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STUDY

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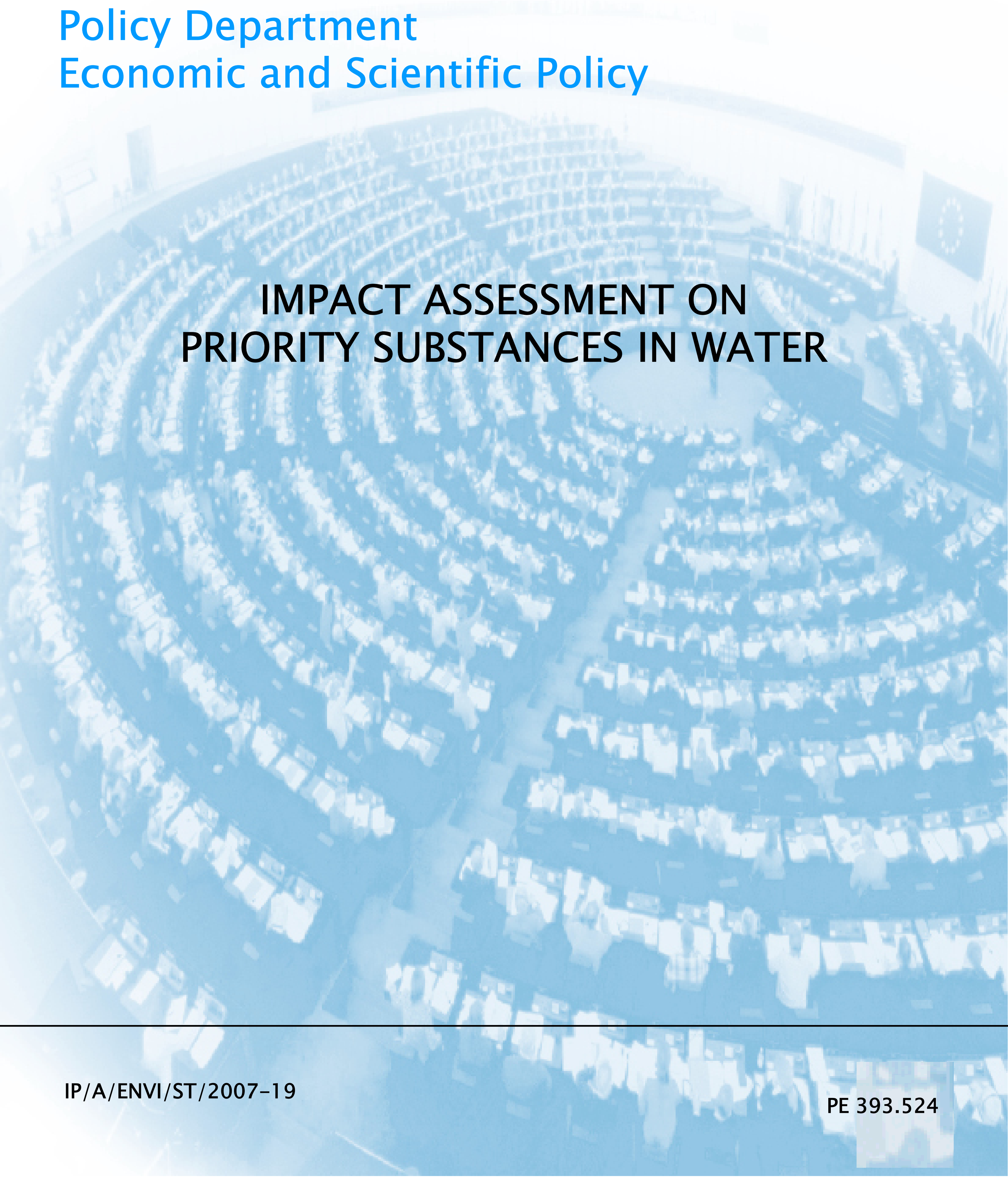

IMPACT ASSESSMENT ON PRIORITY SUBSTANCES IN WATER

IP/A/ENVI/ST/2007-19

PE 393.524

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1 EXECUTIVE SUMMARY

1 The present briefing on the “Impact Assessment on Priority substances in water” has been requested by the Environment, Public Health and Safety (ENVI) Committee of the European Parliament in the context of the Procedure 2006/0129 (COD).

2 Considering that water constitutes one of the key economic resources of Europe, water pollution represents a threat to economic development as well as to human health and to the environment. The Water Framework Directive (WFD), adopted in 2000, provided a number of responses to the threats posed by excessive concentrations of chemical substances in EU water.

3 In particular, Article 16 of the WFD sets out a strategy for dealing with chemical pollution of water. A list of priority substances was adopted (Decision 2455/2001/EC) identifying 33 substances of priority concern at Community level, due to their widespread use and their high concentrations in rivers, lakes and coastal waters. A subset of priority hazardous substances was identified: for these, more stringent environmental objectives apply because of their high persistence, bioaccumulation and toxicity.

4 In this context the Parliament envisaged the need to reconsider the pollutants covered, taking into account scientific and technical progress. An impact assessment of different policy options together with a consultation process with interested parties satisfies the requirements of Article 16 (5) of the WFD.

5 The European Parliament foresees a number of changes of classification of substances. More than two dozen substances have been put onto a list for future revew in order to assess whether they should be considered priority substances or priority hazardous substances, or whether no regulatory changes are required.

6 The purpose of the work is to assess the likely impact on Member States, on Commission resources and on Community funds of these possible changes of classification and of future assessment of the substances. An assessment has been made of the foreseen environmental and economic impact of those changes.

7 Our approach to this work, following the guidance of the Request for Study, comprised the following steps:

(a) Highlight the possible economic effects of the proposed changes, through case studies;

(b) calculate the environmental impact of the changes envisaged in the policy proposal using a methodology similar to Life Cycle Impact Assessment (LCIA);

(c) study the consequences for the waste water treatment and the water supply sector; and

(d) analyse the administrative and financial consequences for Member States and for the European Commission, in case of final adoption of the changes to the lists.

8 In our impact assessment we have divided the substances into two groups:

(e) the Priority Substances candidates (that include the pollutants under review), and

(f) the Priority Hazardous Substances candidates.

9 The results of our Impact Assessment, which should be interpreted with caution and keeping in mind the simplifying assumptions made, were:

(g) The environmental benefits of declaring Priority the candidate pollutants is quantitatively similar to the benefit of declaring Hazardous the Hazardous candidates substances:

(h) There are marked differences in the health impacts of the two classes of substances. The ban of Hazardous substances would have an impact in the region of €2 to 3 million per year while the reduction in the emission of priority substances would have a potential benefit in the region of €340 to €480 million per year.

(i) Case studies conducted show that the economic cost of phasing out Hazardous substances' emissions would be very high, especially if all of them are banned together, because of substitutability problems, especially in the agricultural sector. For example phasing out only atrazine could cost €25 ml per year. If atrazine and alachlor were banned together the cost would be much higher.

(j) The economic cost of declaring the proposed pollutants priority substances would be much smaller and in many cases moderate, due to different industries research, already in place, to reduce emissions of dangerous pollutants.

10 However, given the high uncertainties of the estimates as well as the numerous data gap it is impossible to derive definitive conclusions from this analysis. We recommend that the parliament commissions a full impact assessment study that can shed additional lights on the costs and benefits associated with this proposal.

1 INTRODUCTION

1.1 The present briefing on the “Impact Assessment on Priority substances in water” has been requested by the Environment, Public Health and Safety (ENVI) Committee of the European Parliament in the context of the Procedure 2006/0129 (COD).

1.2 This section sets this impact assessment into context.

The Problem

1.3 One of the main threats to water quality is pollution resulting from inputs of chemical substances. These can be naturally occurring (such as metals) or can be man-made (pesticides, for example)

1.4 There are more than 30,000 chemicals produced in and marketed in the EU. In addition some chemicals are not produced intentionally, but they are the results of other human activities (e.g. dioxins or polyaromatic hydrocarbons).

1.5 Such substances can be very dangerous. They can reach an aquatic environment in a variety of ways, including:

(a) direct discharge from industry or waste water treatment;
(b) indirect discharge through the use of plant protection products;
(c) trough leaching from landfill sites; or
(d) as a fall-out (atmospheric deposition).

1.6 One example of the negative impact these substances can have is arises if they enter into rivers or lakes which are used for the abstraction of drinking water. Technology is available to preserve the safety of drinking water, but is often expensive and reflected in higher water prices.

1.7 Another example is the accumulation of hazardous substances in fish. There are many international studies illustrating current environmental and human health concerns about the chemical pollution of fresh and marine waters.

1.8 Considering that water constitutes one of the key economic resources of Europe, water pollution represents a threat to economic development as well as to human health and protection of the environment. Supply of drinking water and water for other domestic, agricultural and industrial purposes are strongly hit by chemical pollution. Future economic development will further increase the dependence of Europe on water resources, and in many areas has already created more intensive pressure. Further, many natural areas of rivers, lakes, estuaries and coastal waters help promote tourism, and provide outlets for recreational activities such as angling, swimming and boating. Water pollution can thus have very widespread impacts.

1.9 Regulation of chemical pollution is not an easy task and can sometimes be ineffective, for a number of reasons:

(a) First, the number of potentially hazardous substances is considerable and can further expand (to minimize this risk, a dynamic and iterative regulatory approach is required).
(b) Second, many of the substances of highest concern persist in the environment for a long time and so, even if they are banned, those released in the past will continue to be found in the environment for many years later.
(c) Thirdly, lack of implementation and defiance of regulations can reduce their bite.

Regulatory Framework

1.10 The community first adopted legislation regarding chemical pollution of waters in 1976 (Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community). Subsequently, several "Daughter Directives", from 1982 to 1990, have set specific limit values and environmental quality objectives for a list of pollutants.

1.11 The Water Framework Directive (WFD), adopted in 2000, incorporated and updated this long term policy into a modern and flexible response to the threats posed by excessive concentrations of chemical substances in EU water.

1.12 In particular, Article 16 of the WFD sets out a strategy for dealing with chemical pollution of water. A list of priority substances was adopted (Decision 2455/2001/EC) identifying 33 substances of priority concern at Community level, due to their widespread use and their high concentrations in rivers, lakes and coastal waters. A subset of priority hazardous substances was identified: for these, more stringent environmental objectives apply because of their high persistence, bioaccumulation and toxicity.

1.13 The WFD requires the achievement of "good chemical status" by 2015 as a rule, but there are cases where deadlines can be extended or objectives lowered. In addition to this principal objective, there are requirements for "no deterioration" of water quality and the obligation for Member States to progressively reduce pollution from priority substances and to cease emissions, discharges and losses of priority hazardous substances.

1.14 As a next step the commission was required to come forward with Environmental Quality Standards (EQS) and emissions controls for priority substances. The proposal 2006/0129 (COD) to amend the WFD Directive implements this obligation with the exception of introducing additional emissions controls. At the same time this proposal includes repeal of the existing "daughter directives". As stated in the proposal for a review of the Directive "From the point of view of Community interest and for a more effective regulation of the surface water protection, it is appropriate that EQS are set up for pollutants classified as priority substances on Community level and to leave to the Member States to lay down, where necessary, rules for remaining pollutants on national level subject to the application of relevant Community rules".

1.15 As pointed out by the Commission (2006): "good chemical surface water status is achieved in a water body if concentrations of pollutants do not exceed the relevant EQS established at Community level".

1.16 In this context the Parliament has envisaged the need to periodically reconsider the pollutants covered, taking into account scientific and technical progress.

1.17 Impact assessment of different policy options, together with a consultation process with interested parties satisfies the requirements of Article 16 (5) of the WFD.

1.18 The present study addresses the first point with regard to the changes in the classification of a number of substances and to the creation of a future revision list.

1.19 The proposed changes and the revision list can be found in the European Parliament legislative resolution of 22 May 2007, co decision procedure, first reading: 9 pollutants are candidates to become priority substances, 11 to become priority hazardous substances, and 28 substances have been put in a future revision list.

Our approach

1.20 Our approach to this work, following the guidance of the Request for Study, comprised the following steps:

(a) Highlight the possible economic effects of the proposed changes, through case studies;
(b) calculate the environmental impact of the changes envisaged in the policy proposal using a methodology similar to Life Cycle Impact Assessment (LCIA);
(c) study the consequences for the waste water treatment and the water supply sector; and
(d) analyse the administrative and financial consequences for Member States and for the European Commission, in case of final adoption of the changes to the lists.

1.21 In our impact assessment we have divided the substances into two groups:

(a) the Priority Substances candidates (that include the pollutants under review), and
(b) the Priority Hazardous Substances candidates.

1.22 The remainder of this report is as follows:

(a) Section 2 deals with the effects on the economic system
(b) Section 3 presents our analysis of the possible effects on the environment and on human health
(c) Section 4 analyzes the case of Dutch water industry to highlight possible effects on the waste water treatment sector and, finally
(d) a full toxicological review for each substance is reported in Appendix 1.

2 ECONOMIC ASSESSMENT

Major steps

2.1 In order to assess the economic impacts of the proposed changes we relied on a literature review of the available studies and a number of case studies for the substances subject to review.

Literature review

2.2 We collected an extensive number of studies and data which are relevant to the economic assessment under consideration. The following studies, among others, have been used:

(a) EU relevant documents on relevant regulations and impact assessment including:

- European Commission (2006) : "Impact Assessment: Proposal for a Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC;
- Study report on "Assessing economic impacts of the specific control measures for priority substances and priority hazardous substances regulated under Article 16 of the Water Framework Directive" carried out by ECOLAS;
- RPA (2000), *Socio-Economic Impact of the Identification of Priority Hazardous Substances under the Water Framework Directive, Study on behalf of the DG ENV*;
- DEFRA (2002), *Regulatory Impact Assessment – Priority List of Substances Under Article 16 of the Water Framework Directive*;
- Study report on "Proposed environmental quality standards for priority substances current compliance and potential benefits" carried out by WRc.
- Documents related to the consultation process between the Commission and Stakeholders;

(b) Relevant documents and impact assessments for different substances, from different sources among which the European Chemical Bureau;

(c) Public domain studies or data sources on the health and environmental implications of the chemicals under the proposed revision, including:

- the potential channels or routes of exposure to these chemicals;
- the impacts on health;
- the magnitude of such impacts;
- the environmental implications;

(d) Public domain studies or data sources on

- the EU water and waste water treatment sector;
- the production technologies and costs with reference to the use of the chemicals falling under the proposed revision in different industries;

2.3 These studies provided useful insights and a considerable amount of information. However, they clearly represent a second best opportunity in with respect to the gathering of primary data. Ideally questionnaires should have been designed and sent to different industries sectors and EU Member States to collect data to quantify the economic, environmental and social impacts of the proposal. However previous studies experience has shown that only limited information was obtained trough questionnaires. Therefore all Impact Assessment studies carried out in this field should be treated with caution given the lack of objective data on which they can be based.

2.4 Finally, given the time and budget constraints of this project, the questionnaire approach was not feasible. Hence we adopted a case study approach.

Case studies

2.5 The selection on the substances to analyse has been based on the criterion of reaching a balanced view of the impacts of the proposal: case studies are targeted to cases that are representative. We also tried to select substances for which we had more data to complete the environmental assessment, again to give the most possible complete insights on the effects of the proposed changes.

2.6 The last criterion of selection has been data availability, which of course may be associated with a risk of biasing the case studies towards those substances that are better known. However, many of the substances (especially those in the review list) are not currently monitored and it is difficult, if not impossible to find information on the current level of emissions. This has been confirmed by the experts we contacted to carry out the assessment.

2.7 A first assessment of the expected economic impacts at substance level has been made on the results (when available) of two previous economic assessments by RPA (2000) and DEFRA (2002). EU BREFs documents for sectors under consideration and EU Risk Assessment Reports and Risk reduction Studies have been widely used together with the EPER database and the Haskoning data sheets. Information has been integrated, when possible, with telephone interviews with experts and industry representatives.

2.8 Due to the large data gap and to time constraints the procedure used to assess costs for different options has the transfer of results from similar studies. This made the definition of scenarios not straightforward.

2.9 Substances covered by case studies include:

- Atrazine
- Alachlor
- Diurion
- Trifluralin
- Lead and its compounds
- Aldrin
- Endrin
- DDT
- AMPA
- Glysophate
- Bentazone
- Mecaprop
- Dicofol
- Bisphenol A
- Perifluorinated compounds.

2.10 Sectors covered include:

- Agriculture
- PVC
- Aluminium production
- Paper
- Semi-conductors.

Priority Hazardous Substances candidates

Atrazine

Production Profile

2.11 There is one, relatively small producer of atrazine in the EU. The remaining amounts are imported, particularly from the US. It is estimated that around 700 tpa are produced in the EU (based upon information in ECPA).

2.12 There are 11 companies reported to be producing/supplying atrazine in the Chemicals and Companies Database (RSC, 1998).

Market profile

2.13 Sales of atrazine in the EU are wound 2,000 tpa based upon sales projections for 2001 (ECPA, 2006b)

2.14 Atrazine is used on a variety of crops as an herbicide. It is reported to be authorised for use in member states except Finland, Sweden, Denmark, Italy, Germany and Austria (CEC, 2000d). Its use within other Member States is also restricted (Whitehead, 1999).

2.15 It has selective herbicidal for the control of broadleaf and grassy weeds on cropped land but also acts as a non-selective herbicide on non-cropped land.

Economic assessment

2.16 The scenario considered refers to the ban of atrazine. Actually this scenario allows us to study the possible effects of a complete phase out of the emissions since the substance under consideration can reach water, not only trough industrial discharges from producers but also trough indirect losses (the majority of releases happen trough dispersive use) from plant protection, trough leaking from landfill sites and as a fall-out (atmospheric deposition). The ban is likely to lead to the closure of many production plants (according to the ECOLAS study), while the phase out of emissions is likely to significantly increase their costs

2.17 Ideally, a study of the value of atrazine should compare the current economics of crops production using atrazine with the next-best alternative available to crop growers if atrazine were banned. The difference between these two scenarios would be the appropriate measure of the value of atrazine. Different studies on the US offer a quite incomplete economic picture; thus it is useful to start by outlining the components of a complete analysis. In the scenario without atrazine, several aspects of farm revenues could change, with contradictory effects on farmers' bottom line:

- Farmers would buy and apply other herbicides, potentially increasing costs per acre.
- Yields per acre could decrease, if the other herbicides were less effective.
- Acreage planted in crop could decrease, if corn production became less profitable.
- The market price of corn could increase, if production decreased.
- Acreage withdrawn from crop production could be used to grow other crops, generating additional revenue.

The first three effects represent losses for farmers, or decreases in net farm income. The last two, in contrast, represent increases in farm incomes. It is not clear, a priori, which effects would predominate: gains from the increased price of corn, plus revenues from expansion of other crops, might or might not outweigh the more obvious costs of farming without atrazine.

2.18 There are not, to our knowledge, available analytical studies on the costs of banning atrazine in the EU context. DEFRA (2002) estimated a significant impact of a reduction in emissions of atrazine.

2.19 Estimates for the UA have suggested that a ban could cost producers and consumers US$517 (short term) to US$665million (long term) for their annual use of 80 to 90 million pounds[1] per annum. This would equate to 33m EUR for the use in the EU (if the cost per tonne of atrazine were the same). The US costs estimates were based upon an economic model which predicted effects such as a shift away to more costly weed control strategies and decreased corn yields (Ribaudo and Bouzaher, 1994).

2.20 A relatively complete study of the economics of banning atrazine, estimating all five effects, was performed for a 1994 USDA report. Using 1991 data, this study applied Iowa State University's CEEPES (Comprehensive Environmental Economic Policy Evaluation System) suite of models to simulate the effects of pesticide bans and other policies on a multi-state growing area that includes more than 80 per cent of U.S. corn acreage. For the ban on atrazine, the study projects:

- Increased herbicide costs of $1.08 per acre
- Yield losses of 1.19 per cent, or 1.3 bushels per acre
- A decrease in corn acreage of 2.35 per cent, or 1.7 million acres
- A 1.83 per cent increase in the price of corn
- Increases of 1.5 million acres planted in soybeans and 0.1 million acres in wheat— almost exactly absorbing the reduction in corn acreage

2.21 The net loss to farmers (of ten major crops, not just corn) of $269 million is outweighed by gains of $287 million for government support programs; combining the two, there is an $18 million gain to suppliers as a whole (farmers plus the government) from banning atrazine. Thus the fourth and fifth effects —the benefits of the price increase and the expansion of other crops— were estimated to be slightly more valuable than the revenue lost to increased herbicide costs, yield losses, and decrease in corn acreage. The study estimated the loss to domestic and foreign consumers, who would face higher prices for corn-based products such as beef and corn syrup, at $258 million. The aggregate economic effect on society is therefore a loss of $240 million— equivalent to $355 million in 2006 dollars. This would equate to 17.5m EUR for the use in the EU (if the cost per tonne of atrazine were the same). Not all studies have been this complete. Other, more recent, studies consider only the first two of the five effects, the costs of alternative herbicides and the impact on yields.

2.22 For example an EPA study, published in 2002, estimates the cost of banning atrazine five times the estimate from USDA and a study conducted by the Triazine Network gives similar results.

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[1] A pound is equivalent to 0.454 Kg

2.23 Possible alternatives to atrazine are reported to include cyanazine, simanzine and bromoxynil (DETER, 1996). Their efficacy and economic implications have not been examined. It should be noted that simanzine is also a PS and thus the overall implications could be greater if both atrazine and simanze were to become PHSs.

2.24 Enforcement costs could be considerable.

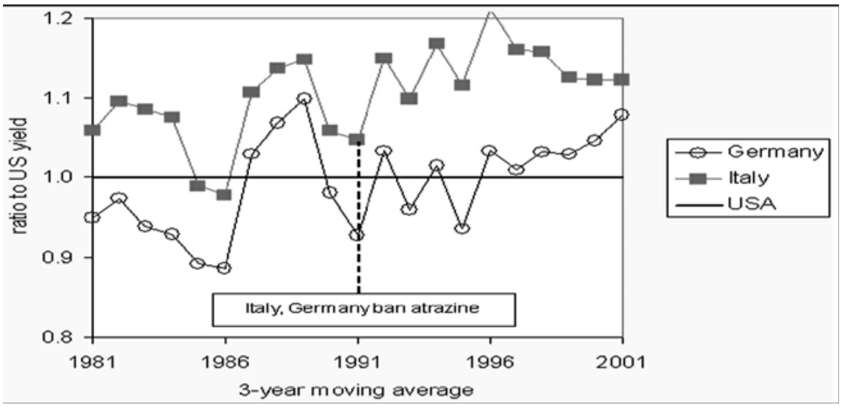
The natural experiment

2.25 Several European countries moved to ban atrazine on their own well before the EU decision. Sweden, Finland, and Denmark had all banned atrazine by 1994, but none of these countries is a significant corn (maize) producer.

2.26 More remarkable, and more informative for economic analysis, is the fact that two countries that produce millions of tons of corn, Italy and Germany, both banned atrazine in 1991. Italy adopted the European Union's Drinking Water Directive in 1985, earlier than many EU nations. It soon became clear that pesticides in the groundwater used for drinking in many areas exceeded allowable levels. This was particularly true in the fertile Po river valley, where atrazine was commonly used on corn and rice. Since more than 80 per cent of farmers in northern Italy get their drinking water from groundwater, public concern about the safety of their water supplies may have been particularly strong. By 1987 the Italian government had to shut off drinking water to some parts of northern Italy to comply with the pesticide standards, resulting in public outrage. Trying to lower pesticide concentrations, the government enacted several temporary bans on atrazine use, at first only in areas where the chemical was found in unacceptable concentrations. After a few years of temporary and/or local bans, the ban on selling atrazine became permanent national policy in 1991. Germany, another corn producing nation, had also banned atrazine by 1991.

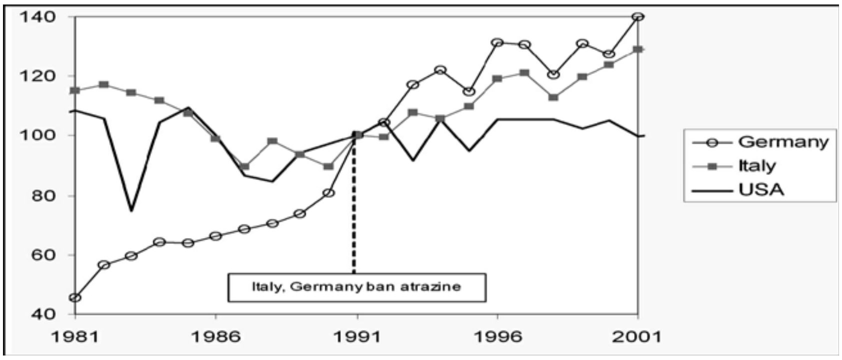
2.27 These public policy decisions provide a natural experiment. While Italy and Germany both banned arazine in 1991, the United States continued to allow its use. If atrazine is crucial to corn yield or profitability, then the data for Italy and Germany should look worse, relative to the United States, after 1991 than before. More specifically, if the ban on atrazine had negative effect on corn producers, then either yields or harvested areas, or both, should be depressed by the loss of that herbicide in Italy and Germany after 1991. Conversely, the United States, where atrazine remained available, should look relatively better on one or both of these measures after 1991.

Figure 2.1: Corn yields relative to the United States



Source: Ackerman (2007)

Figure 2.2: Corn, area arvested (1991=100)



Source: Ackerman (2007)

2.28 As can be seen in Figure 2.1 and Figure 2.2, a comparison of international data provides no support for the hypothesis that banning atrazine in 1991 harmed corn production in either Italy or Germany. Both graphs are based on the FAO's ProdSTAT database.

2.29 For yields the trend is upward in all three countries. Figure 2.1 shows no signs of yields dropping in Germany or Italy after 1991, relative to the US yield- as would be the case if atrazine were essential.

2.30 Figure 2.2 highlights that Italy and Germany experienced faster growth in harvested areas after banning atrazine than before. The United States, in contrast, shows no upward trend in the decade after 1991. This is just the opposite pattern that would be expected if atrazine made a major contribution to the profitability in corn.

Conclusions

2.31 The cost of phasing out atrazine emissions seems moderate. It could become significant if its potential substitutes are banned as well. Costs for the society as a whole range from 17 to 33 m€ per year., however there is a high level of uncertainty.

Alachlor

Production profile

2.32 Only one supplier of alachlor, based in Germany, is listed in the Chemicals Companies database.

2.33 The Chemical Directory (CIA, 2000) lists two producers within the EU and one additional supplier. The production volume is larger than 1000 tpa.

Market profile

2.34 Alachlor is authorised in five Member States at the present time: France, Spain, Portugal, Italy and Greece (CEC, 2004). Based upon this pattern, it seems to be most suited with warmer climates. Alachlor is used as an herbicide on crops such as corn, cabbage and cotton.

2.35 No information has been found on quantities used or produced in the EU, nor on the associated values. However, an estimated 6,000 to 7,000 tpa are used un the US.

Economic assessment

2.36 The scenario considered refers to the ban of alachlor. Actually this scenario allows us to study the possible effects of a complete phase out of the emissions since the substance under consideration can reach water not only trough industrial discharges from producers but also trough indirect losses from plant protection, trough leaching from landfill sites and as a fall-out (atmospheric deposition).

2.37 A complete study on value of alachlor should move on the lines outlined for a study on atrazine, considering different potential impacts on farmers' income, prices, consumers and yields.

2.38 DEFRA (2002) estimated a low impact of reduction in emissions of alachlor.

2.39 A study by Xepapadeas (1991) estimates that bans on Alachlor should have a smaller economic impact on farmers and probably involve lower enforcement costs than those for Atrazine, since there are a number of good substitute herbicides.

2.40 However, when Alachlor was banned in Canada, the chemical firms exhibited opportunistic behaviour and raised the price of the substitutes by over 15 per cent, which significantly increased the cost of weed control. If both Atrazine and Alachlor are banned, the drop in net returns would be somewhat greater than for just Atrazine or Alachlor alone, because of limited substitutes. The loss in net returns to farmers would be even higher if cropping system changes are required to improve weed control, particularly when substantial new capital investments are required and existing capital assets have few alternative uses (high asset specificity and low salvage values). Farm asset fixity or specificity raises the transaction costs of making major changes in farming systems. Thus enforcement costs for a ban on both Atrazine and Alachlor could be high. The ban could also have a differential impact regionally. For example, regions with good rainfall and better weather conditions for a range of different herbicides to be used to control weeds, will suffer lesser economic costs. Thus bans on selected herbicides may put certain countries at a competitive disadvantage and farmers would have greater incentives not to comply, which could raise enforcement costs.

2.41 Cox and Easter (1990) estimate that the impact on US farmers using conventional tillage practices of a ban of alachlor would be a reduction of 10 per cent in the net return, assuming good weather (1 per cent assuming bad weather). Hence, a ban of alachlor can have important heterogeneous distributive effects on countries with different climate conditions. These conclusions can be, with some caveats, applied to Europe.

2.42 Fox suggested that the ban of Alachlor in Canada could lead to a 35 per cent increase in the price of other grass herbicides, which would reduce producers' surplus by $2.6 to $6.2 million per year.

2.43 A study of by Viscusi, Hakes and Carlin (1997) estimates that a joint bans of alachlor and atrazine would have a cost of 247 billions, which would equate 12 billions EUR for Europe, under reasonable assumptions.

Conclusions

2.44 The cost of phasing out alachlor emissions seems moderate. It could become significant if its potential substitutes are banned as well. There could be important redistributive effects among regions.

2.45 However, if both atrazine and alachlor are banned together the cost to society could be as high as €12 billion per year given the lack of substitutes. There is a high level of uncertainty on these estimates.

Diurion

2.46 Diuron is produced from 3,4- dichloroaniline and, through degradation in the environment, it may also be a source of this substance via biological degradation (however, this has not been confirmed). Other phenylurea herbicides are also produced from 3,4-DCA, such as linuron, propanil and neburon.

2.47 3000 tonnes per year are, with only one producer in the EU25.

2.48 Phase out of discharges is likely to incur significant costs for the production site (ECOLAS, 2005). Ban on use is likely to lead to the closure of the production facility. Economic consequences similar to the other herbicides studied. DEFRA (2002) finds similar results

Simanzine

2.49 There is one production site (in Italy) producing 300 tpa. There is one additional company that sells simanzine which is imported from the US.

2.50 Like atrazine, simanzine is the triazine group of herbicides which are used largely to control broadleaf weeds. It is used on crops such as corn, fruit (e.g. grapes and citrus) and nuts, as well as in certain non-agricultural applications as lawns.

2.51 Given the relatively small level of use as compared to other herbicides, the cost implications of emissions phase out and possible ban are likely to be of similar nature but of a much smaller scale.

Trifluralin

2.52 Trifluralin is reported to be authorised for use in all Member States except Sweden, Denmark and the Netherlands (CEC, 2000d). It is one of the major herbicides and is used to control annual grasses and many broad level weeds in a wide range of fodder, cereal, vegetable, oilseed and soft fruit crops including a range of minor uses that are important to the horticultural industry. It is reported by industry to provide inexpensive weed control in crops which have low profit margins.

2.53 It is reported that the key applications for Trifluralin are sunflowers and oilseed rape (OSR). In France it is used on over half of the areas growing these crops (400,000 ha and 700,000 ha respectively). It is also used widely in fodder peas, small grains and various vegetables and fruit crops.

2.54 An estimated 3,200 tonnes were applied in Europe in 1999 (including non-EU countries). The level of use is reported to be reasonable static.

2.55 Possible alternatives include cyanazine, carbetmide, propyamide. There are possibly higher environmental impacts with some of these substitutes.

2.56 Industry reported that the key problem with finding alternative herbicides, are with the two applications: sunflowers and oilseed rape. The main problem is in terms of finding broad leaf herbicide suitable for post-emergence use, for which industry report that there are few alternatives.

2.57 There are two production sites in the EU25 (Hungary and Italy). Six EU- based suppliers are reported in the Chemical and Companies Database (RSC, 1998).

2.58 The above facilities are reported by industry to form part of a global supply chain. A phase out in the EU would be likely to lead to a sizeable loss of exports and employment. In addition phase out of discharges is likely to incur significant costs for the production site (ECOLAS, 2005). Ban on use is likely to lead to the closure of the production facility. Economic consequences would be similar to the other pesticides studied, but of greater magnitude due to the problem of substitutability. DEFRA (2002) finds similar results.

Lead and its compounds

2.59 Marketing and use restrictions have been introduced for the use of lead in most paints through Directive 89/677/EEC. Limit values for lead in drinking water and sewerage sludge have been introduced as well as legislation regarding lead in ambient air. Batteries containing lead are also covered by Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances.

2.60 A phase out on the use of lead in petrol has been agreed under the UN-ECE protocol.

2.61 There are also various risk management activities in place concerning a number of applications and possible concerns (at the European or national level). These are considered in detail in a report by the OECD (1999) and include the following:

(a) Lead in petrol (generally being phased out);
(b) Exposure of children (migration limits from consumer products);
(c) Prohibition of use in some food packaging;
(d) Concentration found in ceramics;
(e) Prohibition of the use of lead shot in some areas;
(f) Drinking water limits;
(g) Limits in packaging and packaging waste;
(h) Occupational exposure limits; and
(i) Reduction of emissions to air and limits in ambient air.

2.62 EU production of lead was 1,556,000 tonnes in 1999 of which 652,000 tonnes was primary production and 904,000 tonnes was from recycling (Euromax, 2000).

2.63 Total consumption of refined lead was 1,703,000 tonnes in 1999 and an additional 120,000 tonnes was recovered from secondary materials and used directly in products. Total consumption was around 1,820,000 tonnes (Eurometeux, 2000).

2.64 In terms of lead stabilisers, around 112,000 (around 3 per cent of the total lead consumption) tonnes were used in Europe in 1998, containing about 51,000 tonnes of lead metal and representing 70 per cent of total stabilizer consumption.

2.65 As with other metals, there are various non-intentional emissions since lead is naturally occurring and is a constituent of various substances. It would essentially be impossible to totally cease emissions of lead without having extensive economic implications.

2.66 There are reported to be no substitutes available for other applications, such as some (but possible not all) uses of lead as a stabiliser. For example, calcium/zinc stabilisers can be used for some applications but with increased costs with reduced efficiency in some cases (depending on the application in question).

2.67 Both RPA's (2000) and DEFRA (2002) estimate extensive and significant economic impact from reducing lead emissions, especially on NF metals and batteries industries. The ECOLAS study on NF industry found similar results: even reducing lead emissions by 50 per cent by 20015 and by 80 per cent by 2021 would cause huge cost increases and job losses in NF industry.

2.68 As with other metals, there are various non-intentional emissions since lead is naturally occurring and is a constituent of various substances. It would essentially be impossible to totally cease emissions of lead without having extensive economic implications.

Priority Substances candidates

Aldrin, Dieldrin, Endrin, DDT, AMPA, Glyphosate, Bentazon, Mecoprop, Dicofol

2.69 Aldrin, Dieldrin, Endrin and DDT belong to the same family of pollutants (Persistent Organic Pollutants, POPs), they are all used in the agriculture as insecticides or for plants disease control and they fall under the Stockholm Convention, signed by 122 countries.

2.70 They are studied together with Glyphosate, Bentazon, Mecoprop because their similar economic use and because the economic impact of a reduction in their emissions turns out to be quite similar.

2.71 Aldrin is an insecticide primarily used against soil and crop pests, such as corn rootworm, wireworm, rice water weevil and grasshoppers. Aldrin is most commonly used on corn, potato and cotton crops. It is used also used to protect wooden structures from termites. Aldrin readily converts to dieldrin in plants and animals and, therefore, residues of this chemical are usually found in small amounts. Aldrin has low toxicity to plants, but has adverse effects on aquatic invertebrates, particularly insects. Acute exposure to aldrin has caused death in waterfowl, shorebirds, fish and humans. The International Programme on Chemical Safety (IPCS) estimates the fatal dose for humans to be five grams. The most common human exposure pathway is via food, particularly dairy products and meat. Aldrin has been banned or severely restricted in many countries.

2.72 Dieldrin is an insecticide used against termites, textile and agricultural pests, and insect vectors of disease. The main crops treated with dieldrin include corn, cotton and potato. The use of dieldrin as a vector control has been banned in some countries because of concerns related to the environment and human health. Dieldrin has low toxicity to plants but high toxicity to insects, fish and aquatic animals (frog embryos, for example, have been noted to develop spinal deformities when exposed to dieldrin). Toxic effects on birds and mammals vary. Dieldrin is suspected of negatively affecting the immune response in humans. Humans are exposed to dieldrin through food (mainly dairy products and animal meats). It’s important to note that because aldrin easily converts to dieldrin in plants and animals, levels of dieldrin reflect total concentrations of both chemicals.

2.73 Endrin is an insecticide used against pests of cotton, rice and corn. It has also been used as a rodenticide to combat mice and voles. Many animals can metabolize Endrin. Therefore, it does not accumulate as severely as some of the other persistent organic pollutants. However, endrin is highly toxic to fish and other aquatic organisms. Endrin is suspected of suppressing the human immune system. As with many of the other POPs, humans are exposed to endrin through their diet, although intake levels are usually noted to be very low.

2.74 DDT was broadly used during World War II to control insects (namely mosquitoes) that spread diseases such as malaria, dengue fever and typhus. After the War, DDT was also used on agricultural crops such as cotton. DDT is still used in many countries to control insect vectors that carry disease. Concerns about the serious environmental effects of DDT, particularly on birds, resulted in many countries banning or severely restricting its use in the 1970s. DDT's breakdown products include DDD/TDE and DDE, each of which possesses its own toxic characteristics. DDT is highly toxic to fish, causing severe behavioral changes and death. Acute toxicity of DDT in birds has been observed to affect reproductive success (for example, it causes eggshell thinning in birds of prey). The long-term chronic health effects of DDT on humans include immune system depression and estrogen-like alterations during reproductive development. DDT and its metabolite DDE are listed as possible human carcinogens, particularly as regards hormonal cancers, such as breast cancer.

Humans are mainly exposed to DDT through their food; in fact DDT has been detected in food and breast milk all over the world. To date, 34 countries have banned DDT and 34 have severely restricted its use.

2.75 Glyphosate is a broad-spectrum herbicide used in both agriculture and forestry and for aquatic weed control. Microbial biodegradation of glyphosate occurs in soil, aquatic sediment and water, the major metabolite being aminomethylphosphonic acid (AMPA). Glyphosate is chemically stable in water and is not subject to photochemical degradation. The low mobility of glyphosate in soil indicates minimal potential for the contamination of groundwater. Glyphosate can, however, enter surface and subsurface waters after direct use near aquatic environments or by runoff or leaching from terrestrial applications. Glyphosate and AMPA have similar toxicological profiles, and both are considered to exhibit low toxicity. Under usual conditions the presence of glyphosate in drinking-water does not represent a hazard to human health. It was noted that most AMPA, the major metabolite of glyphosate, found in water comes from sources other than glyphosate degradation.

2.76 Bentazone is a broad-spectrum herbicide used for a variety of crops. Photodegradation occurs in soil and water; however, bentazone is very mobile in soil and moderately persistent in the environment. Bentazone has been reported to occur in surface water, groundwater and drinking-water at concentrations of a few micrograms per litre or less. Although it has been found in groundwater and has a high affinity for the water compartment, it does not seem to accumulate in the environment. Exposure from food is unlikely to be high.

2.77 Mecoprop is a pesticide and is included in the plan of work of the rolling revision of the WHO Guidelines for Drinking-water Quality. The Guidelines for Drinking-water Quality Final Task Force meeting (Geneva, 2003) recommended that several pesticides be referred to the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) with varying levels of priority.

2.78 Dicofol is a persistent organochlorine acaricide. It is used in agriculture and horticulture to control spider mites and soft-bodied mites in apples, pears, soft fruit, cucumbers, tomatoes, hops, vines, lettuce and ornamentals. Dicofol is structurally similar to DDT. It is cumulative in the environment. Dicofol in soil is expected to bind to organic matter and is not likely to leach to groundwater, although there are reports of dicofol in groundwater. However, residues in soil decrease rapidly. In surface water, dicofol is expected to adsorb sediments and can hydrolyse to dichlorobenzophenone. Dicofol accumulates in body fat to a plateau level related to absorption. The USEPA's PBT profiling model predicts dicofol to be persistent and bioaccumulative (USEPA, 2006). Exposure of the public through foods such as pears, blackcurrants and strawberries can be higher than expected and may result in a breach of the ADI (MAFF, 1996). Levels in drinking-water would be expected to be very low.

Economic assessment

2.79 No information has been found on quantities used or produced in the EU, not the associated values. This is likely to be due to the fact that these substances are at the moment simple pollutants and therefore they are not systematically monitored.

2.80 Again our method of analysis has been based on a 'transfer of results' from similar studies.

2.81 Emissions can be classified as direct (from production sites or direct dispersion in the environment) and indirect (trough their usage, leaching from landfill sites and as a fall-out).

2.82 The scenarios considered refer to a reduction in emissions of these substances due to their possible classification as priority.

2.83 The first scenario assumes that the reduction in the pesticides use is achieved trough the adoption of more environmentally sound weed control systems. An actor-participative project on sustainable weed control on pavements was started in 2000 in the Netherlands. The new concept was tested in 2002 and 2003 in nine Dutch municipalities on defined urban areas of 5–25 ha, which formed units from a construction, hydrology and management point of view. Use of the pesticides was reduced by 11–66 per cent (depending on the pesticide, the biggest reduction has been registered for glyphosate) compared to standard practice. Levels of weed control remained good and ecological threshold concentrations in surface waters were not exceeded. Costs of weed control with the new concept were higher (10–25 per cent) compared to the standard practice control of weeds (using herbicides) on pavements, but much lower compared to alternative (non-herbicide) weed control systems. Hence the new concept provides a useful framework for finding a good trade off between economical and ecological aspects of the use of pesticides (see Kemperar et al., 2007).

2.84 The second scenario assumes that the reduction of pesticide usage is achieved trough a major use of Genetically Modified Crops (GM). A study by PG Economics (2005) examines specific global economic impacts on farm income and environmental impacts of the technology with respect to pesticide usage and greenhouse gas emissions for each of the countries where GM crops have been grown since 1996. The analysis shows that there have been substantial net economic benefits at the farm level amounting to a cumulative total of $27 billion (10 billions only for the United States). The technology has reduced pesticide spraying by 172 million kg and has reduced the environmental footprint associated with pesticide use by 14 per cent. In this case the net economic effect would be a benefit rather than a cost. This largely reflects the facilitating role of the GM HT technology in accelerating and maintaining the switch away from conventional tillage to no-or low-tillage production systems with their inherent environmental benefits. The net decrease in the volume of POPs used should, therefore, be placed in the context of the reduced GHG emissions arising from this production system change and the general dynamics of agricultural production system changes.

2.85 According to two DDT producers we interviewed, costs from a moderate reduction of emissions in water would be significant, but not unsustainable. One should also keep in mind that many member countries have already banned DDT, or taken actions to reduce emissions. The same should hold also for the other substances considered

2.86 In conclusion the economic cost of putting these substances in the priority list appears to be moderate. The actual measure of costs depends crucially on the reduction of emissions required to comply with EQS (which in turn depends on the present concentration of these substances in water).

Bisphenol A

2.87 Manufacture of bisphenolA in the EU is estimated at around 700,000 t/y and, taking into account imports and exports, EU consumption is estimated to be approximately 680,000t/y (UK Government, 2002a). Production occurs at six sites, owned by four companies, which are based in Germany, The Netherlands, Belgium and Spain. Bisphenol A is used in:

(a) Polycarbonate production
(b) Epoxy resin production
(c) Can coating manufacture

(d) Phenoplast resins
(e) Unsaturated polyester resin production
(f) PVC production and processing
(g) Alkyloxylated bisphenol-A manufacture
(h) Thermal paper manufacture
(i) Polyols/polyurethane manufacture
(j) Modified polyamide production
(k) Tyre manufacture
(l) Brake fluid manufacture

2.88 The main uses are in the production of polycarbonates and epoxy resins which together account for over 96 per cent of EU consumption. It is ainteresting to note that production in Germany is indicated in the trade statistics as being 495,000 t/y, or around 72 per cent of the total EU production. Based upon trade statistics (CEC, 2001), the total amount of bisphenol-A consumed in the EU is estimated to be worth over €600 million per year

Economic assessment

2.89 The scenarios considered refer to a reduction in emissions of Bisphenol A due to its possible classification as priority substance.

2.90 RPA (2003) considers the possible economic impacts of a reduction of Bisphenol A emissions on two industries: paper industry and PVC sector.

The EU Paper Industry and the recycling of thermal paper

2.91 Clearly, in order to comply with an emission limit or environmental quality standard for bisphenol-A, sites would incur some costs from the introduction of additional effluent treatment or changes to the processes involved. However, this would not be the case for all sites since emissions at some sites are unlikely to pose an unacceptable risk to the environment. Moreover, sites may have to install wastewater treatment units in order to meet their statutory obligations under IPPC, not just because they need to reduce emissions of bisphenol-A to the aquatic environment.

2.92 Different possible treatment options are considered together with different levels of Bisphenol reduction and reported in Table 3.1. Estimations are based on the assumption of 5,000 m3/day of effluent; plants life of 15 yr has been assumed and a discount rate of 3.5 per cent. The cost for each type of treatment includes installation costs and running costs.

Table 3.1: Efficiencies and costs of different treatment techniques. Source RPA (2003)

Treatment technique	Total removed (%)	Annual cost (€000)	Total cost (€000)
Screening	**20**	**40**	**40**
Gravity settling	**60**	**223**	**263**
Aerobic activated sludge	**96**	**712**	**975**
Polishing filtration	**99.6**	**80**	**1055**
Ozone plus bio filtration	**99.96**	**913**	**1069**

2.93 For the paper recycling industry, assuming 200 plants, the annual cost for reducing bisphenol A emissions could range from €14 ml to €290 ml per year depending on the types of technology employed and the percentage of sites requiring such treatment.

PVC industry

2.94 No immediate costs no immediate costs to the PVC industry would result from legislation on bisphenol-A emissions from its use as an inhibitor in the production of PVC. First, this use of bisphenol-A has virtually ceased and, secondly, it is expected that PVC producers will already have in place wastewater treatment facilities due to the nature of the raw materials used in the production of PVC and PVC-based articles (for instance, stabilizers that contain heavy metals); however no specific information is available. If, nevertheless, wastewater treatment facilities are needed, the cost of such investment would be similar to the cost of treatment for paper recycling plants, as described above.

Perifluorinated compounds (PFC)

2.95 Perfluorinated compounds (PFCs) are a family of fluorine-containing chemicals with unique properties to make materials stain and stick resistant. PFCs are incredibly resistant to breakdown and are turning up in unexpected places around the world. Although these chemicals have been used since the 1950s in countless familiar products, they have been subjected to little government testing. There are many forms of PFCs, but the two getting attention recently are PFOA or perfluorooctanoic acid, used to make Teflon products and PFOS or perfluorooctane sulfonate, a breakdown product of chemicals formerly used to make Scotchgard products.

2.96 PFOA is a likely human carcinogen.

2.97 PFCs are widely used in the semiconductors manufacturing sector and in the aluminium production industry.

Economic assessment

2.98 According to different studies and to the interview we conducted with the International Aluminum Institute, the industry is working cooperatively with governments through domestic voluntary programs and globally through voluntary programs to reduce PFCs emissions. This would considerably reduce monitoring and enforcement costs.

2.99 New technologies are being developed and substitutes for these substances are being tested.

2.100 Anode materials that contain no carbon are currently under development, which are not consumed during the electrolysis process. PFC emissions would be totally eliminated, if this technology were successfully commercialized. Finally, additional research is being carried out aimed at developing alternative processes to the 100-year-old Hall-Heroult process. The current candidate processes include carbothermic reduction and a clay chlorination process, both of which would emit no PFCs. Furthermore, recycling currently provides about one-third of worldwide aluminium demand and recycling rates are projected to rise in the future. Recycling produces no PFC emissions, requires only five percent of the greenhouse gas energy required for primary aluminium production and produces only five percent of the emissions of primary production. The IAI is actively working to encourage increased recycling. It has recently formed a Global Aluminium Recycling Committee to develop a better understanding of global material flow, gather improved statistics on recycling and recycling rates.

2.101 An aluminium smelter embodies a large capital investment. The capital cost of any of these technology options, such as a retrofit to an existing plant, is large. However, these changes also improve process efficiency and return. Changes are implemented usually for competitive reasons, not for the prime purpose of reducing PFC emissions. The decision to implement a technology retrofit will depend on a smelter's economic fundamentals and the ability of the new technology to decrease on-going costs per tonne of metal production. Technology retrofits must meet enterprises' internal return criteria. The US EPA and the IAI are collaborating to develop a methodology for estimating the financial implications of anode effects on aluminium smelting facilities. The key cost elements include increased fluoride consumption, decreased aluminum production, and increased power consumption.

2.102 Costs vary by smelter type, by power system design (constant power versus constant current) but preliminary estimates indicate yearly costs resulting from anode effects for a hypothetical "typical" (525 pot facility) range from tens of thousands to millions of US dollars (USEPA & IAI, 2002).

2.103 However, given the research efforts already in place, and the PFCs potential substitutability, the economic cost of putting this substance in the priority list is moderate. Also monitoring costs would be strongly mitigated by the monitoring programs that the IAI has recently sponsored.

2.104 Similar conclusions apply to the semiconductors industry, in which PFCs emissions have already been considerably reduced.

Administrative and financial consequences for Member States and the Commission

2.105 The proposed amendment is a "daughter" instrument under the WFD. This means that the major part of the administrative impact is already covered by the WFD. This includes, e.g. transposition of the main provisions, the monitoring of water quality, the assessment of compliance with EQS, the prior regulation or authorization of discharges, and the reporting obligations to the European Commission. In fact, most of these administrative tasks did already exist through the regulatory framework of Directive 76/464/EEC and the WFD brought about a simplification and streamlining of the administrative burden.

2.106 However, the new amendment will result in some additional administrative burden, namely:

(a) transposition of the Directive into national legislation;
(b) development and agreement of guidelines for "transitional area of exceedance";
(c) "inventories of emissions, discharges, and losses" to be reported by Member States and industry ;
(d) Development of EQS for substances under review;
(e) Monitoring and enforcement costs, especially for some new hazardous substances (discussed in different case studies);
(f) The new proposal also brings some administrative benefits. The proposal for common EQS will save the Member States from having to develop and agree national EQS on hazardous substances not regulated at present time. As usual the Commission intervention can significantly reduce coordination costs among member States.

2.107 As stressed by the Ecolas Study it is difficult to estimate the net administrative costs, i.e. the difference between the above-mentioned impacts and benefits.

3 ENVIRONMENTAL ASSESSMENT

Methodological approach

A first best approach

3.1 In order to calculate the environmental and economic impact of the changes envisaged in the policy proposals on priority substances in water two main steps would be needed. The first would be calculating how the water emissions of these substances would be influenced by the change in policy in the area of interest (i.e. the EU 27). The second would be coupling the change in emission with the effects that the substances have on a number of environmental and economic variables.

3.2 In the literature a similar approach is used when it is necessary to evaluate the effects that a product has on the environment over the entire period of its life. This approach is labelled Life Cycle Impact Assessment (LCIA) and it is widely used internationally. It also appears in the European Commission guidelines on Impact assessment where it is defined as

> The process of evaluating the effects that a product has on the environment over the entire period of its life.

3.3 More precisely LCIA entails the calculations of the effects of all the elementary flows associated with a given product i.e. the multiplication of the amount emitted through the entire life cycle of a product with the "characterisation factors" of these flows for the impact categories of interest.

3.4 Figure 3.1 describes the process.

Figure 3.1: The LCIA Framework

3.5 The effects of the emission of pollutants are clearly numerous; Impact 2002+[2] reports characterisation factors for 14 midpoint categories[3] which are subsequently grouped into four damage categories categories: effects on a) human health, b) ecosystem quality, c) climate change and d) resources.

3.6 The emission of pollutants into the environment has detrimental effects for human health as it affects the human body in a variety of ways. Toxicologist have determined for a number of chemicals the effect factor associated to them. This factor is made up of two components, namely potency and severity. The toxicological potency is a quantitative measure of the likelihood or risk of an effect on the population. The toxicological severity is a measure of the effects, consequences, or damage incurred as a result of exposure. The effects on human health of the emission of pollutants into the environment are usually characterised in terms of Disability Adjusted Life Years (DALYs).

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[2] Impact 2002+ is the LCIA model upon which we relied to estimate the effects. We briefly describe the characteristics of this model in this report. However for more detailed information on Impact 2002+ one should refer to the website http://www.sph.umich.edu/riskcenter/jolliet/impact2002+.htm and the references indicated there.

[3] Human toxicity, respiratory effects, ionizing radiation, ozone layer depletion, photochemical oxidation, aquatic ecotoxicity, terrestrial ecotoxicity, aquatic acidification, aquatic eutrophication, terrestrial acidification and nitrification, land occupation, global warming, non-renewable energy and mineral extraction.

DALYs incorporate both the number of years lost and the number of years lived with a disability in order to measure the overall effect on human health.

3.7 The effects on ecosystem quality are measured through the calculation of the Potentially Disappeared Fraction (PDF), i.e. the share of species that disappear from a square meter of earth surface in one year.

3.8 The effects on climate change and on resources are measured respectively in Kg equivalent of CO2 emissions and MJ. However the former category is dominated by CO2 emission and the latter mainly by the non-renewable energy consumption and are therefore not interesting in our case as the substances object of this study do not have such an impact.

Methodological challenges

3.9 The methodology is therefore based on two distinct parts. The calculation of the change in emissions and the estimations of the effects that these emissions have on the environment.

Calculating characterisation factors

3.10 As stated above, for the second part of the methodology we relied on Impact 2002+. Impact 2002+ is a LCIA model that reports the characterisation factor for thousands of substances for both human health and ecosystem quality. The characterisation factors are reported for different compartments of emissions namely air, water, soil and agricultural soil. given the focus of this study we only considered the characterisation factors for emissions in water.[4]

3.11 The characterisation factors are reported in three different ways. They are:

(a) “at midpoint” i.e. in terms of kg equivalent of a reference substance
(b) “at damage” i.e. in terms of the effects on the four damage categories described above.
(c) “at normalised damage” in terms of “points” where one point is defined as the equivalent damage caused by one person living in the EU in one year.

3.12 The three above categories can be used to estimate the score associated with the emission of different substances. Midpoint characterisation factors are less uncertain however damage factors can be summed over the same damage category to obtain the overall impact of the change in emission.

3.13 In order to estimate the effects on human health we have used the damage characterisation factors so that we have an estimate of the total number of DALYs that may be avoided following a reduction in the use of the substances. However the estimation of the effects on ecosystem quality has been done on the basis of the normalised damage factors. This gives us an estimate of the overall effect on ecosystem quality in terms of the effect of the average European rather than a measure of the change in the PDF due to each of the substances.

3.14 The estimates of the effects on human health are then coupled with an estimate for the European value of a DALY. Research is currently under way to establish an EU wide value for a DALY,[5] however first results are expected not earlier than 2010.

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[4] Unfortunately though, characterisation factors for water emissions of the substances of interest are only available for 19 substances.

[5] See http://www.ncl.ac.uk/ihs/research/project/1697

3.15 In a recently completed study Mason et al (2006) have estimated various ranges for the societal value of a QALY[6] for the UK.[7] The value of a QALY is estimated to lie in the region of £45,000 to £63,000 (€67,500 to €94,500 respectively). We use both figures when estimating potential health benefits.

3.16 Estimates of the value of species are currently very unreliable, if available at all, we report the effects in terms of the environmental damage caused by the average EU citizen and do not attempt a monetary quantification of these effects..

3.17 The available characterisation factors are reported in Table 3.1: Characterisation factors of the substances.

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[6] QALY stands for Quality Adjusted Life Years. However the value of a QALY and the value of a DALY can be considered equal under reasonable assumptions.

[7] Helen Mason, Andrew Marshall, Michael Jones-Lee and Cam Donaldson, Estimating a monetary value of a QALY from existing UK values of prevented fatalities and serious injuries, Department of Public Health and Epidemiology, University of Birmingham, 2006

Table 3.1: Characterisation factors of the substances

Substance	Human health Damage Factor (DALYs per Ton emitted)	Ecosystem quality Damage Factor (Points/Kg emitted*)
DDT	na	na
para-para-DDT	13.17	0.07
Aldrin	55.57	0.06
Dieldrin	32.59	0.18
Endrin	1.80	2.23
Isodrin	na	na
Carbontetrachloride	0.09	0.00002
Tetrachloroethylene	0.003	0.00008
Trichloroethylene	0.0005	0.00001
Amidotrizoate	na	na
AMPA	na	na
Bentazon	0.0002	0.000004
Bisphenol A	0.00003	na
4 4'-Biphenol	na	na
Carbamazepine	na	na
Clotrimazole	na	na
Dibutyl phthalate (DBP)	0.00005	0.0002
Diclofenac	na	na
Dicofol	0.00005	0.003
DTPA	na	na
EDTA	na	na
ETBE	na	na
Free Cyanide	na	na
Glyphosate	0.00021	0.00002
HHCB	na	na
Iopamidol	na	na
Mecoprop (MCPP)	na	na
4-Methylbenzylidene camphor	na	na
Musk ketone	na	na
Musk xylene	na	na
MTBE	0.00021	0.000002
Naphthalene-1,5-disulfonate	na	na
Octyl-Methoxycinnamate	na	na
Perfluorooctane sulphonic acid (PFOS)	na	na
Potassium salt	na	na
Ammonium salt	na	na
Lithium salt	na	na
Diethanolamine (DEA) salt	na	na

Substance	Human health Damage Factor (DALYs per Ton emitted)	Ecosystem quality Damage Factor (Points/Kg emitted*)
Perfluorooctanoic acid (PFOA)	na	na
Ammonium perfluorooctanoate (APFO)	na	na
Quinoxyfen (5,7-dichloro-4-(p-fluorophenoxy)quinoline)	na	na
Tetrabromobisphenol A (TBBP-A)	na	na
Tonalid (AHTN)	na	na
Alachlor	0.001	0.001
Atrazine	0.14	0.01
Diuron	0.001	0.001
Lead	0.03	0.001
Naphtalene	0.0001	0.0001
Octylphenol	na	na
Paratert-Octylphenol	na	na
Pentachlorophenol	0.01	0.002
Simazine	0.01	0.0001
Trichlorobenzene	na	na
Trifluarin	na	na

** One point is equivalent to the impact on ecosystem quality of the average European in one year*

Source: Impact 2002+

Calculating the change in emissions

3.18 The major difficulties arise in the estimation of the change in emissions due to the change in policy. Discussions with experts and our literature review revealed that for many of the substances object of this study data on current levels of emissions are scarce at best and non existent in many cases. In addition given that many of the substances are not monitored at present it is impossible to calculate what reduction the introduction of EQS would imply.

3.19 Some previous studies relied on questionnaires sent to representatives of various industrial sectors in the EU in order to estimate the change in the level of emissions.[8]

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[8] See for instance the 2005 report Assessing economic impacts of the specific control measures for priority substances and priority hazardous substances regulated under article 16 of the Water Framework Directive for the DG Environment of the European Commission

3.20 Even in these cases the authors report that estimating overall emissions was extremely difficult and that serious gaps remained in the data. The scope of this report as well as timing and budget constraints make a similar approach impossible to follow and therefore we had to rely on less precise estimates.

3.21 This fact, coupled with the lack of characterisation factors for a significant share of substances implies that our estimates on the benefits on human health and on ecosystem quality should be interpreted with caution and represent, at best, an estimate of the order of magnitude of these effects.

3.22 We used a number of sources to obtain the amount of pollutants emitted into water. For a limited number of substances it has been possible to use the EPER database. For other substances the Impact 2002+ model reports the overall level of emissions. Other sources used are the website of the Joint Research Centre of the European Commission and the eurochlor website.[9]

3.23 We have assumed that the priority substances that are declared priority hazardous would be completely banned and thus that no emissions would be present after the introduction of the directive.

3.24 For the substances under revision we have assumed a 75 per cent reduction in emissions.[10]

3.25 Finally, we have scaled up the figures obtained to take into account those substances for which we do not have the necessary data. For instance, we have scaled up the figure for the substances that should be declared hazardous by 11/4 as we lack data on seven of them.

3.26 To summarise the following steps have been carried out to estimate the potential benefits:

(a) gather data on overall yearly emissions of the substances of interest from various sources,
(b) assume a change to zero emissions for hazardous substances and a 75 per cent reduction in emissions for other substances,
(c) multiply these reductions for the characterisation factors present in Impact 2002+,
(d) scale up the results obtained to take into account the substances for which not enough data are available
(e) combine the effects on human health with a monetary estimate of the societal value of a DALY to obtain a (yearly) monetary figure for the potential health benefits.

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[9] They are respectively http://ecb.jrc.it and www.eurochlor.org.

[10] Since the EQS that these substances will have to comply with should the Directive be implemented are not presently known it is impossible to come to a more precise figure. However this assumption is in line with those of the Ecolas (2005) report.

Results

3.27 The results of our calculations are summarised in Table 3.2.

Table 3.2: Potential benefits of a reduction in water emissions for priority substances

	For substances that would be classified as hazardous		For substances that would be classified as priority	
Reduction in DALYs	32		5,054	
Improvement in ecosystem quality (points*)	5,808		6,472	
Monetary value of health benefits (Millions of € per year)	2.2	3.1	341	478
Value of a DALY (€)	67,500	94,500	67,500	94,500

** One point is equivalent to the impact on ecosystem quality of the average European in one year*

Source: Europe Economics calculations

3.28 It can be noticed that the environmental impacts of the two classes of substances would have a similar magnitude. In both cases they are roughly equivalent to the yearly impact of 6,000 Europeans. The monetary value of these effects would be heavily dependent on the assumptions made on the value of the environment in general and of biodiversity in particular.

3.29 However there are marked differences in the health impacts of the two classes of substances. The ban of hazardous substances would have an impact in the region of 2 to 3 million € in a year while the reduction in the emission of priority substances would have a potential benefit in the region of 340 to 480 million € per year.

4 WASTE WATER TREATMENT AND WATER SUPPLY SECTOR

4.1 A case study approach has been adopted to get a first indication of the costs involved in the regulation of the substances.

4.2 Again this choice clearly represents a second best opportunity with respect to the gathering of primary data. Ideally questionnaires should have been designed and sent to EU Member States to collect data. However choosing a country with very good data coverage allows us to study the possible effects of the proposed changes in the classification on the water industry of an “hypothetical representative country”.

4.3 The case study has been completed with the help of Dr Adriana Hulsmann, Kiwa Water Research on the basis of reports by KWR experts.

4.4 A short introduction of the Dutch drinking water situation is given.

The situation in the Netherlands

4.5 The annual amount of drinking water produced in the Netherlands is 1269 million m^3. Most drinking water (60 per cent) is produced from groundwater and 40 per cent is directly or indirectly (after dune infiltration) produced from surface water. The river Rhine and the river Meuse are the most important surface water sources.

4.6 The quality of drinking water in the Netherlands has a very high compliance rate with the quality standards of the EU Drinking Water Directive 98/83/EC. In the case the concentrations of any chemical substance is too high the concentrations are lowered to meet the standards through appropriate treatment.

4.7 One of the Water Framework Directive 2000/60/EC objectives is to reach a situation in which Member States can produce drinking water with relatively simple treatment methods. To achieve this target pollution of drinking water sources and the levels of priority substances and other potentially harmful substances should be low or they should be absent. If concentration of these substances is not sufficiently low additional treatment step(s) have to be installed to produce safe drinking water. The costs for this more efficient treatment in addition to the simple treatment are calculated for various groups of substances.

4.8 Groundwater treatment is relatively simple and consists of aeration and sand filtration and in some cases removal of hardness (conditioning of the water). In case unwanted substances remain in the water activated carbon filtration is installed as additional treatment.

4.9 Surface water treatment is more complicated as the quality is not as good as groundwater and there are more fluctuations in water quality. Standard simple treatment consists of coagulation, sedimentation, rapid sand filtration and disinfection (UV or ozone). No chlorine is added to drinking water in the Netherlands, except in outbreak situations.

4.10 Unfortunately the status of the drinking water sources is not or not yet as good as desired by the WFD. Surface water is contaminated by organic micro pollutants such as pesticides, pharmaceuticals (human and veterinary), solvents, flame retardants, body care products, household chemicals, and even heavy metals that are not to be removed by “simple” treatment processes. But groundwater sources are also threatened by anthropogenic influences. Additional treatment steps have to be introduced to remove organic micro pollutants.

4.11 Important groups of substances that cause problems in the drinking water supply are:

- Pesticides such as bentazon, mecoprop and isoproturon;
- Metabolites of pesticides such as AMPA, dimethylsulfamide, dichlorobenzamide BAM);
- Chlorinated solvents such as: tri and tetrachloroethylene, chlorofluorohydrocarbons;
- Aromatic solvents such as (terpentine, thinner, white spirit etc), benzene, toluene, xylenes;
- Petrol additives such as MBTE and ETBE;
- Glycolethers such as diglyme, triglyme;
- Pharmaceuticals such as carbamazepine, ibuprofen and phenazon;
- X-ray contrast agents such as iopamidol, amidotricoic acid;
- Industrial wastewater discharges with (by-) products as penta and hexa (methoxymethyl)melamine, M431, 3-cyclo-1,1-dimethylureum.

Figure 4.1: Sources of pollution relevant for drinking water production from surface water sources in the Netherlands

Key: Red indicates pollution sources: domestic, consumers and traffic origin
Yellow indicates pollution sources: agriculture
Green indicates areas without significant pollution (focus on nature conservation).

Assessment of current substances

4.12 A total of 304 substances have been assessed, which are either on the priority list of the EC (41 priority substances), regulated by the Dutch legislation (179) or not yet regulated but present in Dutch water sources. A table with the results of the assessment is attached, taking into account that overlaps in the above mentioned lists have been deleted.

4.13 All the substances have been assigned to three categories, which are problematic substances (red in the table), potentially problematic substances (orange in the table) and non-problematic substances (green in the table).

4.14 A total of 28 problematic substances occur in Dutch surface water, some of which have a transboundary source. These substances are insufficiently removed by simple treatment processes, and final concentrations in drinking water after treatment will cause non-compliance. Additional investment is necessary to adopt the treatment process in order to produce safe drinking water.

4.15 A total of 181 potentially problematic substances occur in drinking water sources in the Netherlands. The substances are present in water sources but not yet in too high concentrations. The legal limits for the substances in surface water are such that simple treatment will not be able to produce safe drinking water from such sources. Substances without legal limits which are not removed by simple treatment belong also to this category.

4.16 A total of 95 substances are non-problematic. For them there is sufficient protection to be able to produce safe drinking water.

Table 4.1: substances and categories

Bijlage I

prioritaire stoffen uit EC-voorstel	stoffen met MKE (Ned wetgeving)	niet genormeerde stoffen
Benzo(a)pyreen	carbendazim	AMPA
Isoproturon	dimethoaat	Chloortoluron
Diuron	2,4-D	Diclofenac
Atrazin	bentazon	Diisopropylether (DIPE)
Naftaleen	chloridazon (pyrazon)	Glyfosaat
1,2-Dichloorethaan	MCPA	Carbamazepine
Hexachloorbutadieen	Mecoprop-p	MTBE
Anthraceen	fluoride	bezafibraat
Chloorfenvinfos	metolachloor	Amidotrizoic acid
Fluorantheen	boor	Iopamidol
Tetrachloormethaan	demeton	iopromid
Alachloor	3-chloorpropeen	DTPA
Dichloormethaan	4-chloor-2-nitroaniline	EDTA
Benzeen	dichlooranilinen	Diglyme
Simazin	fenantreen	ETBE
Pentachloorbenzeen	arseen	2,6-dichloorbenzamide (BAM)
Tributyltin	terbutylazine	n,n-diethyl-3-methyl-benzamide (DEET)
Benzo(ghi)peryleen	1,1,2-trichloortrifluorethaan	dimethoaat
Indeno(1,2,3-cd)pyreen	4-chloor-2-nitrotolueen	dimethylsulfamide (DMSA)
Hexachloorbenzeen (HCB)	isopropylbenzeen	metazachloor
Kwik	benzylideenchloride	nicosulfuron
alfa-Endosulfan	1,2-dibroomethaan	sulcotrion
p,p-DDT	linuron	johexol
Trichloormethaan	trichloorfenolen	jomeprol
som DDT	chloortoluidinen	fenazon
Cadmium	dimethylamine	caffeïne
Som 4 drins	1,3-dichloorpropeen	metoprolol
Lood	2,3-dichloorpropeen	naproxen
Benzo(b)fluoranteen	chryseen	sotalol
Benzo(k)fluoranteen	dibutyltinoxyde	oestrogene actviteit
1,2,3-Trichloorbenzeen	tolclofos-methyl	oestron
1,2,4-Trichloorbenzeen	2-amino-4-chloorfenol	tri(2-chloorethylfosfaat) (TCEP)
1,3,5-Trichloorbenzeen	chloropreen	urotropine
Trifluralin	dichloordiisopropylether	trifenyl-imidazool-triglycine (Mw431)
Lindaan (gamma-HCH)	omethoate	2,4,6-trichlorophenol
Nikkel	tributylfosfaat	4,4'-sulfonyldiphenol
Tetrachlooretheen (PER)	2,4-dichloorfenol	Bisphenol-A
Trichlooretheen (TRI)	chloornitrotoluenen	DCPA
C10-13 chlooralkanen	tetrabutyltin	Monoacid degradate
Chloorpyrifos	methabenzthiazuron	Diacid degradate
Pentachloorfenol	1-chloor-4-nitrobenzeen	Diazinon
	diethylamine	Pyrethrum
	1,2,4,5-tetrachloorbenzeen	Pyrethrin II
	2-chloorfenol	Cyfluthrin
	3-Chloorfenol	Deltamethrin
	4-Chloorfenol	Fenvalerate
	4-chloor-3-methylfenol	Lambda cyhalothrin
	1-chloor-2-nitrobenzeen	Phenothrin
	chloorprofam	Tetramethrin
	2-chloor-p-toluidine	Permethrin
	1,2-dichloorpropaan	Hexachlorobenzene
	hexachloorethaan	Irgarol
	2,4,5-T	M431
	1,3-dichloorpropaan-2-ol	NDMA and related nitrosocompounds
	epichloorhydrine	DMS (precursor for NDMA)
	2-chloorethanol	Perchlorate
	1,2-dichloorbenzeen	Benzothiazoles
	1,3-dichloorbenzeen	Benzotriazoles
	1,4-dichloorbenzeen	Perfluorooctanoic acid
		Perfluorooctano-sulfonate
	benzylchloride	Acetylsalicyclic acid
	2-chloortolueen	Phenazone
	3-chloortolueen	Ibuprofen
	4-chloortolueen	Lincomycine
	metazachloor	Sulfamethoxazole
	ethylbenzeen	Clofibric acid
	xylenen	Prometon
	dichloorprop	Prozac
	chlooralhydraat	Dibenzofuran
	styreen	Quinaldine
	chloorbenzeen	RDX
	1,1-dichloorethaan	Dichlofluanid

Key: *Column 1: EC priority substances*
Column 2: Additional substances regulated within Dutch legislation
Column 3: Non-regulated substances.

Additional cost calculation

4.17 On the basis of a study for the Dutch water supply sector Kiwa Water Research calculated back in 2004 (Puijker et al. , 2004 in Dutch) that an additional annual cost of 23 million Euro (investment and operation cost) was needed to remove pesticides from water resources. A more recent calculation (2007) defines the additional annual cost at 44 million euro. This calculation is based on the current situation, in other words the current pollution.

4.18 For two more scenarios the additional costs (above the "simple treatment" costs) have been calculated. The scenarios address the situation where increased pressure on existing drinking water sources make in necessary to invest in more additional treatment steps to continue to produce safe drinking water that meets the proposed European standards and Dutch drinking water standards.

Table 4.2: Additional cost calculation

Scenario	Additional costs required	Comments
Scenario 1	**44 m€/year**	**Removal of pesticides**
Scenario 2	**159 m€/year**	**Average scenario to remove a large number of substances**
Scenario 3	**276 m€/year**	**Worst case scenario to remove substances from groundwater and surface water**

4.19 Scenario 1 assumes the removal of pesticides from surface water and groundwater. Scenario 2 assumes the addition of advanced oxidation for both surface water and groundwater to remove a large number of substances. Scenario 3, the worst case scenario, assumes that the presence (number and or concentrations) of problematic substances in surface water and groundwater is such that reversed osmosis needs to be installed. However, even with the application of R.O. it is still possible that not all substances are (sufficiently) removed to produce safe drinking water. The estimated costs for the Dutch drinking water supply will be between €150 and €275 million per year which is an increase of 30 to 55 per cent of the costs of the desired "simple treatment" mentioned in the WFD.

4.20 A calculation of costs for measures to prevent pollution of drinking water sources or additional treatment of effluents of waste water treatment plants from industries and communities is not available yet but these will probably be at least in the same order of magnitude.

4.21 The calculations are based on the following assumptions: a drinking water poduction of 1269 Mm^3/year (502 surface water, 61 bankinfiltrate, 706 groundwater, Dutch data 2006).

5 CONCLUSIONS

5.1 In this study we conduct a preliminary Impact Assessment on Priority substances in water as requested by the Environment, Public Health and Safety (ENVI) Committee of the European Parliament in the context of the Procedure 2006/0129 (COD).

5.2 The purpose of the work is to assess the likely impact on Member States, on Commission resources and on Community funds of these possible changes of classification and of future assessment of the substances. An assessment has been made of the foreseen environmental and economic impact of those changes.

5.3 Our approach to this work, following the guidance of the Request for Study, comprised the following steps:

(a) Highlight the possible economic effects of the proposed changes, through case studies;
(b) calculate the environmental impact of the changes envisaged in the policy proposal using a methodology similar to Life Cycle Impact Assessment (LCIA);
(c) study the consequences for the waste water treatment and the water supply sector; and
(d) analyse the administrative and financial consequences for Member States and for the European Commission, in case of final adoption of the changes to the lists.

5.4 The results of our Impact Assessment, which should be interpreted with caution and keeping in mind the simplifying assumptions made, were:

(a) The environmental benefits of declaring Priority the candidate pollutants is quantitatively similar to the benefit of declaring Hazardous the Hazardous candidates substances:
(b) There are marked differences in the health impacts of the two classes of substances. The ban of Hazardous substances would have an impact in the region of €2 to 3 million per year while the reduction in the emission of priority substances would have a potential benefit in the region of €340 to €480 million per year.
(c) Case studies conducted show that the economic cost of phasing out Hazardous substances' emissions would be very high, especially if all of them are banned together, because of substitutability problems, especially in the agricultural sector. For example phasing out only atrazine could cost €25 ml per year. If atrazine and alachlor were banned together the cost would be much higher.
(d) The economic cost of declaring the proposed pollutants priority substances would be much smaller and in many cases moderate, due to different industries research, already in place, to reduce emissions of dangerous pollutants.

5.5 However, given the high uncertainties of the estimates as well as the numerous data gap it is impossible to derive definitive conclusions from this analysis. We recommend that the parliament commissions a full impact assessment study that can shed additional lights on the costs and benefits associated with this proposal.

APPENDIX 1: SUBSTANCES CHEMICAL PROFILE AND TOXOLOGICAL REVIEW

Report on potential dangers to the environment and human health from lists of substances (Pollutants to priority; Priority to Priority Hazardous; and a further list of 28 substances) by Dr Alexandra Farrow, School of Health Sciences & Social Care, Mary Seacole Building Brunel University, Uxbridge Middlesex

A1.1 Categories for chemicals have been derived using

- (a) IARC carcinogen category;
- (b) US California carcinogen list: http://www.oehha.ca.gov/prop65/prop65_list/files/singlelist09-28-07.xls
- (c) environmental half life (the longer the half life the greater the hazard)
- (d) toxicity information (animal and/or human)
- (e) The website to produce a CalTOX score was also used to assess hazard. [http://www.scorecard.org/chemical-profiles/hazard]
- (f) Pubmed

A1.2 CalTOX utilizes data on a pollutant's physical-chemical properties and the landscape characteristics of the environment receiving a release to model how that chemical will be distributed among seven connected environmental compartments (e.g., soil, water, air). CalTOX predicts the chemical concentrations in these compartments which will result from a continuous release of a pollutant, taking into account transport and transformation processes that affect the pollutant. CalTOX applies a multi-pathway exposure assessment model to these ambient concentrations to estimate the total chemical dose people may receive from a release. CalTOX produces an estimate of the average daily dose that is associated with a unit release of a chemical to air or water in a model environment, expressed in milligrams of a chemical per kilogram of body weight. [Ref: CalEPA Office of Environmental Health Hazard Assessment Hazard Identification Document].

Table A.1: Hazard Category for Pollutants to Priority (n=9); Priority to Priority Hazardous (n=12)

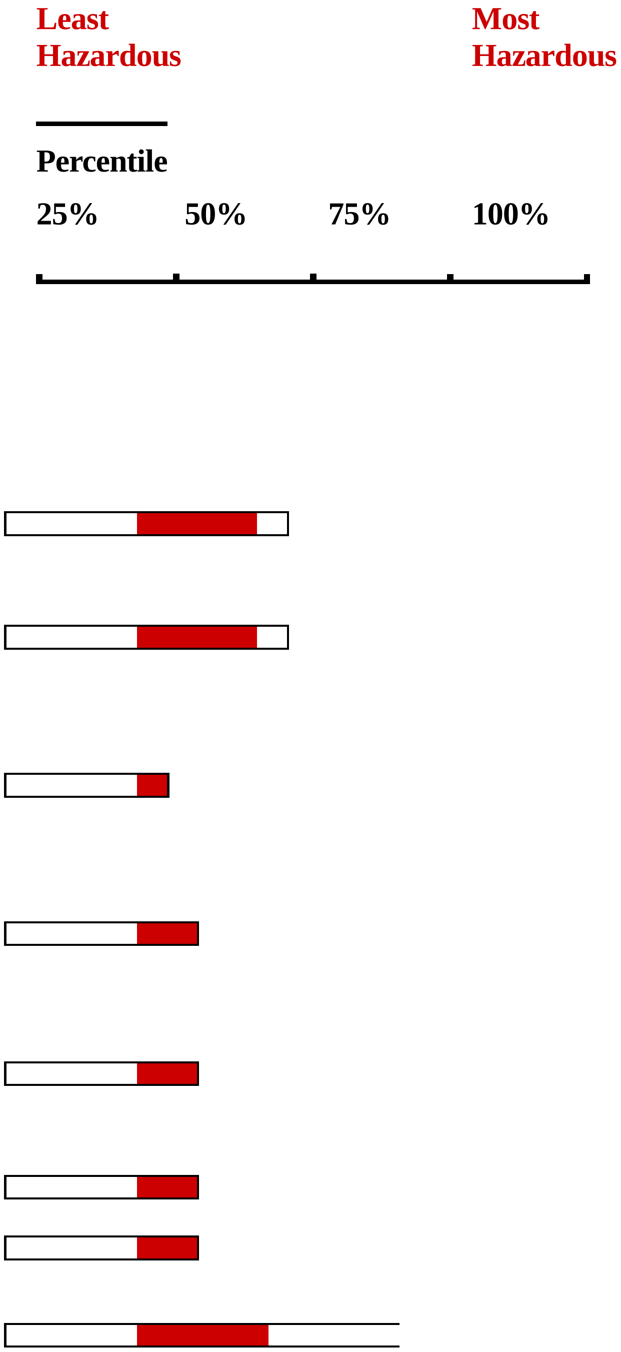
A1.3 (1 represents the most hazardous; category 5 the least hazardous.)

Common Chemical name	**Haz Cat (1-5)**	**Comments**	**Comments / Recent references**
Total DDT (E-DDT)	1	Estrogenic; Immuno-suppressive; Recognised carcinogen;Persistent	IARC 1991 Fiorini et al 2007
p,p'DDT	1	Estrogenic; Immuno-suppressive; Tumour promoting; Persistent	Koner et al, 1998 Iscan et al, 2002
Aldrin	1	Recognised carcinogen	
Dieldrin	1	Recognised carcinogen	
Endrin	2	Endocrine disrupter;	
Isodrin	3	Persistent	
Carbon-tetrachloride	2	Recognised carcinogen	
Tetrachloro-ethylene	2	Recognised carcinogen	
Trichloroethylene	2	Recognised carcinogen	
Alachlor	1	Recognised carcinogen	
Atrazine	2		
Diuron	2	Recognised carcinogen; Developmental Toxicant; Cardiovascular or Blood Toxicant	high volume chemical: US production >1m pounds / yr
Lead	1	Recognised carcinogen; Reproductive & Developmental Toxicant	high volume chemical with US production exceeding 1m pounds annually
Lead compounds	1	Recognised carcinogen; Reproductive & Developmental Toxicant	
Naphthalene	2	Recognised carcinogen	high volume chemical: US production > 1m pounds annually; used in consumer products including pesticides
Octylphenol 1,1,3,3-tetra-methylbutyl phenol	3	Suspected endocrine toxicant	high volume chemical with US production >1m pounds annually; used in pesticides
Paratert-octylphenol 4- (1,1,3,3-tetra methylbutyl) phenol	2	Suspected endocrine toxicant Persistent in the environment	high volume chemical with US production exceeding 1m pounds annually
Pentachloro-phenol	2	Recognised carcinogen; persistent	Used in at least 2 industries; used in pesticides
Simazine	4	Suspected carcinogen; suspected endocrine toxicant	
Trichloro-benzenes	3?		Lacking information
1,2,4 Trichloro-benzenes	2	Suspected carcinogen; suspected developmental and neuro toxicant	high volume chemical with US production exceeding 1m pounds annually; used in pesticides; used in 4 industries
Trifluralin	2	Suspected carcinogen; suspected developmental, endocrine, reproductive and immuno toxicant	Used in consumer products including pesticides

A1.4 Individual chemicals in the above table are presented below from the US Pollution information site http://www.scorecard.org/chemical-profiles/hazard]

Chemical: ALDRIN

CAS Number: 309-00-2



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

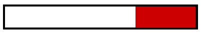
Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

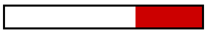
Ecological Health Rankings

Toxicity and persistence

Environmental Hazard Value Score (IRCH)



Ecological Risk Screening Score (WMPT)



Integrated Environmental Rankings

Combined human and ecological scores

Total Hazard Value Score (IRCH)

Chemical: DIELDRIN

CAS Number: 60-57-1

Hazardous
Hazardous

Human Health Rankings

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

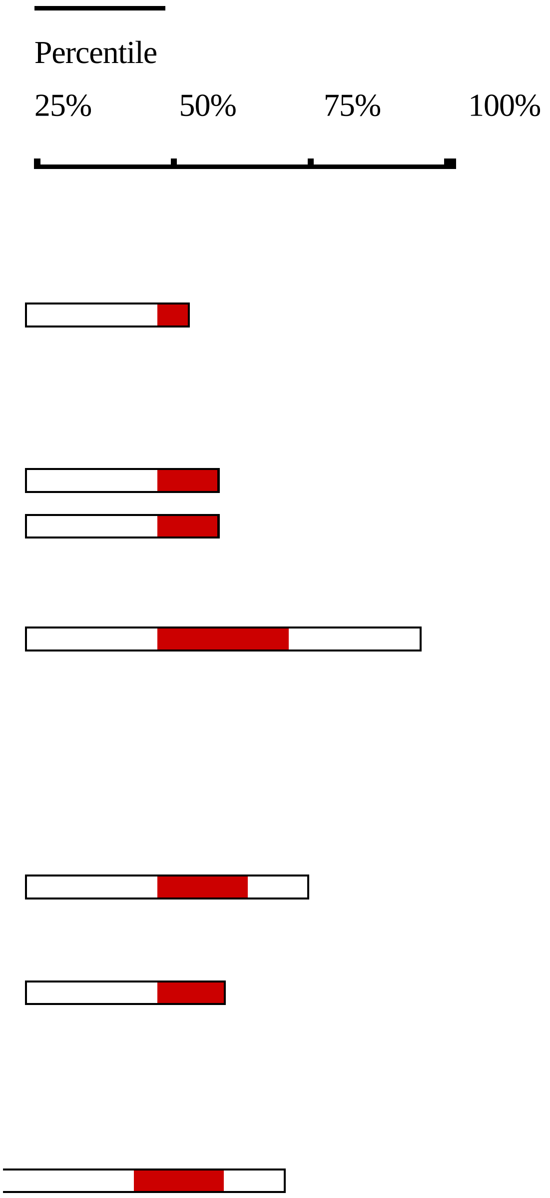
Toxicity and persistence

Environmental Hazard Value Score (IRCH)

Ecological Risk Screening Score (WMPT)

Chemical: ENDRIN
CAS Number: 72-20-8

Least
Hazardous Most
Hazardous



Human Health Rankings

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

Total Hazard Value Score (IRCH)

Chemical: ISODRIN
CAS Number: 465-73-6

Least
Hazardous Most
Hazardous

Percentile

25% 50% 75% 100%

Human Health Rankings

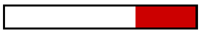
Toxicity and exposure potential

Worker Exposure Hazard Score (IRCH)

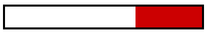
Ecological Health Rankings

Toxicity and persistence

Environmental Hazard Value Score (IRCH)



Ecological Risk Screening Score (WMPT)



Integrated Environmental Rankings

Combined human and ecological scores

Total Hazard Value Score (IRCH)

Chemical: CARBON TETRACHLORIDE

CAS Number: 56-23-5

Least
Hazardous **Most**
Hazardous

Percentile

25% 50% 75% 100%

Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

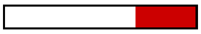
Ecological Health Rankings

Toxicity only

Ecological Effects Score (UTN)

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

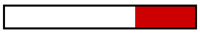


Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

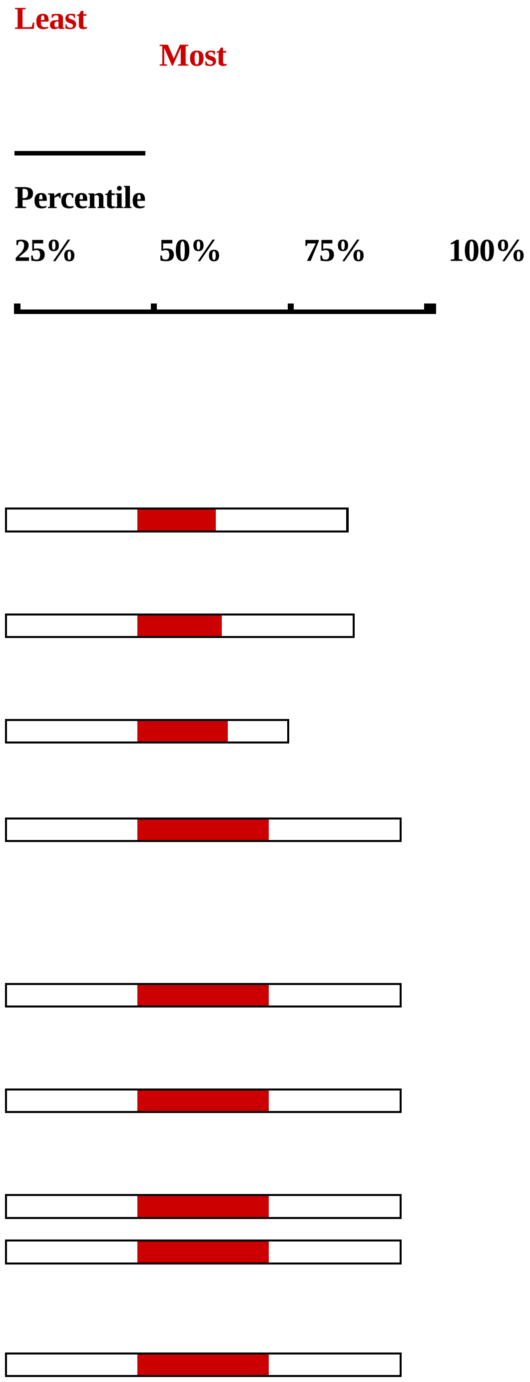
Total Hazard Value Score (IRCH)



Total Hazard Value Score (UTN)

Chemical: TETRACHLOROETHYLENE
CAS Number: 127-18-4

Hazardous
Hazardous



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

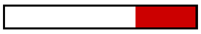
Ecological Health Rankings

Toxicity only

Ecological Effects Score (UTN)

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

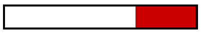


Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

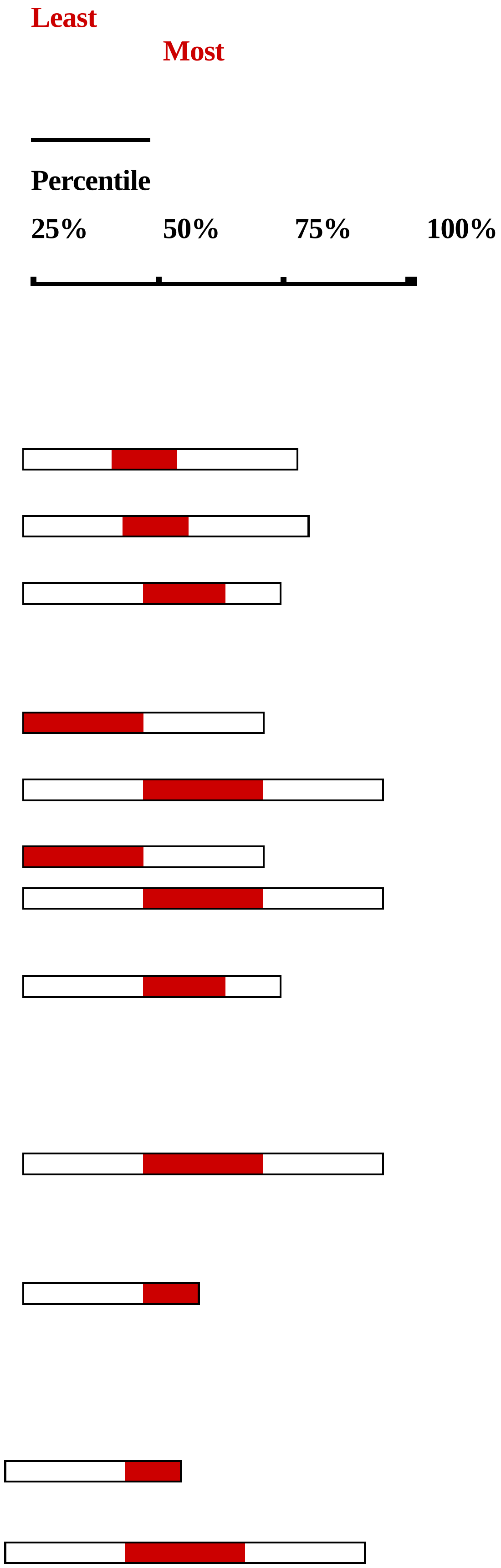
Total Hazard Value Score (IRCH)



Total Hazard Value Score (UTN)

Chemical: TRICHLOROETHYLENE
CAS Number: 79-01-6

Hazardous
Hazardous



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

Ecological Effects Score (UTN)

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

Integrated Environmental Rankings

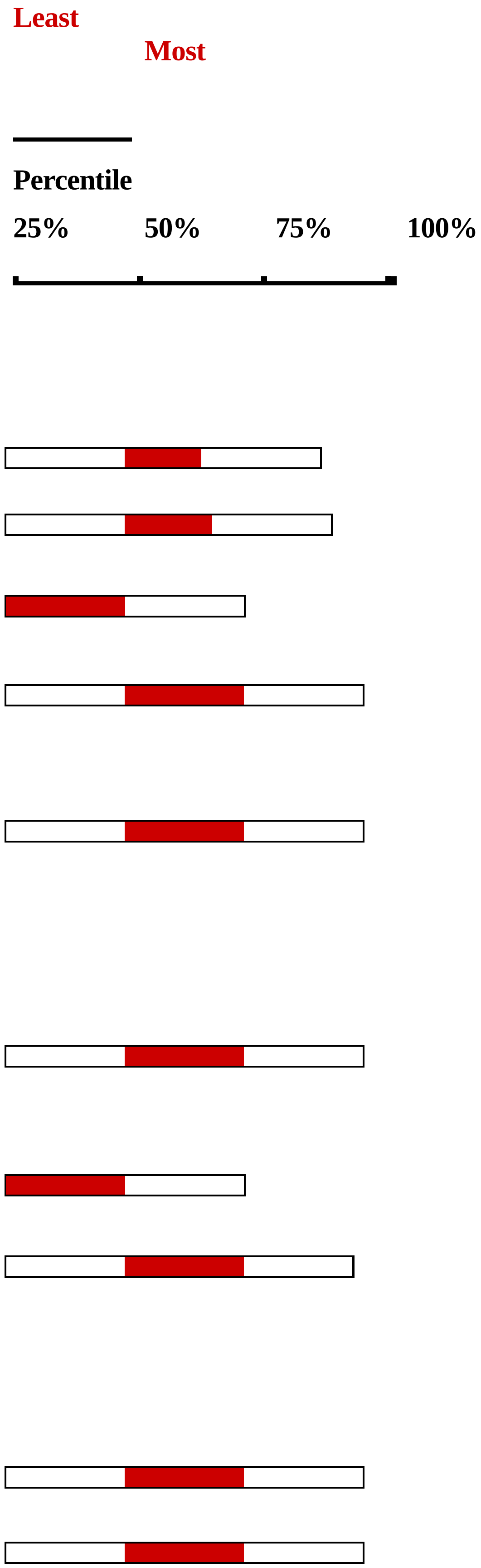
Combined human and ecological scores

Total Hazard Value Score (IRCH)

Total Hazard Value Score (UTN)

Chemical: ALACHLOR
CAS Number: 15972-60-8

Hazardous
Hazardous



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

Ecological Effects Score (UTN)

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

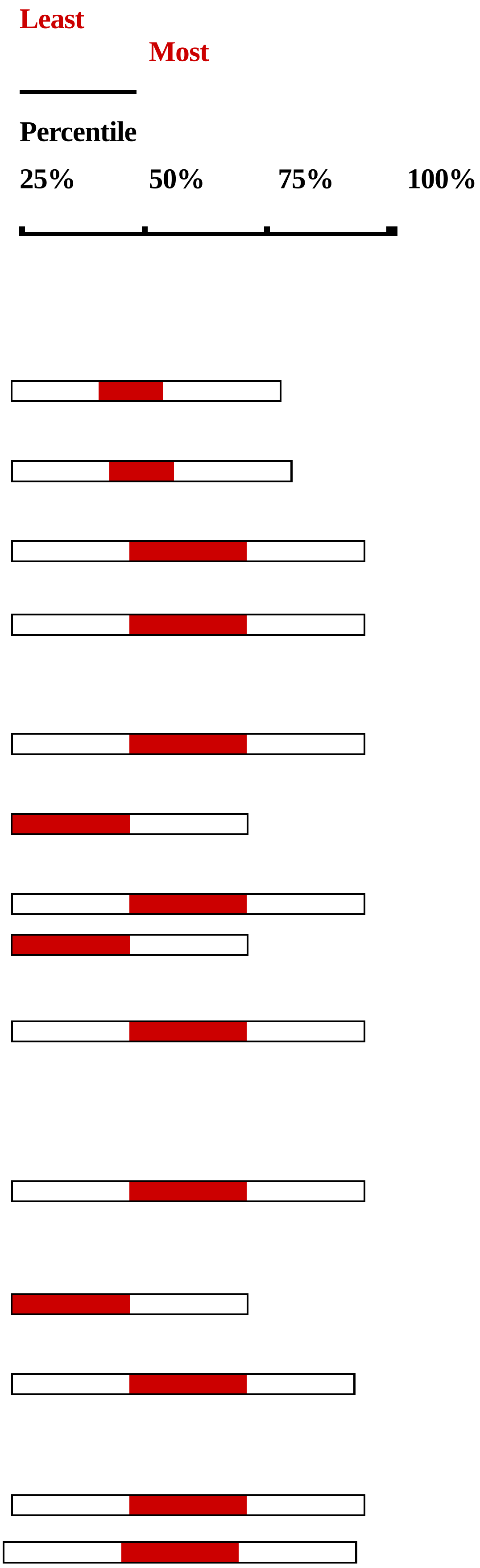
Combined human and ecological scores

Total Hazard Value Score (IRCH)

Total Hazard Value Score (UTN)

Chemical: ATRAZINE
CAS Number: 1912-24-9

Hazardous
Hazardous



Human Health Rankings

Toxicity only
Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and persistence
Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential
Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only
Ecological Effects Score (UTN)

Toxicity and persistence
Environmental Hazard Value Score (IRCH)

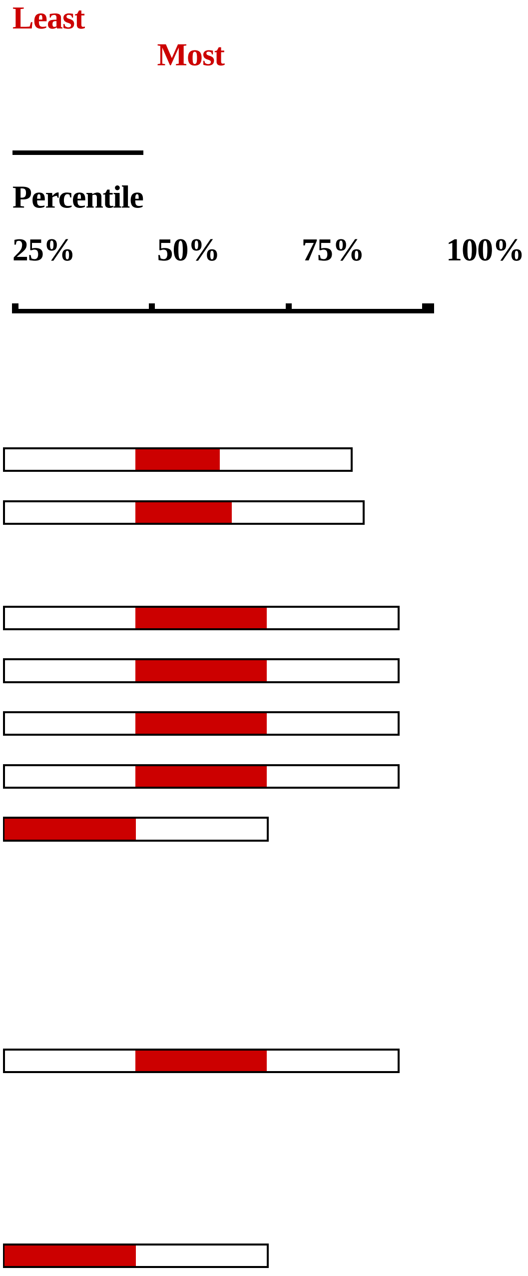
Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores
Total Hazard Value Score (IRCH)

Total Hazard Value Score (UTN)

Chemical: DIURON
CAS Number: 330-54-1



Human Health Rankings

Toxicity only

- **Ingestion Toxicity Weight (RSEI)**
- **Inhalation Toxicity Weight (RSEI)**

Toxicity and exposure potential

- **Cancer Risk Score - Air Releases (EDF)**
- **Cancer Risk Score - Water Releases (EDF)**
- **Noncancer Risk Score - Air Releases (EDF)**
- **Noncancer Risk Score - Water Releases (EDF)**
- **Worker Exposure Hazard Score (IRCH)**

Ecological Health Rankings

Toxicity and persistence

- Environmental Hazard Value Score (IRCH)

Integrated Environmental Rankings

Combined human and ecological scores

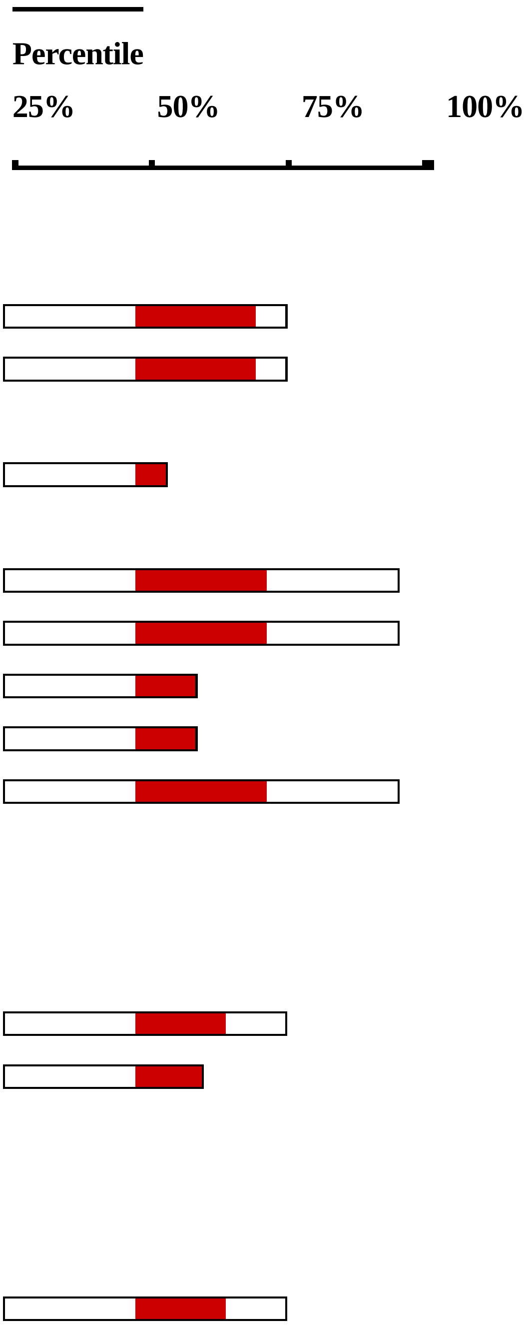
- Total Hazard Value Score (IRCH)

Chemical: LEAD
CAS Number: 7439-92-1

Least

Hazardous **Most**

Hazardous



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

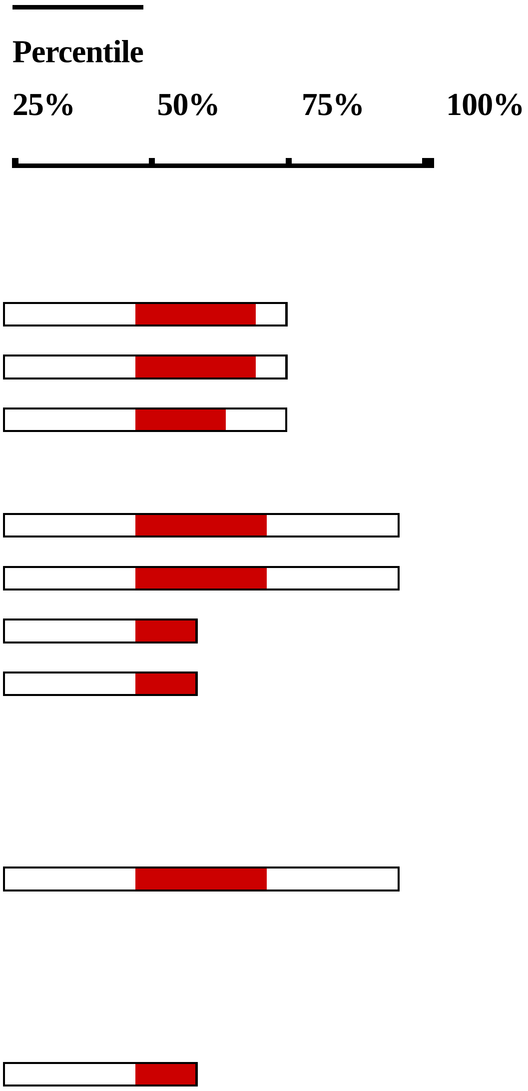
Total Hazard Value Score (IRCH)

Chemical: LEAD COMPOUNDS
CAS Number: LCT000

Least

Hazardous **Most**

Hazardous



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Human Health Effects Score (UTN)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Ecological Health Rankings

Toxicity only

Ecological Effects Score (UTN)

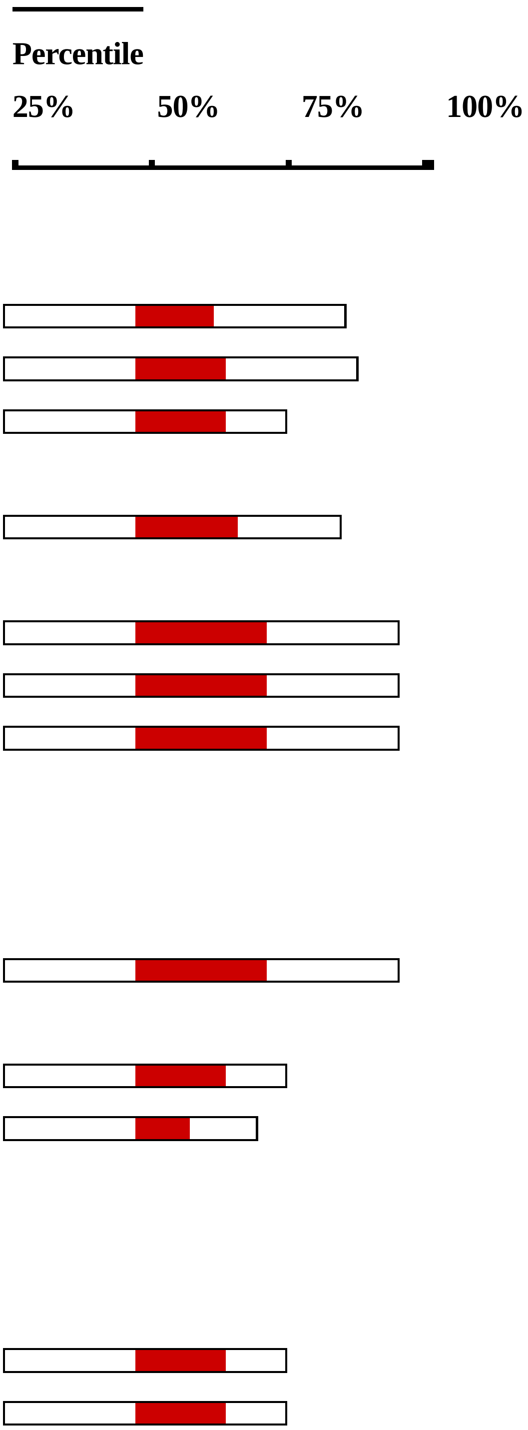
Integrated Environmental Rankings

Combined human and ecological scores

Total Hazard Value Score (UTN)

Chemical: NAPHTHALENE
CAS Number: 91-20-3

Least
Hazardous **Most**
Hazardous



Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)
- Human Health Effects Score (UTN)

Toxicity and persistence

- Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

- Ecological Effects Score (UTN)

Toxicity and persistence

- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)

Chemical: Octylphenol (1,1,3,3-TETRAMETHYLBUTYL)PHENOL
CAS Number: 27193-28-8

Least
Hazardous **Most**
Hazardous

Percentile

25% 50% 75% 100%

Ecological Health Rankings

Toxicity and persistence

Ecological Risk Screening Score (WMPT)

Chemical: Para-tert-Octylphenol 4-(1,1,3,3-TETRAMETHYLBUTYL)PHENOL
CAS Number: 140-66-9

Least
Hazardous **Most**
Hazardous

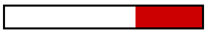
Percentile

25% 50% 75% 100%

Ecological Health Rankings

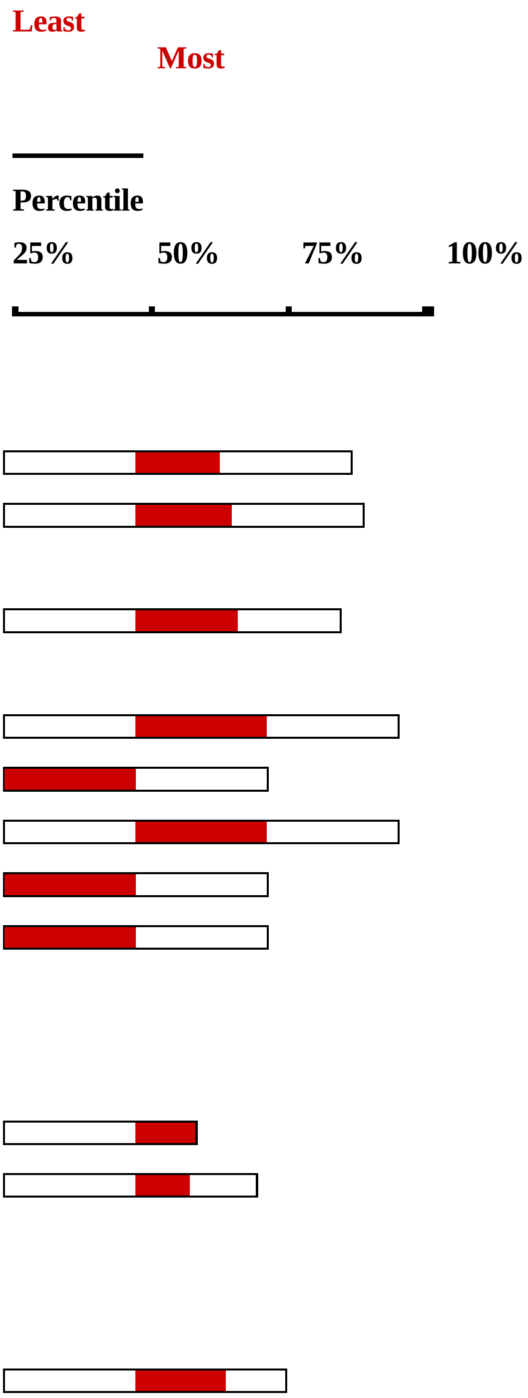
Toxicity and persistence

Ecological Risk Screening Score (WMPT)



Chemical: PENTACHLOROPHENOL
CAS Number: 87-86-5

Hazardous
Hazardous



Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)

Toxicity and persistence

- Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

- Cancer Risk Score - Air Releases (EDF)
- Cancer Risk Score - Water Releases (EDF)
- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity and persistence

- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

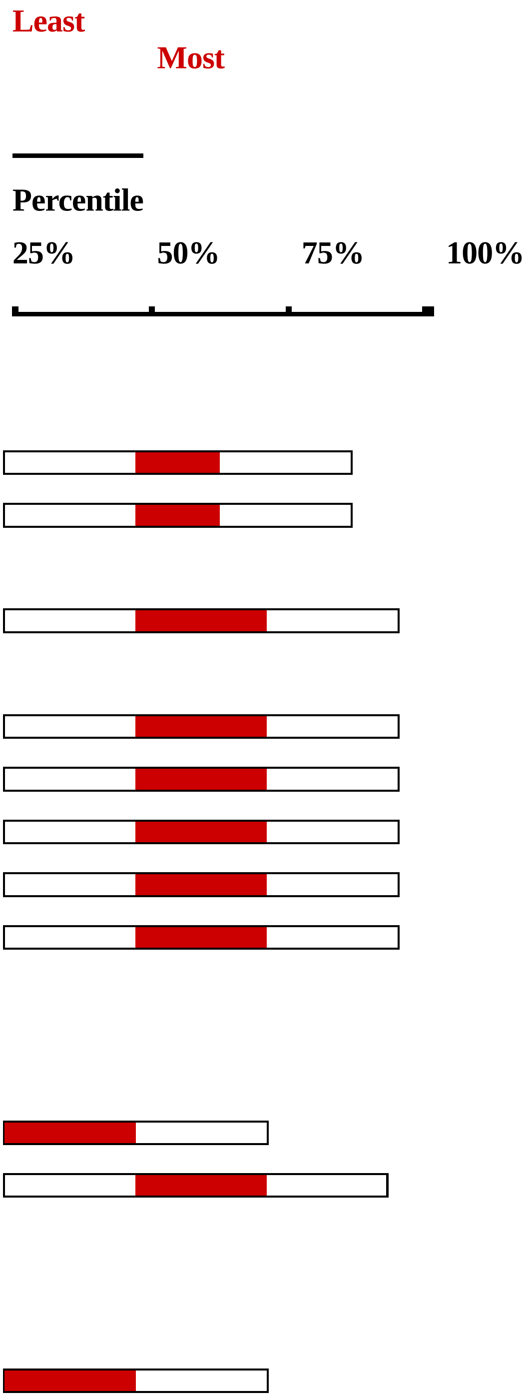
Integrated Environmental Rankings

Combined human and ecological scores

- Total Hazard Value Score (IRCH)

Chemical: SIMAZINE
CAS Number: 122-34-9

Hazardous
Hazardous



Human Health Rankings

Toxicity only

Ingestion Toxicity Weight (RSEI)

Inhalation Toxicity Weight (RSEI)

Toxicity and persistence

Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

Cancer Risk Score - Air Releases (EDF)

Cancer Risk Score - Water Releases (EDF)

Noncancer Risk Score - Air Releases (EDF)

Noncancer Risk Score - Water Releases (EDF)

Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity and persistence

Environmental Hazard Value Score (IRCH)

Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

Total Hazard Value Score (IRCH)

Chemical: TRICHLOROBENZENE
CAS Number: 12002-48-1

Least
Hazardous **Most**
Hazardous

Percentile

25% 50% 75% 100%

Ecological Health Rankings

Toxicity and persistence

Ecological Risk Screening Score (WMPT)

Chemical: 1,2,4-TRICHLOROBENZENE
CAS Number: 120-82-1

Least
Hazardous **Most**
Hazardous

Human Health Rankings

Toxicity only

- Ingestion Toxicity Weight (RSEI)
- Inhalation Toxicity Weight (RSEI)
- Human Health Effects Score (UTN)

Toxicity and persistence

- Human Health Risk Screening Score (WMPT)

Toxicity and exposure potential

- Cancer Risk Score - Air Releases (EDF)
- Cancer Risk Score - Water Releases (EDF)
- Noncancer Risk Score - Air Releases (EDF)
- Noncancer Risk Score - Water Releases (EDF)
- Worker Exposure Hazard Score (IRCH)

Ecological Health Rankings

Toxicity only

- Ecological Effects Score (UTN)

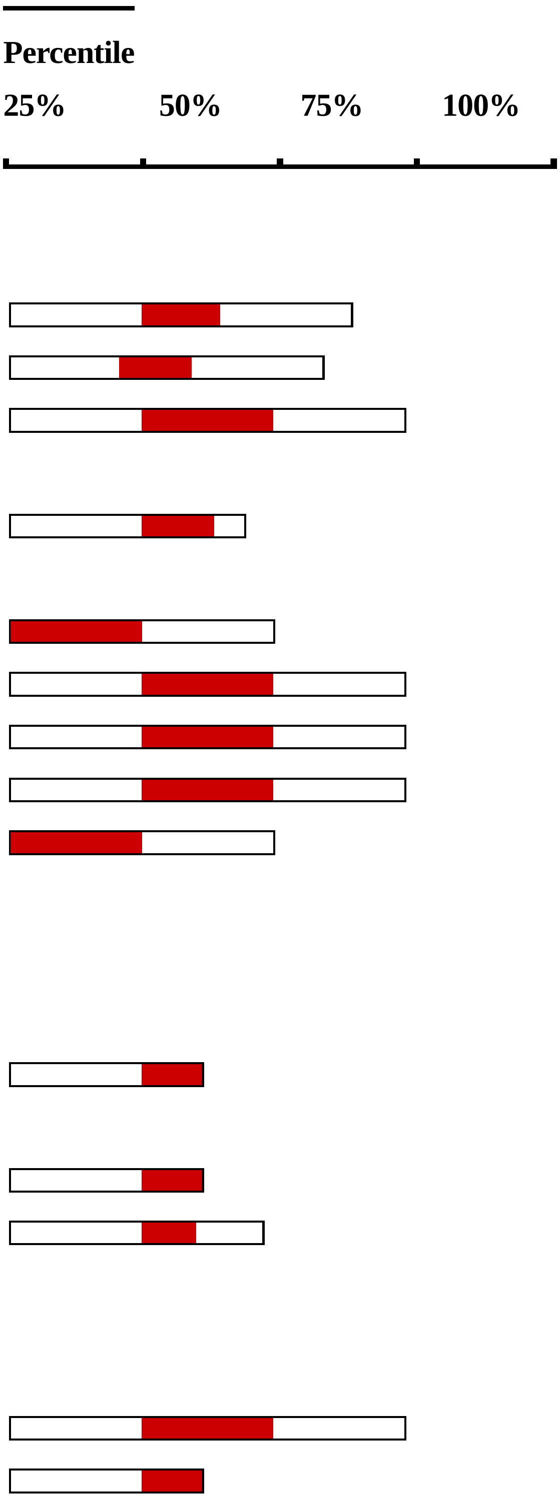
Toxicity and persistence

- Environmental Hazard Value Score (IRCH)
- Ecological Risk Screening Score (WMPT)

Integrated Environmental Rankings

Combined human and ecological scores

- Total Hazard Value Score (IRCH)
- Total Hazard Value Score (UTN)



Chemical: TRIFLURALIN
CAS Number: 1582-09-8

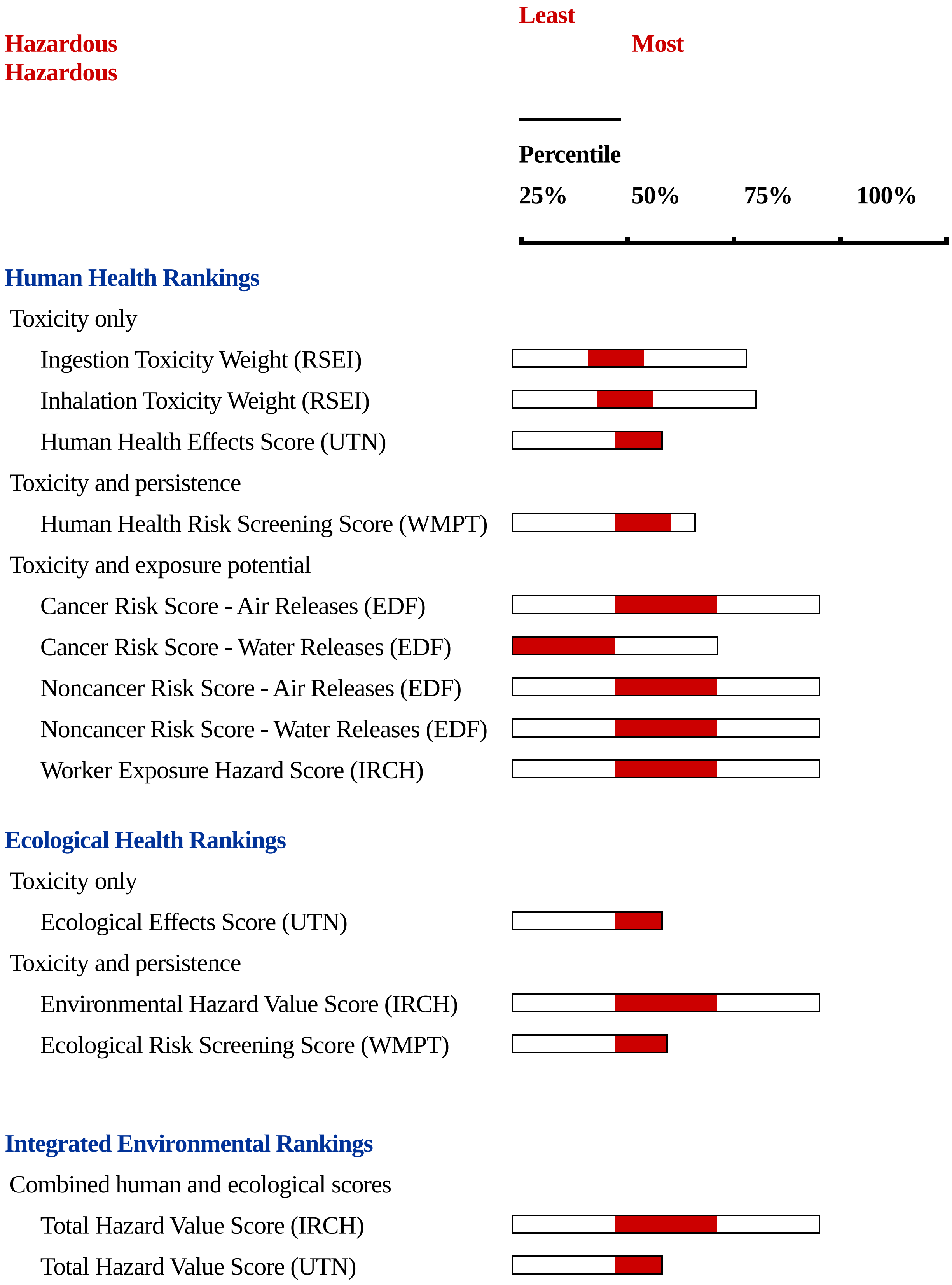


Table A.2: Hazard Category for Pollutants in the revision list

5.6 (1 represents the most hazardous; category 5 the least hazardous.)

	Cas Number	**EU Number**	**Name of substance**	**Priority hazardous substances**
(1)	*131-49-7*	*205-024-7*	*Amidotrizoate*	*5*
(2)	*1066-51-9*		*AMPA*	*4*
(3)	*25057-89-0*	*246-585-8*	*Bentazon*	*4*
(4)	*80-05-7*		*Bisphenol A*	*2*
(5)	*92-88-6*	*202-200-5*	*4 4'-Biphenol*	*2*
(6)	*298-46-4*	*06-062-7*	*Carbamazepine*	*4*
(7)	*23593-75-1*	*245-764-8*	*Clotrimazole*	*4*
(8)	*84-74-2*	*201-557-4*	*Dibutyl phthalate (DBP)*	*3*
(9)	*15307-86-5*		*Diclofenac*	*5*
(10)	*115-32-2*	*204-082-0*	*Dicofol*	*3*
(11)	*67-43-6*	*200-652-8*	*DTPA*	*4*
(12)	*60-00-4*	*200-449-4*	*EDTA*	*4*
(13)	*637-92-3*	*211-309-7*	*ETBE*	*5*
(14)	*57-12-5*		*Free Cyanide*	*2*
(15)	*1071-83-6*	*213-997-4*	*Glyphosate*	*4*
(16)	*1222-05-5*	*214-946-9*	*HHCB*	*4*
(17)	*60166-93-0*	*262-093-6*	*Iopamidol*	*4*
(18)	*7085-19-0*	*230-386-8*	*Mecoprop (MCPP)*	*4*
(19)	*36861-47-9*	*253-242-6*	*4-Methylbenzylidene camphor3*	*3*
(20)	*81-14-1*	*201-328-9*	*Musk ketone*	*5*
(21)	*81-15-2*	*201-329-4*	*Musk xylene*	*5*
(22)	*1634-04-4*	*16-653-1*	*MTBE*	*4*
(23)	*81-04-9*	*201-317-9*	*Naphthalene-1,5-disulfonate*	*2*
(24)	*5466-77-3*	*226-775-7*	*Octyl-Methoxycinnamate*	*4*
(25)			*Perfluorinated Compounds (PFCs)*	*2*
	1763-23-1	*217-179-8*	*Perfluorooctane sulphonic acid (PFOS)*	
	2795-39-3	*220-527-1*	*Potassium salt*	
	29081-56-9	*249-415-0*	*Ammonium salt*	
	29457-72-5	*249-644-6*	*Lithium salt*	
	70225-39-5		*Diethanolamine (DEA) salt*	
	335-67-1	*206-397-9*	*Perfluorooctanoic acid (PFOA)*	
	3825-26-1	*223-320-4*	*Ammonium perfluorooctanoate (APFO)*	
(26)	*124495-18-7*		*Quinoxyfen (5,7-dichloro-4-(p-fluoro phenoxy)quinoline)*	*4*
(27)	*79-94-7*	*201-236-9*	*Tetrabromobisphenol A (TBBP-A)*	*3*
(28)	*21145-77-7*	*244-240-6*	*Tonalid (AHTN)*	*5*

A1.5 The text below provides background information on the derivation of the hazard category

A1.6 **Amidotrizoate** is a contrast medium for the radiological examination of the gastrointestinal tract and is composed of Sodium Amidotrizoate 100 mg/mL and Meglumine Amidotrizoate 660 mg/mL. It can be administered orally or as an enema and is primarily indicated in cases in which the use of barium sulphate is unsatisfactory, undesirable or contraindicated. Undesirable effects in association with the use of iodinated contrast media are usually mild to moderate and transient in nature. However, severe and life - threatening reactions as well as deaths have been reported. Vomiting, nausea and diarrhoea are the most frequently recorded reactions. Systemic hypersensitivity is rare, mostly mild and occurs generally in the form of skin reactions. However, the possibility of a severe hypersensitivity reaction cannot be entirely excluded. The hypertonic Gastrografin solution may give rise to diarrhoea, but this ceases as soon as the intestine has been emptied. Existing enteritis or colitis may be temporarily exacerbated. In case of obstruction the prolonged contact with bowel mucosa can lead to erosions and to bowel necrosis. Absorption of amidotrizoic acid, the radio-opaque agent of Gastrografin, following oral administration is only 3 per cent. Non-clinical data reveal no special hazard for humans based on conventional studies of systemic toxicity, genotoxicity, toxicity to reproduction, local tolerance and contact-sensitising potential. Studies of genotoxic effects (gene-, chromosomal and genome mutation tests) using the salt mixture sodium- and meglumine amidotrizoate *in vivo* and *in vitro* gave no indication of a mutagenic potential of Gastrografin. Tumourigenicity studies have not been carried out. Due to the absence of genotoxic effects and taking into account the metabolic stability, pharmacokinetics and the absence of any indication of toxic effects of sodium- or meglumine amidotrizoate on fast - growing tissues, as well as the fact that Gastrografin is only administered once, there is no evident risk of a tumourigenic effect on humans. Due to the low resorption from the gastrointestinal tract no risk to either the pregnancy or the foetus is to be expected following inadvertent administration of Gastrografin during pregnancy. This evaluation is supported by many years of clinical experience with Gastrografin. Studies of contact-sensitising effect gave no indication of a sensitising potential of meglumine amidotrizoate. However, many years of clinical experience with Gastrografin show that the anaphylactoid reactions known to appear after other iodine-containing contrast media can occur.

A1.7 **Glyphosate** is a broad-spectrum herbicide used in both agriculture and forestry and for aquatic weed control. Microbial biodegradation of glyphosate occurs in soil, aquatic sediment and water, the major metabolite being aminomethylphosphonic acid (AMPA). Glyphosate is chemically stable in water and is not subject to photochemical degradation. The low mobility of glyphosate in soil indicates minimal potential for the contamination of groundwater. Glyphosate can, however, enter surface and subsurface waters after direct use near aquatic environments or by runoff or leaching from terrestrial applications. Glyphosate and AMPA have similar toxicological profiles, and both are considered to exhibit low toxicity. A health-based value of 0.9 mg/litre can be derived based on the group ADI for AMPA alone or in combination with glyphosate of 0.3 mg/kg of body weight, based upon a NOAEL of 32 mg/kg of body weight per day, the highest dose tested, identified in a 26-month study of toxicity in rats fed technical-grade glyphosate and using an uncertainty factor of 100. Because of their low toxicity, the health-based value derived for AMPA alone or in combination with glyphosate is orders of magnitude higher than concentrations of glyphosate or AMPA normally found in drinking-water. Glyphosate was not evaluated in the first two editions of the *Guidelines for Drinking-water Quality*, published in 1984 and 1993. In the addendum to these Guidelines, published in 1998, a health-based value of 5 mg/litre was derived for glyphosate.

A1.8 However, the health-based value is orders of magnitude higher than the concentrations normally found in drinking-water. Under usual conditions, therefore, the presence of glyphosate in drinking-water does not represent a hazard to human health, and it was not deemed necessary to establish a guideline value for glyphosate. It was noted that most AMPA, the major metabolite of glyphosate, found in water comes from sources other than glyphosate degradation.

A1.9 **Bentazone** is a broad-spectrum herbicide used for a variety of crops. Photodegradation occurs in soil and water; however, bentazone is very mobile in soil and moderately persistent in the environment. Bentazone has been reported to occur in surface water, groundwater and drinking-water at concentrations of a few micrograms per litre or less. Although it has been found in groundwater and has a high affinity for the water compartment, it does not seem to accumulate in the environment. Exposure from food is unlikely to be high. Long-term studies have not indicated a carcinogenic potential, and a variety of *in vitro* and *in vivo* assays have indicated that bentazone is not genotoxic. A health-based value of 300mg/litre can be calculated on the basis of an ADI of 0.1mg/kg of body weight established by JMPR. This guideline value was amended to 0.3mg/litre in the addendum to the Guidelines, published in 1998. However, because bentazone occurs at concentrations well below those at which toxic effects are observed, it is not considered necessary to derive a health-based guideline value.

A1.10 **Bisphenol A (BPA)** is a synthetic chemical compound used in a wide range of consumer products and is classed as a hormone disruptor. Bisphenol A is the monomer used to manufacture polycarbonate plastic, the resin lining of cans, plastic food wrap and other products, with global capacity in excess of 6.4 billion lb/year. Because the ester bonds in these BPA-based polymers are subject to hydrolysis, leaching of BPA has led to widespread human exposure. A study in the US found that 95% of people tested had been exposed to BPA. Studies have linked low-dose BPA exposure with such effects as: permanent changes to genital tract; increase prostate weight; decline in testosterone; breast cells predisposed to cancer; prostate cells more sensitive to hormones and cancer; and hyperactivity. Several recent studies show that thyroid hormone receptors (TR) may be unintended targets of chemicals manufactured for industrial purposes to which humans and wildlife are routinely exposed. Polychlorinated biphenyls, polybrominated diphenyl ethers, bisphenol-A, and specific halogenated derivatives and metabolites of these compounds have been shown to bind to TRs and perhaps have selective effects on TR functions. A number of common chemicals, including polybrominated biphenyls and phthalates, may also exert such effects. When we consider the importance of thyroid hormone in brain development, it will be important to pursue the possibilities that these chemicals-or interactions among chemical classes-are affecting children's health by influencing TH signaling in the developing brain. The plastic monomer and plasticizer bisphenol A (BPA) is one of the highest volume chemicals produced worldwide. BPA is used in the production of polycarbonate plastics and epoxy resins used in many consumer products. Vandenberg et al outlined studies that address the levels of BPA in human tissues and fluids. They reviewed the few epidemiological studies available that explore biological markers of BPA exposure and human health outcomes. They examined several studies of levels of BPA released from consumer products as well as the levels measured in wastewater, drinking water, air and dust. Lastly, they reviewed acute metabolic studies and the information available about BPA metabolism in animal models. The reported levels of BPA in human fluids are higher than the BPA concentrations reported to stimulate molecular endpoints in vitro and appear to be within an order of magnitude of the levels needed to induce effects in animal models.

In a further revue Tsai concluded that overall, it is likely that BPA is not a carcinogenic risk to humans, and is also rapidly glucuronidated and excreted through the route of urine. In 31 publications with vertebrate and invertebrate animals, significant effects occurred below the predicted "safe" or reference dose of 50 μg/kg/day BPA. An estrogenic mode of action of BPA is confirmed by *in vitro* experiments, which describe disruption of cell function at 10^{-12} M or 0.23 ppt.

A1.11 **4,4'-Biphenol** is an important organic intermediate. It can be used as antioxidant for rubbers and plastics and also as dyestuff intermediate and oil product stabilizer. Owing to its excellent thermal resistance, it can be used as modifying monomer for polyester, polyurethane, polycarbonate and epoxy resin to produce engineering plastics and composite materials with excellent properties. High-purity 4,4'-biphenol is mainly used to synthesize liquid crystal polymers (LCP). 4 4'-Biphenol, systematically known as 4,4'-dihydroxybiphenyl, consists of two aromatic hydrocarbons bonded together, each bonded to a hydroxyl group. 4 4'-Biphenol is harmful in contact with skin, and irritating to the eyes and respiratory system. Upon decomposition, it can form harmful gases like carbon monoxide and dioxide. It should not be stored with strong oxidising agents. 4,4-Biphenol is manufactured on a large scale by the oxidation and then reduction of 2,6-Ditertiarybutylphenol followed by de-akylation.

A1.12 **Carbamazepine ("CBZ")** is an anticonvulsant and mood stabilizing drug, used primarily in the treatment of epilepsy and bipolar disorder. It is also used to treat ADD, ADHD, schizophrenia and trigeminal neuralgia. Carbamazepine is known to render many hormonal contraception products ineffective, due to its action as a cytochrome P450 enzyme inducer, which is the system that metabolizes many oral contraceptives. Carbamazepine causes more cytochrome P450 enzyme to be produced, which hastens removal of the contraceptive from the blood plasma. Common side effects include drowsiness, motor coordination impairment and/or upset stomach. Carbamazepine preparations may also greatly decrease a person's alcohol tolerance. Carbamazepine is a recognised health hazard as a developmental toxicant. It is suspected of having adverse health effects with regard to the cardiovascular system, the gastrointestinal system and the kidney. It is also suspected of being a neurotoxicant, a respiratory toxicant and of having an adverse effect on the skin and sense organs.

A1.13 **Clotrimazole** is used in the treatment of candidal vaginitis and candidal vulvitis. The data demonstrate that any risk associated with using clotrimazole 2 per cent cream or 500 mg pessary is extremely small and thus the hazard to health is low. The extensive sales in the UK of Canesten pessary and cream formulations and the combined product, with minimal numbers of adverse event reports, provide reassurance about the safety of the product. There is no evidence to suggest that widespread availability is causing resistance to antifungal agents.

A1.14 **Dibutyl phthalate (DBP)** is a commonly used plasticizer. It is also used as an additive to adhesives or printing inks. It is soluble in various organic solvents, e.g. in alcohol, ether and benzene. DBP was added to the California Proposition 65 (1986) List of suspected teratogens in November of 2006. It is a suspected endocrine disrupter. It was used in some nail polishes; all major producers began eliminating this chemical from nail polishes in 2006. The substance can be absorbed into the body by inhalation of its aerosol and by ingestion. The occupational exposure limit is TLV: 5 mg/m^3 as TWA (ACGIH 2001). Animal tests show that this substance possibly causes toxicity to human reproduction or development. The substance is toxic to aquatic organisms.

The term endocrine-disrupting-chemicals is used to define a structurally diverse class of synthetic and natural compounds that possess the ability to alter various components of the endocrine system and potentially induce adverse health effects in exposed individuals and populations. Research on these compounds has revealed that they use a variety of both nuclear receptor-mediated and non-receptor-mediated mechanisms to modulate different components of the endocrine system.

A1.15 **Diclofenac** (marketed as Voltaren, Voltarol, Diclon, Dicloflex Difen, Difene, Cataflam, Pennsaid, Rhumalgan, Modifenac, Abitren, Arthrotec and Zolterol, with various drug dose combinations) is a non-steroidal anti-inflammatory drug (NSAID) taken to reduce inflammation and an analgesic reducing pain in conditions such as in arthritis or acute injury. It can also be used to reduce menstrual pain, dysmenorrhea. The name is derived from its chemical name: 2-(2,6-dichloranilino) phenylacetic acid. In the United Kingdom, India, and the United States, it may be supplied as either the sodium or potassium salt, while in some other countries only as the potassium salt. Diclofenac is available as a generic drug in a number of formulations. Over the counter (OTC) use is approved in some countries for minor aches and pains and fever associated with common infections. Diclofenac is well-tolerated after 30 years' experience by the general human population, but may unexpectedly become intolerated in some of the elderly population of long term users. Diclofenac is just one example of a large number of NSAID drugs that may be detected in water. However, the risk to human health and the environment is low.

A1.16 **Dicofol** is a persistent organochlorine acaricide. It is used in agriculture and horticulture to control spider mites and soft-bodied mites in apples, pears, soft fruit, cucumbers, tomatoes, hops, vines, lettuce and ornamentals. Dicofol is structurally similar to DDT. It is cumulative in the environment. Dicofol in soil is expected to bind to organic matter and is not likely to leach to groundwater, although there are reports of dicofol in groundwater. However, residues in soil decrease rapidly. In surface water, dicofol is expected to adsorb to sediment and can hydrolyse to dichlorobenzophenone. Dicofol accumulates in body fat to a plateau level related to absorption. The USEPA's PBT profiling model predicts dicofol to be persistent and bioaccumulative (USEPA, 2006). Exposure of the public through foods such as pears, blackcurrents and strawberries can be higher than expected and may result in a breach of the ADI (MAFF, 1996). Levels in drinking-water would be expected to be very low. Dicofol was extensively absorbed from the gastrointestinal tract. At near steady-state conditions, the highest tissue concentrations were found in adipose tissue, followed by the adrenal glands, thyroid and liver. The *p,p′*-dicofol isomer, the main component of technical dicofol, was more persistent in the body than the *o,p′*-isomer. Dicofol and DDT showed a similar pattern of distribution and elimination. Dicofol had moderate acute oral toxicity. It produces signs of toxicity consistent with central nervous system depression. WHO has classified dicofol as slightly hazardous (WHO, 1992). Based on the JMPR ADI of 0–0.002 mg/kg of body weight, the health-based value is 0.006 mg/l based on a 60-kg adult drinking 2 litres of water with an allocation of 10% of the ADI to drinking-water (because of the potential for some high exposures from fruit).

A1.17 **DTPA (diethylenetriamine penta acetic acid)** is useful as a non-radioactive carrier for radioactive metal elements. Information on the human health effects from exposure to this substance is limited. Inhalation causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Large oral doses may cause irritation to the gastrointestinal tract. It may cause irritation to skin. Symptoms include redness, itching, and pain Eye contact causes irritation, redness, and pain. Repeated exposure to may cause kidney damage and alter genetic material.

A1.18 **EDTA acid** is mainly used as sequestrant in water treatment, detergent, photography, paper-making, oil industry, and metal deactivator. It is a metal chelating agent. Human exposure to EDTA arises directly from its use in food additives, medicines, and personal care and hygiene products. Exposure to EDTA from drinking-water is probably very small in comparison with that from other sources. Once EDTA is present in the aquatic environment, its speciation will depend on the water quality and the presence of trace metals with which it will combine. The removal of EDTA from communal wastewater by biodegradation in sewage purification plants is very limited. Guideline value is 0.6 mg/litre for EDTA as the free acid. It occurs in surface waters generally at concentrations below 70 mg/litre, although higher concentrations (900 mg/litre) have been measured; detected in drinking-water prepared from surface waters at concentrations of 10–30 mg/litre ADI 1.9 mg/kg of body weight as the free acid (ADI of 2.5 mg/kg of body weight proposed by JECFA for calcium disodium edetate as a food additive). Limit of detection 1 mg/litre by potentiometric stripping analysis Treatment achievability 0.01 mg/litre using GAC plus ozonation. Concern has been expressed over the ability of EDTA to complex, and therefore reduce the availability of, zinc. However, this is of significance only at elevated doses substantially in excess of those encountered in the environment.

A1.19 Calcium disodium edetate is poorly absorbed from the gut. The long-term toxicity of EDTA is complicated by its ability to chelate essential and toxic metals. Those toxicological studies that are available indicate that the apparent toxicological effects of EDTA have in fact been due to zinc deficiency as a consequence of complexation. EDTA does not appear to be teratogenic or carcinogenic in animals. The vast clinical experience of the use of EDTA in the treatment of metal poisoning has demonstrated its safety in humans.

A1.20 **ETBE and MTBE.** A recent study from the Department of Chemical Engineering at the University of Nebraska-Lincoln compared the behaviour in water of ETBE and MTBE and found that:

- ETBE is four times less soluble in water than MTBE
- ETBE’s life in water is ½ of MTBE’s
- ETBE’s life in air is ½ of MTBE’s
- ETBE Biodegrades easier than MTBE
- ETBE can be more easily removed from water.

A1.21 Among the oxygenates, more work is needed to fully determine the differences between MTBE and ETBE – prior to making an assessment that “all ethers have similar” water characteristics.

A1.22 Methyl *tertiary*-butyl ether is commonly referred to as MTBE. No human cancer studies in relation to MTBE exposure have been published for either the general population or occupationally exposed cohorts. There have been a number of human studies of neurological and clinical effects of exposure to MTBE by inhalation, with mixed results. In general, no objective changes could be seen at levels of MTBE normally found, even in such microenvironments as petrol filling stations. The weight of evidence suggests that MTBE is not genotoxic. MTBE is more likely to be non-genotoxic than genotoxic. The dose-related increase in lymphomas and leukaemia in female rats cannot be dismissed.

The weight of evidence supports a conclusion that MTBE is a rodent carcinogen, but the data are insufficient to reach any conclusions about its potential to cause human cancer. The available data are therefore considered inconclusive and limited in their use for human carcinogenic risk assessment (IPCS, 1998). The International Agency for Research on Cancer (IARC, 1999) has classified MTBE in Group 3, not classifiable as to its carcinogenicity to humans.

A1.23 Cyanides can be found in some foods, particularly in some developing countries, and they are occasionally found in drinking-water, primarily as a consequence of industrial contamination. TDI 12 mg/kg of body weight, based on a LOAEL of 1.2 mg/kg of body weight per day for effects on behavioural patterns and serum biochemistry in a 6-month study in pigs, using an uncertainty factor of 100 for inter- and intraspecies variation (no additional factor for use of a LOAEL instead of a NOAEL was considered necessary because of doubts over the biological significance of the observed changes). Limit of detection 2 mg/litre by titrimetric and photometric techniques Treatment achievability Cyanide is removed from water by high doses of chlorine. The guideline value is considered to be protective for acute and considerations long-term exposure. The acute toxicity of cyanides is high. Effects on the thyroid and particularly the nervous system were observed in some populations as a consequence of the long-term consumption of inadequately processed cassava containing high levels of cyanide. A health-based guideline value of 0.07 mg/litre, which was considered to be protective for both acute and long-term exposure, was derived in the 1993 Guidelines. The risk assessment was originally conducted in 1993. The Final Task Force Meeting in 2003 agreed that this risk assessment be brought forward to this edition of the Guidelines for Drinking-water Quality.

A1.24 **HHCB, musk ketone (20), musk xylene (21) and Synthetic musks** used in fragrances cannot be treated as one single group –they are all very different. While traces of some musks have been found in human fat, blood, and breast milk, intensive research has shown these levels do not pose a risk to human health. Synthetic musks are safe for use in cosmetic and household products under the current conditions of use. Traces of musks have been found in the environment. The levels of the predominant artificial musks have been demonstrated to be well below any levels of concern to the environment. However, musk xylene continues to be studied by the fragrance industry because of uncertainties about its fate in the environment. Because of these uncertainties, companies in Europe are voluntarily restricting its use in consumer products. For centuries, animal extracts from musk deer and other species were used in the making of perfumes for the quality and longevity of their scent. As these species became endangered and awareness of animal protection increased, the fragrance industry developed synthetic substances to replace these natural materials. Synthetic musks have been used safely for decades in skin care products, and fine fragrances (perfumes). The best-known musks are two nitro-musks (NMs), **musk xylene** and **musk ketone**, and two polycyclic musks (PMs), which are described by the acronyms AHTN and **HHCB**. Synthetic musks are not defined by any common chemical structure; the only common factor among all synthetics musks is their musky scent. Because they lack a common chemical structure, they cannot be treated as a single group. Polycyclic musks are most widely used for detergents and cosmetic products. Nitro-musks are mainly used in cosmetics. Nitro-musks in particular have been the subject of extensive testing, examining both human and environmental safety. In 2004, European

Commission's Scientific Committee on Cosmetics and Non-Food Products (SCCNFP[1]) confirmed what all available test results demonstrate—that the use of musk xylene and musk ketone as fragrance materials is safe for the consumer. This opinion resulted in Commission Directive 2004/88/EC of September 8, 2004, a technical adaptation to the Cosmetics Directive (76/768/EEC), which set limits up to which musk xylene and musk ketone can be safely used in cosmetic products. In September 2002, the SCCNFP issued opinions on AHTN and HHCB. The committee concluded that HHCB could be used in cosmetic products without restriction and that AHTN could be used up to 12 per cent in fragrances, a level corresponding to the highest levels in current use. Most products containing NMs or PMs, such as detergents, soaps, and cosmetics, eventually end up in water. Thus, minute traces of these materials have been found in sewage and surface water. They can also be found in fish living in these waters. As a result, the EU has issued environmental risk assessments for the NMs. The results of the current research are summarized in detail by HERA and in the HHCB submission to the U.S. EPA's High Production Volume Chemicals program. The key conclusion is that measured concentrations in the environment, as well as human exposures, are well below levels that could cause harm. The EU is currently evaluating the environmental risk assessments for the PMs. AHTN and HHCB will not be considered as PBTs as they do not fulfil the criteria for being defined as persistent, bioaccumulative, or toxic. The results of studies with organisms living in sediment and soil have shown that the trace levels found in these media are safe for these organisms. The same holds true for fish and the aquatic environment. (A recent publication has raised some uncertainty with regards to the sensitivity of specific aquatic species, for which more assurance is requested to finalise the risk assessment. The fragrance industry is investigating this matter and will develop further information to resolve the concerns of this uncertainty.) A scientific advisory panel sponsored by the EU has recently evaluated these and other findings for both Tonalid and Galaxolide. Based on their recommendations, the European Commission has deleted both chemicals from its PBT listing (EU, 2003), effectively removing them from the Commission's priority chemicals program. In addition, the European Commission's Scientific Committee on Cosmetic Products and Non-food Products (SCCNFP) has recently reviewed the risks of both Tonalid and Galaxolide as fragrances in cosmetic products, such as perfumes and lotions. The SCCNFP consists of academic and governmental scientists and physicians who are retained by the Commission to provide independent technical input on risk assessments. The SCCNFP has recommended that no restrictions be established on the use of Galaxolide in cosmetic products, and that a limit of 12 per cent (by volume) be established for Tonalid. Practically speaking, this limit is technically relevant only for fine fragrance products, since other cosmetic applications use far lower levels. Regulatory authorities have not had the opportunity to review recent biomonitoring studies on Tonalid and Galaxolide. However, a determination of exposure based on measured blood levels indicates that the detected levels are well below the allowable limits that authorities have concluded are safe. As a result of the RIFM data and government recommendations, P&G has concluded that both Tonalid and Galaxolide can continue to be used safely.

A1.25 **Iopamidol**. A review was carried out by the California Environmental Protection Agency Department of Pesticide Regulation Medical Toxicology Branch of the toxicological data relating to iodine and iodine complexes. It concluded that there were considerable data gaps and that most of the studies that had been carried out were inadequate.

A1.26 **Mecoprop (MCPP)** is a pesticide and is included in the plan of work of the rolling revision of the WHO Guidelines for Drinking-water Quality. The Guidelines for Drinking-water Quality Final Task Force meeting (Geneva, 2003) recommended that several pesticides be referred to the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) with varying levels of priority. These were pentachlorophenol (medium), alachlor (high), ametryn (high), chlorotoluron (low), cyanazine (low), diazinon (low), dichlobenil (medium), 1,2-dichloropropane (low), 1,3-dichloropropene (low), diuron (medium), MCPA (low), methoxychlor (high), metolachlor (low), molinate (high), pendimethalin (no priority set), simazine (high), dichlorprop (low), **mecoprop (medium)** and 2,4,5-T (medium).

A1.27 **4-Methylbenzylidene camphor.** Following application of sunscreen containing 4-methylbenzylidene camphor there were detectable concentrations in human blood and urine up to 24 hours after sunscreen use (Janjua et al 2004; Schauer et al 2006). In terms of hormone disruption estrogenic activity was detected in vitro and in vivo (Schlumpf et al 2001, 2004; Schmutzler et al 2004; Gomez et al 2005; Heneweer et al 2005; Schreurs 2005; Maerkel et al 2007). There was limited information concerning the release of free radicals or other harmful breakdown products. There was no evidence of sensitisation, allergy or photoallergy. There was only slight photodegradation on exposure to sunlight. There was UVB protection but no UVA effectiveness.

A1.28 **Naphthalene-1,5-disulfonate.** Sulfonated naphthalenes and their formaldehyde condensates (SNFC) are ubiquitous water pollutants due to their widespread uses, anionic character, and refractory behaviour. They are predominantly applied in the textile industry and as concrete super plasticisers in the construction business, each with global uses of about 150,000 tons per year. The environmental impact of sulfonated naphthalenes originating from textile finishing was already thoroughly investigated. However, the role of the construction industry as a source for SNFC in the environment was largely unknown. A recent study focused on the environmental risk of SNFC deriving from construction activities. Since modern construction technology is increasingly based on chemical admixtures and since SNFC are among the mostly used concrete admixtures this study is a suitable example for the environmental risk assessment of polar organic construction chemicals in general. Most monomers were degraded within 195 days, while naphthalene-1,5-disulfonate and the SNFC oligomers were refractory. In the groundwater, SNFC components with chain lengths of one to four units were found. They exhibit different migration times in the aquifer. This was explained by adsorption experiments with a 0.16 to 0.5 mm fraction of aquifer material which showed that the adsorption ability of the oligomers was increasing with the chain length. Oligomers with chain lengths of more than four units were found to adsorb within hours to an extent of more than 90 per cent. This implies that they are strongly adsorbing onto the cement and, therefore, do not leach into the groundwater. It was estimated that about 5 per cent of the applied SNFC leaches into the groundwater. About 80 per cent of this amount is biodegraded in the aquifer, while 20 per cent remain in the groundwater. Further investigations on additional SNFC sources revealed that SNFC from construction site wastewater as well as from wastewater of SNFC producers can enter the environment by way of wastewater treatment plants. Since naphthalene-1,5-disulfonate and the SNFC oligomers persisted in adapted biological treatment plants, they can enter the environment unchanged. The measured environmental concentrations of SNFC were the basis for a risk assessment for groundwater and surface waters.

Only one PEC/PNEC ratio for a worst case scenario turned out to be above 1, implying possible impact of the environment. With this study, the major sources for SNFC in the environment which are related to the construction industry were identified and the fate and behaviour of SNFC in the groundwater was thoroughly investigated, providing a representative example for the environmental risk of polar organic construction chemicals.

A1.29 **Perfluorinated Compounds (PFCs)** are a family of fluorine-containing chemicals with unique properties to make materials stain and stick resistant. PFCs are incredibly resistant to breakdown and are turning up in unexpected places around the world. Although these chemicals have been used since the 1950s in countless familiar products, they have been subjected to little government testing. There are many forms of PFCs, but the two getting attention recently are PFOA or perfluorooctanoic acid, used to make Teflon products and PFOS or perfluorooctane sulfonate, a breakdown product of chemicals formerly used to make Scotchgard products. PFOA is a likely human carcinogen; it causes liver, pancreatic, testicular, and mammary gland tumours in laboratory animals. PFOS causes liver and thryoid cancer in rats. PFCs cause a range of other problems in laboratory animals, including liver and kidney damage, as well as reproductive problems. PFOA's half-life in our bodies, or the time it would take to expel half of a dose, is estimated at more than four years. PFOS's half-life is estimated at more than eight years. A comparative study on the use of cetyltrimethylammonium bromide (CTAB)-coated silica and sodium dodecyl sulphate (SDS)-coated alumina mixed hemimicelles-based solid-phase extraction (SPE) for the pre-concentration of six perfluorinated compounds (PFCs) in environmental water samples was presented. The six analytes, heptafluorobutyric acid (HFBA), perfluoroheptanic acid (PFHeA), perfluorooctanic acid (PFOA), perfluorooctanic sulfonic (PFOS), perfluorononanic acid (PFNA) and perfluorodecanic acid (PFDeA) were quantitatively retained on both sorbent materials. The cationic surfactant (CTAB adsorbed onto silica) was more appropriate for SPE of PFCs. The main factors affecting adsolubilisation of PFCs including the amount of surfactant, pH of solution, sample loading volume and desorption were investigated and optimized. Concentration factor of 500 were achieved by SPE of 500 mL of several environmental water samples. The method detection limits obtained for HFBA, PFHeA, PFOA, PFOS, PFNA and PFDeA were 0.10, 0.28, 0.07, 0.20, 0.10 and 0.05 ng/L, respectively. The relative standard deviation of recoveries ranged from 2 to 8 per cent, which indicated good method precision. Occurrence of perfluorooctane sulfonate (PFOS) in the tissues of humans and wildlife is well documented. In the study by Taniyasu et al concentrations and distribution of PFOS, perfluorohexane sulfonate (PFHS), and perfluorobutane sulfonate (PFBS) were determined in samples of surface water, fish and bird blood and livers, and human blood collected in Japan. Notable concentrations of PFOS were found in surface water and fish from Tokyo Bay. PFOS was found in all of the 78 samples of fish blood and liver analyzed. Based on the concentrations of PFOS in water and in fish livers, bioconcentration factors were calculated to range from 274 to 41 600. Concentrations of PFOS in the blood of Japanese human volunteers ranged from 2.4 to 14 ng/mL. PFHS was detected in 33 per cent of the fishes analyzed, at concentrations severalfold less than those of PFOS.

A1.30 **Quinoxyfen** is a fungicide whose primary activity on the mildew pathogen is the prevention of the formation of appressoria. Secondary activity affects spore germination and spore viability. Instead of forming appressoria, spores landing on treated leaf surfaces produce a germ tube that elongates until its internal reserves are exhausted. Once starved of resource the fungus dies. In view of the characteristics of the substance with regard to the screening criteria for persistence, bioaccumulation and toxicity in Annex D to the Stockholm Convention on Persistent Organic Pollutants, a tripartite meeting was organised on 13 February 2003 between the Commission, the notifier and the Rapporteur Member State. The overall conclusion from the evaluation is that it may be expected that plant protection products containing quinoxyfen will fulfil the safety requirements laid down in Article 5(1)(a) and (b) of Directive 91/414/EEC. The review established that the residues arising from the proposed uses, consequent on application consistent with good plant protection practice, have no harmful effects on human or animal health. The Theoretical Maximum Daily Intake (TMDI) for a 60 kg adult is 0.4 per cent of the Acceptable Daily Intake (ADI), based on the FAO/WHO European Diet (August 1994). The review has identified acceptable exposure scenarios for operators, workers and bystanders, which require, however, confirmation for each plant protection product in accordance with the relevant sections of the above mentioned uniform principles. The review has also concluded that under the proposed and supported conditions of use there are no unacceptable effects on the environment.

A1.31 **Tetrabromobisphenol A (TBBP-A)** is widely used and incorporated in polymers as a reactive or additive flame retardant. Contact of the general population is with products made from these polymers and would not result in significant uptake of TBBPA. Furthermore, the acute and repeated dose toxicity of TBBPA is very low. TBBPA is poorly absorbed from the gastrointestinal tract. The risk for the general population from TBBPA exposure is, therefore, considered to be insignificant. Occupational exposure to TBBPA is primarily as particulates during packaging or mixing operations. The control of dust through the use of local ventilation and other engineering methods will reduce the risk to workers. If dust cannot be adequately controlled, respiratory protection should be used. Where detected in the environment, TBBPA is mainly found in soil and sediment samples. A relatively high bioconcentration factor seems to be balanced by rapid excretion and the compound has not normally been found in environmental biological samples. The phenolic groups of TBBPA may be methylated in the environment and the resulting Me2-TBBPA is more lipophilic. This compound has also been found in sediment, fish, and shellfish.

APPENDIX 2: RELEVANT REFERENCES

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