for catchment and more local measures has not yet been established. The EA's approach to reviewing PoMs means that the importance of some issues may decline over time whilst new problems will be identified that need to be addressed. (Environment Agency, 2005c).

6.1 Spatial Extent

Risk maps have now been produced by the EA showing the spatial distribution of those rivers and groundwaters at risk of failing to meet the standards required by the WFD due to various pollutants, including pesticides (Environment Agency, 2005a) (Figure 3). These maps give an indication as to which RBDs may take actions in their PoMs to reduce water pollution. Areas have been identified in a number of RBDs where there is a high certainty of not meeting the objectives of the WFD and it thus seems certain that measures will be put in place in these basins. Locations where there is a high certainty of failure include parts of Lincolnshire, in the Anglian RBD, Yorkshire, in the Humber RBD, parts of the West Midlands, spanning the Severn and Humber RBDs, and parts of Kent, in the South East RBD. A significant proportion of surface waters in Wales are also at risk of failing WFD objectives, spanning the Western Wales, Dee and Severn RBDs. The Environment Agency acknowledges, however, that the illegal use of plant protection products containing cypermethrin as a sheep dip is the reason for the problem in Wales and that addressing the issue falls outside the remit of PSD. Many areas have also been classified as 'probably at risk' (although more data is needed to confirm this) and it may, therefore, be that all RBD authorities take action to reduce pesticide pollution in a similar fashion. Nevertheless, a significant proportion of surface waters have been deemed not to be at risk from pesticide pollution, for instance, most of the Thames RBD and a substantial area of the Humber RBD. However, given that Thames Water Utilities has detected excessive concentrations of isoproturon in rivers in the catchment over the winter 2004/05 (Blake, 2005), it may be prudent to assume that even these areas will not escape measures to reduce levels of pesticides in surface waters. Moreover, the EA's risk mapping has highlighted that groundwaters in the Thames catchment are likely to fail WFD objectives unless further actions are taken to reduce pollution by pesticides, as well as other chemicals. Many other RBDs also contain aquifers thought to be at risk.

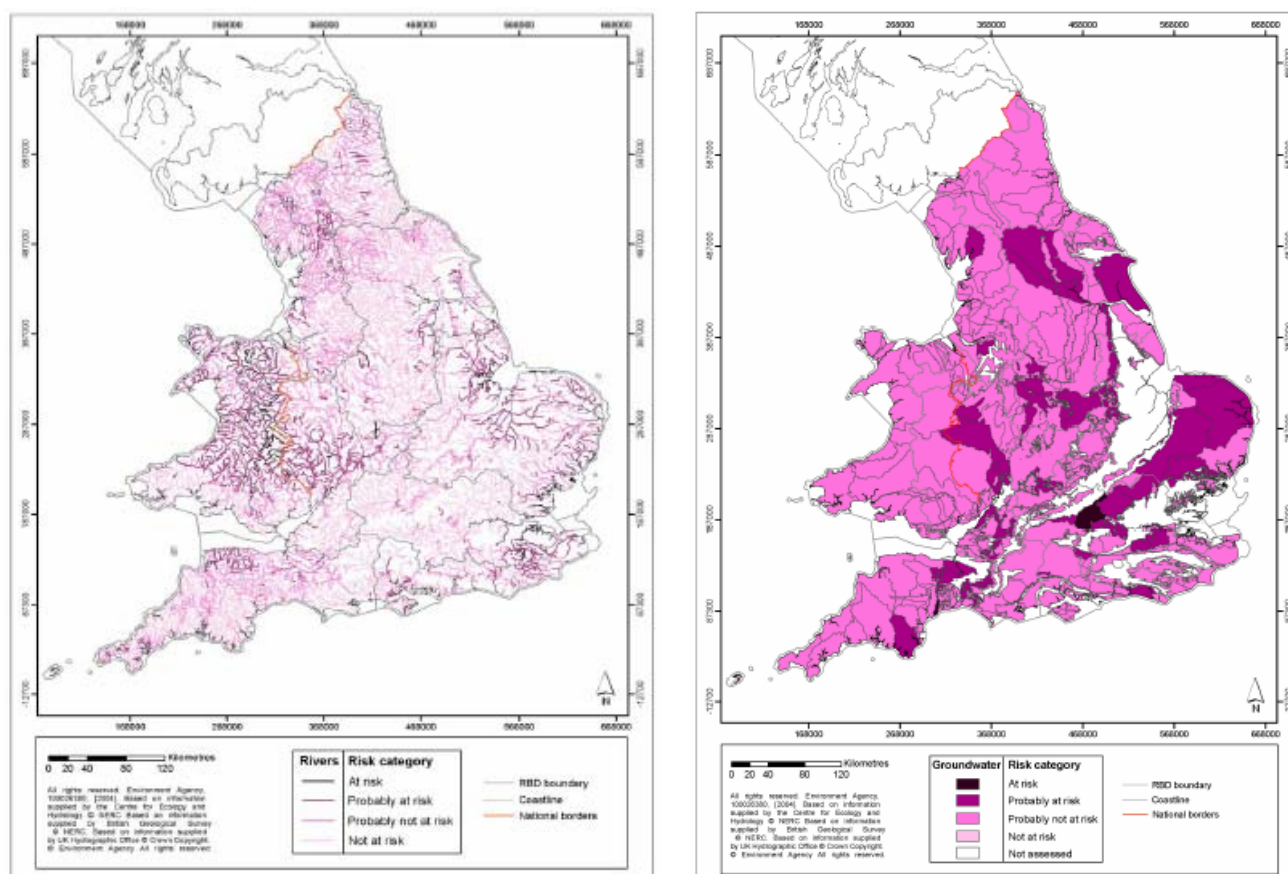


Figure 3. Rivers and groundwaters at risk of failing Water Framework Directive objectives due to pesticide pollution (Environment Agency, 2005a).

6.2 Costs of remediation

A number of studies and consultations have been commissioned/undertaken by Defra and the EA investigating the economic costs and potential benefits of WFD implementation.

The potential costs of measures aimed at pesticide reduction in surface waters has not been considered in isolation, but estimates for targeted action to address all pollutants in catchments most at risk from diffuse pollution have been quoted at £300-400 million (Marsden, 2004). The costs of addressing pesticide pollution alone would obviously be much less.

During the period of implementation there are likely to be increasing pressures for the Environment Agency to recover the costs of enforcing the provisions of the WFD directly from stakeholders, including the agricultural industry. However, the Agency's stated aim is to ensure full assessment of the costs of options before any decisions are taken on them in RBMPs including (Environment Agency, 2004c):

- Development of clear, agreed methods for the even-handed assessment of costs and economic impacts of options across the major sectors, including water industry and sources of diffuse pollution, such as agriculture and others.
- Development (in collaboration with the major stakeholders concerned) of clear pro formas for the sectors to provide and present estimates of the costs of options affecting them.
- Development of a clear process for independent validation of these cost estimates.
- Use of these costs of options, along with indications of their effectiveness, to prepare cost-effective packages of options for RBMPs for consultation with stakeholders and the public.

In spite of the above, the basic principle 'The Polluter Pays' (written in to the WFD) is likely to be adhered to where a suitable mechanism exists, meaning that the polluter should in general bear the cost of pollution prevention, control and remediation (Chave, 2001). However, this will be particularly challenging given that the true costs of diffuse pollution can be difficult to determine and apportion to particular sectors. How this might be applied to pollution of water bodies by agricultural pesticides remains unclear. It seems, however, that the Polluter Pays Principle (PPP) will not be enforced upon individual farmers anymore than it is today (Dave Martin, Environment Agency, pers. comm.) and it is therefore unlikely that prosecutions would be brought for diffuse pollution unless the Agency's monitoring network is expanded significantly in rural catchments. Moreover, regulatory policies relating to how the WFD will operate in the UK have not been established yet (John Batty, Environment Agency, pers. comm.).

Historically it has been very difficult to apply the PPP to agricultural water pollution due to the problem of establishing a definite link between the pollution and its source (Marshall, 1998). This is easier for relatively severe pollution incidents, for instance, large quantities of slurry entering a watercourse leading to discoloration, odour and fish kills. This may also be the case where farm ponds have been polluted by runoff from specific fields. Farmers should be aware that the WFDs focus on all water bodies may mean that these ponds receive greater interest from the EA in the future. Assigning a source down to the individual farm scale for pesticides detected in a river at concentrations in the $\mu\text{g/l}$ range, or below, is very difficult however. In reality, the same compounds are likely to have been applied to different areas of land and could be entering watercourses from any of these, which further complicates determining who the polluter is. Moreover, low levels of pesticides in water bodies are only ever likely to result in chronic ecological effects, making the presence of these substances in a water body less evident. A range of pollutants is also likely to be responsible for any ecological effect, not just pesticides. It is highly unlikely that the EA will have sufficient resources to implement a monitoring network to detect pesticides throughout a catchment on anything more frequent than a monthly basis, further reducing the likelihood of detections. Whilst the difficulty of assigning a source to diffuse pesticide pollution may severely limit the application of the PPP, this may increase the likelihood of a pesticide tax being implemented. Under this scenario, all farmers would collectively fund efforts to reduce the effects of these chemicals that have entered water bodies due to their use on farms.

6.3 Monitoring and standards

Management of chemical pollutants in RBDs will be by a combination of Environmental Quality Standards (EQSs) and emission controls. The new proposal for a Daughter Directive may introduce an EU level emission control regime for all substances, including pesticides, on the priority list. Failure of an EQS for a listed substance will cause that water body to fail good chemical status and, therefore, good ecological status. The Member State is then required to address the failure in its PoMs to restore the water body to good status. The basis of compliance is still to be agreed although earlier discussions at the EU level have favoured mandatory annual average concentrations with non-statutory maximum admissible concentrations. The regulatory regime for addressing failures has not been agreed in the UK yet, although additional monitoring is likely to be the starting point to establish further information on a problem once it has been identified (John Batty, Environment Agency, pers. comm.). The current standard of $0.1 \mu\text{g/l}$ may change once threshold values have been agreed for good status (European Union, 2003).

In addition to setting harmonised EQSs for water, the Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE) has also recommended that similar standards are set for sediments and biota, although no timescale has been proposed.

Artificial and heavily modified water bodies may not have to meet such stringent chemical and ecological quality. These include those waters that have been created or altered by human activity (Article 2(8)), such as agricultural ditches, reservoirs and channels modified for flood defence. Member States must still ensure that the highest ecological and chemical status possible is achieved however (Article 4(5)). It is, therefore, likely that pesticide

concentrations in agricultural ditches, as well as other artificial water bodies, will have to be below threshold values established for other waters.

7. Priority Substances

Key to controlling chemicals in the environment, including pesticides, are the defined 'Priority Hazardous' and 'Priority' substances lists. The WFD includes in its specific aims "the elimination of Priority Hazardous Substances" (para 27) and "to contribute to the progressive reduction of hazardous substances to water" (para 23). In order to do this, the Commission was required to identify a list of priority hazardous substances. A procedure called COMMPS (Combined monitoring-based and modelling-based priority setting) was devised by the Fraunhofer Institute in Germany. This list was based on an extensive scientific analysis of surface water and sediment data from the whole of Europe, and was mediated by a Europe-wide team of experts. This first list was based on the best scientific evidence available at the time of agreement (November 2001).

The list (Table 3) identifies 33 substances or groups of substances that have been shown to be of major concern for European waters. Within this list, 11 substances have been identified as Priority Hazardous Substances that are of particular concern for the inland, transitional, coastal and territorial waters. All Priority Hazardous Substances will be subject to cessation or phasing out of discharges, emissions and losses by 2020. A further 14 substances are identified as being subject for review for identification as possible Priority Hazardous Substances. The remaining 7 substances currently remain as Priority Substances. It is pertinent to note that atrazine and simazine are now only authorised for a limited number of essential uses and so are less likely to be found in the environment.

Although the currently identified Priority Hazardous Substances do not contain any pesticides, a number of the Priority Substances being reviewed are pesticides, including atrazine, chlorpyrifos, endosulfan, isoproturon and trifluralin and these may be upgraded to Priority Hazardous. Although outright banning of Priority Hazardous Substances is not stipulated, restrictions to use would mean that alternative chemicals would have to be used in agriculture. At this review, the status of all substances will be reviewed in the light of new data and it is, therefore, possible that further substances will be targeted for elimination or reduction in the environment.

Table 3. Current list of priority substances (pesticides highlighted).

	CAS number	Name of priority substance	Identified as priority hazardous substance
(1)	15972-60-8	Alachlor	
(2)	120-12-7	Anthracene	Under review
(3)	1912-24-9	Atrazine	Under review
(4)	71-43-2	Benzene	
(5)	n.a.	Brominated diphenylethers	YES
(6)	7440-43-9	Cadmium and its compounds	YES
(7)	85535-84-8	C ₁₀₋₁₃ -chloroalkanes	YES
(8)	470-90-6	Chlorfenvinphos	
(9)	2921-88-2	Chlorpyrifos	Under review
(10)	107-06-2	1,2-Dichloroethane	
(11)	75-09-2	Dichloromethane	
(12)	117-81-7	Di(2-ethylhexyl)phthalate (DEHP)	Under review
(13)	330-54-1	Diuron	Under review
(14)	115-29-7	Endosulfan	Under review
(15)	206-44-0	Fluoranthene (****)	
(16)	118-74-1	Hexachlorobenzene	YES
(17)	87-68-3	Hexachlorobutadiene	YES
(18)	608-73-1	Hexachlorocyclohexane	YES
(19)	34123-59-6	Isoproturon	Under review
(20)	7439-92-1	Lead and its compounds	Under review
(21)	7439-97-6	Mercury and its compounds	YES
(22)	91-20-3	Naphthalene	Under review

	CAS number	Name of priority substance	Identified as priority hazardous substance
(23)	7440-02-0	Nickel and its compounds	
(24)	25154-52-3	Nonylphenols	YES
(25)	1806-26-4	Octylphenols	Under review
(26)	608-93-5	Pentachlorobenzene	YES
(27)	87-86-5	Pentachlorophenol	Under review
(28)	n.a.	Polyaromatic hydrocarbons	YES
(29)	122-34-9	Simazine	Under review
(30)	688-73-3	Tributyltin compounds	YES
(31)	12002-48-1	Trichlorobenzenes	Under review
(32)	67-66-3	Trichloromethane (Chloroform)	
(33)	1582-09-8	Trifluralin	Under review

The remaining Priority Substances will also be subject to efforts to progressively reduce concentrations in the environment, and so it is likely that in the medium term these compounds will be targeted by RBD authorities. Farmers will, therefore, have to use replacement products. Moreover, the Commission will review the substances placed on the lists at least every four years (using the COMMPS process).

As control standards for all aquatic pollutants change, in particular as detection methods improve, and as scientific evidence evolves, there may be additions to the list of Priority Hazardous Substances. In the light of the history of these processes, it is unlikely that the list will become more liberal. It is uncertain, however, whether there will be a gradual increase in the number of substances on the Priority Hazardous Substances list or whether new substances will only be added as use of others is phased out or their negative impacts are successfully addressed. It will be important that PSD remains aware of the review of the COMMPS process, and its potential implications.

7.1 Metabolites

Although the WFD does not explicitly deal with metabolites, EC guidance (Sanco/221/2000 February 2003) on the treatment of metabolites under the Plant Protection Products Directive would seem to apply equally to the WFD. Pesticide metabolites are, therefore, only likely to be seen as important if they are present in the environment at significant concentrations, as defined in Directive 91/414.

7.2 Effects of chemical mixtures and sub-lethal effects

Due to the explicit need to define water quality in terms of ecological status, and also to protect wetland areas, we can anticipate a shift from simple concentration-based definitions of pollution. The immediate implication for pesticides is that we can expect an increasing emphasis on ecotoxicological information. In particular, we might anticipate the requirement for more information on pollution suites, rather than on single pesticides. Issues such as overall exposure rates may also become important.

Quantification of ecological status will not necessarily be linear across landscapes, we might, for example, expect very different standards for an upland salmon stream and a fen-land ditch. In order to do this, ecotoxicological information relating to specific habitats may be required.

Given that achieving good ecological status is the main focus of the WFD, it could be envisaged that the effects of pesticides on aquatic ecosystems could receive increasing scrutiny. Some research literature exists to show that effects are most likely to be due to mixtures of chemicals rather than single compounds. Additionally, even though individual substances may be present only at concentrations below those found to have measurable impacts, mixtures of these compounds may result in negative impacts. If good ecological status is not achieved in a particular catchment and concentrations of individual chemicals have not been above EQSs then RBDs may place increasing attention on factors such as chemical mixtures, pulsed exposures and sub-lethal effects. Although the literature indicates that it will be some years before these factors are considered in pesticide risk assessments, knowledge is developing in this area (e.g. Backhaus et al., 2003; Borgert et al., 2004; Cold and Forbes, 2004). It would therefore be pertinent for PSD to keep abreast of developments.

8. Conclusions

The Water Framework Directive (WFD) is the most significant piece of environmental legislation to be developed in recent decades, and places a statutory obligation upon Member States to ensure that water bodies are in good chemical and ecological status by 2015. Failure to do so may result in heavy financial penalties. Work to implement the Directive in the UK is well underway and achievements to-date include the establishment of River Basin Districts and their characterisation.

It is well accepted that meeting the goals of the WFD will require significant changes in land management. The agriculture sector will have to respond positively, given that farming uses 75% of the land area nationwide and is responsible for a good deal of the pollutants found in water bodies (Environment Agency, 2004d; Land Use Consultants, 2004). The development of new management regimes will, however, take place in full consultation with a wide range of stakeholders, including farmers, the agro-chemical industry and regulators (Environment Agency, 2004b).

A number of implications have been identified for the use of pesticides in agriculture. As the Competent Authority, the Environment Agency is likely to seek to reduce concentrations of those compounds most frequently detected in water bodies. A number of mechanisms may be used for doing this, including regulatory schemes, incentive schemes, voluntary actions and Programmes of Measures (POMs). POMs may include any of the aforementioned methods. A range of existing schemes may be used as part of these actions, including the new Single Farm Payment and agri-environment schemes (ELS and HLS), as well as the Voluntary Initiative (VI). Some of these are likely to be included in Environmental Management Systems for Farms (EMSF) when developed. Although still on hold at present, the possibility of a pesticide tax remains. Furthermore, the regulatory environment may change in the future, through tighter standards, the identification of new 'Priority Hazardous Substances' and the need to assess chemical mixtures and sub-lethal effects for instance.

The development of the National Pesticides Strategy, currently in draft form, will be key to confirming the direction that the Government, and thus the Environment Agency, will take in reducing pesticide pollution.

Appendix 1: Definitions

(As defined in the Water Framework Directive)

For the purposes of this Directive the following definitions shall apply:

- 1) "Surface water" means inland waters, except groundwater; transitional waters and coastal waters, except in respect of chemical status for which it shall also include territorial waters.
- 2) "Groundwater" means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.
- 3) "Inland water" means all standing or flowing water on the surface of the land, and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured.
- 4) "River" means a body of inland water flowing for the most part on the surface of the land but which may flow underground for part of its course.
- 5) "Lake" means a body of standing inland surface water.
- 6) "Transitional waters" are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows.
- 7) "Coastal water" means surface water on the landward side of a line every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters.
- 8) "Artificial water body" means a body of surface water created by human activity.
- 9) "Heavily modified water body" means a body of surface water which as a result of physical alterations by human activity is substantially changed in character, as designated by the Member State in accordance with the provisions of Annex II.
- 10) "Body of surface water" means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water.
- 11) "Aquifer" means a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.
- 12) "Body of groundwater" means a distinct volume of groundwater within an aquifer or aquifers.
- 13) "River basin" means the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta.
- 14) "Sub-basin" means the area of land from which all surface run-off flows through a series of streams, rivers and, possibly, lakes to a particular point in a water course (normally a lake or a river confluence).
- 15) "River Basin District" means the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3(1) as the main unit for management of river basins.
- 16) "Competent Authority" means an authority or authorities identified under Article 3(2) or 3(3).
- 17) "Surface water status" is the general expression of the status of a body of surface water, determined by the poorer of its ecological status and its chemical status.
- 18) "Good surface water status" means the status achieved by a surface water body when both its ecological status and its chemical status are at least "good".
- 19) "Groundwater status" is the general expression of the status of a body of groundwater, determined by the poorer of its quantitative status and its chemical status.

- 20) "Good groundwater status" means the status achieved by a groundwater body when both its quantitative status and its chemical status are at least "good".
- 21) "Ecological status" is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V.
- 22) "Good ecological status" is the status of a body of surface water, so classified in accordance with Annex V.
- 23) "Good ecological potential" is the status of a heavily modified or an artificial body of water, so classified in accordance with the relevant provisions of Annex V..PE-CONS
- 24) "Good surface water chemical status" means the chemical status required to meet the environmental objectives for surface waters established in Article 4(1)(a), that is the chemical status achieved by a body of surface water in which concentrations of pollutants do not exceed the environmental quality standards established in Annex IX and under Article 16(7), and under other relevant Community legislation setting environmental quality standards at Community level.
- 25) "Good groundwater chemical status" is the chemical status of a body of groundwater, which meets all the conditions set out in table 2.3.2 of Annex V.
- 26) "Quantitative status" is an expression of the degree to which a body of groundwater is affected by direct and indirect abstractions.
- 27) "Available groundwater resource" means the long term annual average rate of overall recharge of the body of groundwater less the long term annual rate of flow required to achieve the ecological quality objectives for associated surface waters specified under Article 4, to avoid any significant diminution in the ecological status of such waters and to avoid any significant damage to associated terrestrial ecosystems.
- 28) "Good quantitative status" is the status defined in table 2.1.2 of Annex V.
- 29) "Hazardous substances" means substances or groups of substances that are toxic, persistent and liable to bio-accumulate; and other substances or groups of substances which give rise to a equivalent level of concern..
- 30) "Priority substances" means substances identified in accordance with Article 16(2) and listed in Annex X. Among these substances there are «priority hazardous substances» which means substances identified in accordance with Article 16(3) and (6) for which measures have to be taken in accordance with Article 16(1) and 16(8).
- 31) "Pollutant" means any substance liable to cause pollution, in particular those listed in Annex VIII.
- 32) "Direct discharge to groundwater" means discharge of pollutants into groundwater without percolation throughout the soil or subsoil.
- 33) "Pollution" means the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment.
- 34) "Environmental objectives" means the objectives set out in Article 4.
- 35) "Environmental quality standard" means the concentration of a particular pollutant or group of pollutants in water, sediment or biota which should not be exceeded in order to protect human health and the environment.
- 36) "Combined approach" means the control of discharges and emissions into surface waters according to the approach set out in Article 10.
- 37) "Water intended for human consumption" has the same meaning as under Directive 80/778/EEC, as amended by Directive 98/83/EC.
- 38) "Water services" means all services which provide, for households, public institutions or any economic activity:

(a) abstraction, impoundment, storage, treatment and distribution of surface water or

groundwater;

(b) waste water collection and treatment facilities which subsequently discharge into surface water.

39) "Water use" means water services together with any other activity identified under Article 5 and Annex II having a significant impact on the status of water. This concept applies for the purposes of Article 1 and of the economic analysis carried out according to Article 5 and Annex III, point (b).

40) "Emission limit values" means the mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during any one or more periods of time. Emission limit values may also be laid down for certain groups, families or categories of substances, in particular for those identified under Article 16. The emission limit values for substances shall normally apply at the point where the emissions leave the installation, dilution being disregarded when determining them. With regard to indirect releases into water, the effect of a waste water treatment plant may be taken into account when determining the emission limit values of the installations involved, provided that an equivalent level is guaranteed for protection of the environment as a whole and provided that this does not lead to higher levels of pollution in the environment.

41) "Emission controls" are controls requiring a specific emission limitation, for instance an emission limit value, or otherwise specifying limits or conditions on the effects, nature or other characteristics of an emission or operating conditions which affect emissions. Use of the term "emission control" in this Directive in respect of the provisions of any other Directive shall not be held as reinterpreting those provisions in any respect.



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9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

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