# Revised Draft pCEA Chapter on Chemicals Following Stakeholder Review

**September 2007**

**Authors: Risk & Policy Analysts Ltd**

# Acknowledgements

This final version of the Chemicals pCEA draws heavily on the text and figures presented in the draft final report prepared by Entec, with the assistance of the Environment Agency, for Defra. Additional work has been undertaken to add further details of potential measures and their costs and to address comments made by stakeholders on the draft final report. This work has included consultation with the Environment Agency and with a selection of the stakeholders to either gather new information or to clarify comments on the draft final.

# EXECUTIVE SUMMARY

*The principal conclusion of the pCEA report is that a phased approach to implementation, allowing for a programme of investigations, phasing and more innovative measures to achieve standards by 2027, is substantially cheaper than a limited phasing approach, with the introduction of measures to meet the standards as far as possible by 2015 (unless technically infeasible).*

*The actual cost differential between the approaches is of the order of £400 million per annum. However, there is a considerable degree of uncertainty with regard to the final cost of Water Framework Directive implementation. This uncertainty is in part due the fact that Environmental Quality Standards have yet to be finalised. For both options the most significant cost impact is on the water industry and to a lesser extent, ports.*

*A limited phasing approach with the introduction of measures to achieve objectives by 2015 would primarily rely on "end of pipe" controls, such as additional treatment at sewage treatment works. A phased approach would rely much more on source control, for example restrictions on the use of some chemicals in applications where they could be released to water.*

*Chemical inputs arise from a very diverse range of sources, urban and agricultural land use, industry, domestic release to sewers, mines, ports and harbours. All sources have a role to play and the relative importance varies depending on the chemical. The cost effectiveness of source control options depends on the substance and its use profile. This, together with, the large uncertainty about the compliance gap that needs to be closed and the potentially very high costs of 'end-of-pipe' treatment suggests that there is a need for further investigations and pilots to reduce uncertainties before committing to widescale investment in infrastructure.*

*There are a number of significant other initiatives on chemicals coming in, such as REACH, that we can reasonably expect to reduce emissions of chemicals to water. Phasing actions would also allow more time for other measures to take effect to reduce the compliance gap and to provide greater certainty on the remaining gap that end-of-pipe treatment may need to address.*

*At this stage, the benefits of the phased approach which reduces the risk of incurring significant and unnecessary costs appear to outweigh these risks of failing WFD objectives. This balance of risks and benefits may change in the second round of planning as uncertainties are resolved.*

# TABLE OF CONTENTS

**EXECUTIVE SUMMARY .............................................................. iii**

**1. INTRODUCTION ..............................................................1**
1.1 Background ..............................................................1
1.2 Aims and Scope ..............................................................2

**2. WFD OBJECTIVES ..............................................................5**
2.1 General Objectives ..............................................................5
2.2 Priority Substances ..............................................................5
2.3 Specific Pollutants ..............................................................8
2.4 Other Objectives ..............................................................10

**3. PRESSURES AND TRENDS ..............................................................13**
3.1 General Considerations ..............................................................13
3.2 Pressures and Trends for Priority Substances ..............................................................13
3.3 Pressures and Trends for Specific Pollutants ..............................................................19
3.4 Most Likely EQS Failures ..............................................................19
3.5 Implications of Measures and Regulations ..............................................................20

**4. APPORTIONMENT AND UNCERTAINTY ..............................................................25**

**5. MEASURES TO MEET WFD OBJECTIVES ..............................................................37**
5.1 Substances and Measures Considered ..............................................................37
5.2 The Options ..............................................................38
5.3 Overview of Measures ..............................................................39
5.4 Overview of Measures for Each Substance ..............................................................44

**6. COST OF MEASURES ..............................................................53**
6.1 Introduction ..............................................................53
6.2 Costs for Each Option ..............................................................63
6.3 Differences in Previous Cost Estimates and Stakeholder Concerns ..............................................................65
6.4 Cost-Effectiveness Analysis ..............................................................69
6.5 Assumptions and Limitations ..............................................................69

**7. FURTHER CONSIDERATIONS ..............................................................71**
7.1 Measures to Reduce Uncertainty ..............................................................71
7.2 Alternative Cost Sharing ..............................................................71
7.3. Other Considerations ..............................................................72

**8. CONCLUSIONS ..............................................................75**

**9. REFERENCES ..............................................................77**

# ACRONYMS

| | |
|---|---|
| Defra | Department for Environment, Food and Rural Affairs |
| EA | Environment Agency |
| EC | European Commission |
| EQS | Environmental Quality Standards |
| GCS | Good Chemical Status |
| GES | Good Ecological Status |
| NADiP | Non-Agricultural Diffuse Water Pollution |
| pCEA | preliminary Cost Effectiveness Analyses (Analysis) |
| PHS(s) | Priority Hazardous Substance(s) |
| PPP | Plant Protection Products |
| PRP | Pollution Reduction Programmes |
| PS(s) | Priority Substance(s) |
| SP(s) | Specific Pollutant(s) |
| RBMP | River Basin Management Planning |
| WwTW | Wastewater Treatment Works |
| WFD | Water Framework Directive |

# 1. INTRODUCTION

## 1.1 Background

The Department for Environment, Food and Rural Affairs (Defra) is undertaking preliminary cost effectiveness analyses (pCEA) for a number of UK market sectors in order to determine the potential costs associated with implementing the requirements of the Daughter Directive[1] for Priority Substances (PS) under Annex X of the WFD and specific pollutants (SP) under Annex VIII.

This report provides the conclusions of this work to date, drawing on a range of sources. The Water Industry via UK Water Industry Research Ltd (UKWIR) project reference WW17, and more recently via a pCEA Supporting Document, has been conducting extensive investigations into the likely quality requirements of wastewater treatment works (WwTW) effluents to comply with the proposed standards under the WFD. In addition, ICF, Atkins, Entec, RPA and other consultants have undertaken a number of sampling and analysis programmes, literature reviews, regulatory impact assessments (RIA) and economic analyses to determine the likely cost and benefits of options to achieve compliance and the associated level of uncertainty.

The UKWIR WW17 project (Atkins Ltd, RPA Ltd and ICF International, 2006), considered a cost analysis of source control versus end-of-pipe treatment to achieve the required effluent quality, considered diffuse inputs of PS and SP as well as industrial discharges to sewers. The pCEA (Atkins, 2007) examined direct industrial discharges, industrial discharges via WwTW and Non-Agricultural Diffuse Water Pollution (NADiP) although only end-of-pipe costs were considered.

The RIA carried out by RPA considered three options relating to the implementation of the WFD Environmental Quality Standards (EQS) for priority and priority hazardous substances: 'do nothing'; meeting EQS through end-of-pipe controls; and meeting EQS as well as the requirement for cessation of PHS through end-of-pipe and other controls.

Other relevant studies and consultations have included Environment Agency (EA) pollution reduction programmes (PRP) for specific pollutants, pilot Supplementary Plans and Action Plans for individual PHS, and studies of impacts of EU-wide bans, restrictions or charges for the use of specific substances. The previous work has been largely successful in identifying substances for phase out, reduction or pollution prevention, and highlighting those for which there may be concerns regarding compliance with EQS by 2015. Other influences, such as Industry, Agriculture, NADiP and Flood Risk Management, have been the focus of similar pCEA studies.

Entec (draft, July 2007) pulled together these various sources of information to provide an overarching preliminary cost-effectiveness analysis. However, the proposed UKTAG

1 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, Council of the European Union, Brussels, June 2007.

standards[2] for specific pollutants were not agreed in time for a proper assessment within the Entec report. Furthermore, other changes to the proposed Daughter Directive on EQS for the PS, together with information from industry in response to consultation on a draft Partial RIA, have resulted in changes to the estimated costs of the most recent set of the Council of Ministers' proposals.

This final draft of the pCEA for the proposed chemicals standards takes these more recent developments into account. It also takes account of comments received from stakeholders following the pCEA workshop in London on the 12 July 2007.

## 1.2 Aims and Scope

There are two key economic concepts underlying the development of programmes of measures at the national, regional and local level for inclusion in River Basin Management Plans:

- **Cost-effectiveness** (CE): where there a number of potential measures that could be implemented to achieve Good Ecological Status (GES) for a water body, cost effective measures are those which deliver the objective for the least overall cost; and

- **Disproportionately costly** (DC): there are two tests for DC, with these relating to economic efficiency (whether total costs outweigh total benefits) and distributional impacts which includes considerations such as affordability and significant deviations from the polluter pays principle).

This report is mainly concerned with the first concept – identifying those measures which would provide the most cost-effective set of actions for meeting GES in relation to the chemicals standards set either for the priority substances or by UKTAG for the specific pollutants. However, it also recognises that even if a measure is the most cost-effective approach available, it may not be affordable and thus may be disproportionately costly. The intention is not, however, to provide an assessment of whether or not the measures would be disproportionately costly, instead it aims to flag potential affordability issues to ensure that these are considered when selecting the final programme of measures.

This report contains the results of a concentrated effort to consolidate knowledge and information from previous studies to define scenarios for addressing the gap in chemicals compliance with WFD objectives. The focus here is on the 33 PS and the further nine SP for which new standards are being proposed, with emphasis given to a sub-set of these substances for which there is a medium or high risk of failing the proposed EQS in 2015.

---

[2] UK TAG (2007): Proposals for Environmental Quality Standards for Annex VIII Substances, SR1 – 2007, June.

Although other chemical pollutants, such as zinc and copper, may currently be posing risks to the aquatic environment, these mainly relate to historic problems (old mines, contaminated land) or to existing problems at sewage treatment works at least in part due to the fact that current standards do not fully consider bioavailability and natural background levels. No new standards are being proposed for these substances at present. Furthermore, any measures that are required to address current compliance failures should not be included in the costs of meeting the proposed WFD standards. These are costs that would be incurred in any event in order to comply with current standards.

In order to better understand the extent and nature of the gap in water quality that needs to be tackled, a number of scenarios have been developed. These help define an estimate of the starting point prior to WFD implementation ('bottom of the gap') and the uncertainty surrounding cost estimates. Measures range from those immediately applicable (e.g. already approved and funded) but at high costs and with further actions likely to be needed under the WFD to those that may rely on other Directives, policies and initiatives and therefore less direct action under WFD.

For the purposes of this pCEA, two options are considered. These options both assume that site investigations, monitoring and other research that has been identified as essential by the Environment Agency is undertaken as a minimum. In addition, the options then assume:

- **Option 1**: Limited phasing – introduce the measures required to meet the standards as far as possible by 2015 (unless technically infeasible); and

- **Option 2**: Phased action – allow for a programme of investigations, phasing and more innovative measures to achieve standards by 2027.

For Option 1, it is assumed that measures aimed at achieving the EQS are adopted, even though their relative effectiveness is currently unclear. In this case, the aim is to take action to try and meet the EQS by 2015. Option 2 delays action to allow either better information to be collected on the need for action, or for measures at the EU level to either take effect or to be agreed and introduced.

Given these two options, this report considers both measures that use existing knowledge and technology to address reduction in selected chemicals (and therefore represent high certainty of achieving WFD targets) and measures that may rely on innovation, anticipated technological advances or voluntary actions (and are therefore associated with higher uncertainty).

In order to categorise the potential measures according to the above options, there is a need to examine positive and negative trends in usage and in concentrations of the various WFD priority substances and specific pollutants and existing (or anticipated) pressures in various sectors. The possibility of certain sectors offering an increased contribution to reducing the gap and the phasing of measures is also considered.

## 1.3 Organisation of the Report

The remainder of this report has been organised as follows:

- the **WFD objectives** and the proposed standards are set out in Section 2;

- the main **pressures and trends** identified for each of the chemicals/substances are summarised in Section 3, with reference to the key sectors associated with emissions, discharges and losses. This includes a summary of other policies and legislation that will affect levels of the different pollutants in the environment;

- an **apportionment of the gap** between sectors and the identified levels of uncertainty relating to specific sectors and chemicals is provided in Section 4;

- the **measures that may be required to meet the WFD objectives** (i.e. address emissions, discharges and losses of the various chemicals) are then discussed in Section 5 and grouped under the two Options introduced above;

- estimates of the **potential costs** and the associated affordability of the selected measures under the scenarios are discussed in Section 6;

- **measures to reduce uncertainties** and any further considerations are examined in Section 7; and

- the **study conclusions** are provided in Section 8.

This study has been limited by the amount of data and information that was available within the timeframe, as much of the related work is still on-going or was not completed in time to be included in this review.

As a result, attention should be given to the assumptions made within each of the individual reference studies and reports. A list of references is given in the last section of this report. A full cost assessment of implementing the proposed measures was outside the scope of this report.

# 2. WFD OBJECTIVES

## 2.1 General Objectives

The Water Framework Directive sets out the following default objectives for the water environment:

- prevent deterioration of the status of all surface water and groundwater bodies; and
- protect, enhance and restore all bodies of surface water and groundwater with the aim of achieving good status for surface water and groundwater by 2015.

In order to achieve good status, a water body must achieve both good chemical status and good ecological status.

- Good chemical status (GCS) requires achievement of all EQSs, set by the EC, for priority substances in Annex X; for certain other pollutants set out in Annex IX [namely carbon tetrachloride, cyclodiene pesticides (aldrin, dieldrin, endrin, isodrin), DDT, tetrachloro-ethylene, trichloroethylene].

- Good ecological status (GES) requires achievement of all EQSs set at a Member State level for Specific Pollutants. In the first River Basin Planning round, UKTAG are proposing that there will be standards for nine such substances. In addition, there are standards for other ecological elements (e.g. macroinvertebrates, phytoplankton and fish).

## 2.2 Priority Substances

### 2.2.1 The WFD and Proposed Daughter Directive

Article 16 of the WFD sets out a strategy for dealing with the chemical pollution of water. It requires the European Commission to bring forward a proposal for a list of Priority Substances which present a significant risk to or via the aquatic environment, and which should be subject to EU-wide measures, including EQS and emission controls aimed at the progressive reduction of pollution by discharges, emissions and losses to the environment of PS.

In 2001, a list of PS was adopted (Decision 2455/2001/EC) identifying 33 substances of priority concern at Community level, including a subset of Priority Hazardous Substances (PHS). The 33 substances which are the subject of the proposal are:

- Priority Substances: alachlor, atrazine, benzene, chlorfenvinphos, chlorpyrifos, 1,2-dichloroethane, dichloromethane, di(2-ethylhexyl)phthalate (DEHP), diuron, fluoranthene, isoproturon, lead and compounds, naphthalene, nickel and compounds, octylphenol, pentachlorophenol, simazine, trichlorobenzenes, trichloromethane and trifluralin.

- Priority Hazardous Substances: anthracene, brominated diphenylether (pentaBDE only), cadmium and compounds, chloroalkanes ($C_{10-13}$), endosulfan, hexachlorobenzene, hexachlorocyclohexane, hexachlorobutadiene, mercury and compounds, nonylphenols, pentachlorobenzene, polyaromatic hydrocarbons (PAH) and tributyltin compounds.

These substances were prioritised based on their individual bioaccumulation potential, toxicity, persistence, risk to human health, and in relation to the monitored and modelled concentration of each substance in the aquatic environment using the COMMPS (combined modelling and monitoring prioritisation) procedure.

The Directive aims to achieve the progressive reduction of discharges, emissions and losses of all priority substances. It anticipates that a Priority Substances Daughter Directive will establish a date for cessation of 20 years or less within agreement of a proposal. However, in recital 4 of Decision 2455/2001/EC, it was recognised that for substances occurring naturally, or produced through natural processes, such as cadmium, mercury and PAHs, complete phase-out is impossible. Furthermore, no proposals have been put forward for specific emission control measures.

The EU Presidency proposal for the daughter Directive was agreed at Environment Council on 28 June, but a second reading in the European Parliament will be required before a final text is agreed. If agreement is not reached conciliation may be required.

The list of PS required by the Directive was agreed in 2001. However, under Article 16(4) of the Directive, the European Commission must review the list of priority substances in Annex X, which are used to determine good chemical status, every four years. This will next be reviewed in 2008.

### 2.2.2 The Proposed EQS

The current proposal for the daughter Directive would introduce legally binding EQSs for nine substances for which the UK does not currently have statutory standards. In other cases, the proposed EQS are significantly lower than those that currently apply in the UK. Table 2.1 below provides a comparison of the current and proposed EQS. It should be noted that, in some cases, the proposed EQS is below the current limit of detection.

Where the current EQS is similar to or lower than the proposed EQS, or where monitoring data indicates that further control measures are not required, the costs of meeting the requirements of the proposal would be limited. Where the current EQS is higher than the proposed EQS, or the compliance regime is more stringent (for example because a mandatory MAC has been set), more extensive action may be required.

| Table 2.1: Comparison of Current UK EQS and Proposed EQS | | | |
|---|---|---|---|
| **Substance** | **AA-EQS in inland waters** | | **Factor by which the stringency of the proposed is tighter than the current EQS** |
| | **Current EQS** | **Proposal EQS** | |
| Alachlor | - | 0.3 | - |
| Anthracene | - | 0.1 | - |
| Atrazine<br>Simazine | Total } 2 | 0.6<br>1 | 2-3.3 |
| Benzene | 30 | 10 | 3 |
| PentaBDE | - | 0.0005 | - |
| Cadmium and its compounds[1] | 5 | ≤0.08 | 63 |
| | | 0.08 | 63 |
| | | 0.15 | 33 |
| | | 0.25 | 20 |
| Chloroalkanes ($C_{10-13}$) | - | 0.4 | - |
| **Chlorfenvinphos** | **0.03** | **0.1** | **0.3** |
| Chlorpyrifos | - | 0.03 | - |
| **1,2-Dichloroethane** | **10** | **10** | **1** |
| **Dichloromethane** | **2** | **20** | **0.1** |
| Di(2-ethylhexyl) phthalate | - | 1.3 | - |
| Diuron | 2 | 0.2 | 10 |
| **Endosulfan** | **0.003** | **0.005** | **0.6** |
| Fluoranthene | - | 0.1 | - |
| Hexachlorobenzene[2] | 0.03 | 0.01 | 3 |
| **Hexachlorobutadiene[2]** | **0.1** | **0.1** | **1** |
| Hexachlorocyclohexane | 0.1 | 0.02 | 5 |
| Isoproturon | 2 | 0.3 | 7 |
| Lead and its compounds | 4-20* | 7.2 | 3 |
| Mercury and its compounds[2] | 1 | 0.05 | 20 |
| Naphthalene | 10 | 2.4 | 4 |
| Nickel and its compounds | 50-200* | 20 | 2.5 - 10 |
| Nonylphenol | 1 | 0.3 | 3 |
| Octylphenol | 1 | 0.1 | 10 |
| Pentachlorobenzene | - | 0.007 | - |
| Pentachlorophenol | 2 | 0.4 | 5 |
| Polyaromatic hydrocarbons* | - | | - |
| -(Benzo(a)pyrene) | | 0.05 | |
| -(Benzo(b)fluoranthene) | | Σ=0.03 | |
| -(Benzo(k)fluoranthene) | | Σ=0.03 | |
| -(Benzo(g,h,i)perylene) | | Σ=0.002 | |
| -(Indeno(1,2,3-cd)pyrene) | | Σ=0.002 | |
| Tributyltin compounds | 0.02 | 0.0002 | 100 |
| **Trichlorobenzenes** | **0.4** | **0.4** | **1** |
| Trichloromethane (Chloroform) | 12 | 2.5 | 5 |
| Trifluralin | 0.1 | 0.03 | 3 |

Note: *The proposed EQS for PAHs is represented by the sum of the concentrations of each constituent, which must not exceed the individual concentrations presented in the table.
Shaded cells indicate that the proposal EQS is higher than the existing EQS.
1. depending on water hardness
2. standards are also set for the concentration of hexachlorobenzene, hexachlorobutadiene and methyl-mercury in fish, molluscs, crustacean and other biota

### 2.2.3 WFD Article 4 Provisions

As discussed below (see Table 3.1), there is a range of other regulatory measures aimed at reducing emissions of the priority substances to the environment. These include marketing and use restrictions, classification and labelling which will have the effect of reducing the use of particular substances in the workplace and in consumer goods, approval processes under other legislation (e.g. the Plant Protection Products Directive), air quality legislation, etc. The existence of such measures underlies, in part, the European Commission's view that a significant level of action in addition to current or forthcoming regulatory requirements is unlikely to be required.

However, this argument is also supported by two of the more important modifications that have been made to the proposed text for the Daughter Directive, stating that:

- WFD Article 4 exemptions may apply to the objective of achieving the EQSs, and thereby allow for less stringent objectives and extended timescales to achieve good status where measures are technically infeasible or disproportionately costly. In such cases, alternative objectives can be set and the Directive allows extension of the timetable for achieving good status by up to 12 years, or to set an objective that is less stringent than good status.

- WFD Article 4 exemptions also apply to the objective of "aiming to" cease emissions, discharges and losses of PHS and progressive reduction of discharges emissions and losses of PS.

## 2.3 Specific Pollutants

For the first River Basin Planning round, UKTAG are proposing standards for nine specific pollutants (SP): 2,4-D ester and non-ester; chromium; cypermethrin; diazinon; dimethoate; linuron; mecoprop; phenol; and toluene. These standards have been developed following the type of approach that was used by the Commission to establish the EQS for the priority substances, although in this case the UKTAG has applied the approach only to those substances for which adequate data exist. The proposed EQS for these specific pollutants are presented in Table 2.2, together with details of the existing UK standards where these exist.

| **Table 2.2: Proposed UKTAG Standards for Specific Pollutants (Part A)** | | | | |
|---|---|---|---|---|
| **Water** | **Exposure** | **Compliance Statistic** | **UKTAG Proposal** | **Existing Standard** |
| **2,4-D (μg/l)** | | | | |
| Fresh and Salt | Long-term | Annual mean | 0.3 | 40 (acid), 1(ester) |
| | Short-term | 95- percentile | 1.3 | 200 (acid), 10 (ester) |
| **Chromium (VI) (μg/l dissolved) (1)** | | | | |
| Fresh | Long-term | Annual mean | 3.4 | 5 – 50 |
| | Short-term | 95- percentile | Not available | - |
| Salt | Long-term | Annual mean | 0.6 | 15 |
| | Short-term | 95- percentile | 32 | - |
| **Chromium (III) (μg/l dissolved) (1)** | | | | |
| Fresh | Long-term | Annual mean | 4.7 | - |
| | Short-term | 95- percentile | 32 | - |
| **Cypermethrin (ng/l)** | | | | |
| Fresh | Long-term | Annual mean | 0.1 | 0.2 |
| | Short-term | 95- percentile | 0.4 | 2.0 |
| Salt | Long-term | Annual mean | 0.1 | 0.2 |
| | Short-term | 95- percentile | 0.41 | 2.0 |
| **Diazinon (μg/l) (2)** | | | | |
| Fresh | Long-term | Annual mean | 0.01 | 0.03 |
| | Short-term | 95- percentile | 0.02 | 0.1 |
| Salt | Long-term | Annual mean | 0.01 | 0.03 |
| | Short-term | 95- percentile | 0.1 | 0.1 |
| **Dimethoate (μg/l) (3)** | | | | |
| Fresh | Long-term | Annual mean | 0.48 | 1.0 |
| | Short-term | 95- percentile | 4.0 | - |
| Salt | Long-term | Annual mean | 0.48 | - |
| | Short-term | 95- percentile | 4.0 | - |
| **Linuron (μg/l)** | | | | |
| Fresh | Long-term | Annual mean | 0.5 | 2 |
| | Short-term | 95- percentile | 0.9 | 20 |
| Salt | Long-term | Annual mean | 0.5 | 2 |
| | Short-term | 95- percentile | 0.9 | - |
| **Mecoprop (μg/l)** | | | | |
| Fresh | Long-term | Annual mean | 5.5 | 20 |
| | Short-term | 95- percentile | 24 | 200 |
| Salt | Long-term | Annual mean | 0.3 | 20 |
| | Short-term | 95- percentile | 1.7 | 200 |
| **Phenol (μg/l)** | | | | |
| Fresh and Salt | Long-term | Annual mean | 7.7 | 30 |
| | Short-term | 95- percentile | 46 | 300 |
| **Toluene (μg/l) (3)** | | | | |
| Fresh | Long-term | Annual mean | 50 | 50 |
| | Short-term | 95- percentile | 380 | 500 |
| Salt | Long-term | Annual mean | 40 | 40 |
| | Short-term | 95- percentile | 370 | 400 |
| 1) For chromium, a Total Risk Approach as natural background level are negligible<br>2) The UK must continue to comply with the standards set under the standards set under the Dangerous Substances Directive until its repeal in 2013<br>3) The UKTAG recommends adopting a new standard derived using the EU TGD but will look to gain more data to enable a reduced assessment factor to support the second cycle of River Basin Planning | | | | |

UKTAG has also evaluated a further nine substances as potential SP: 2,4-dichlorophenol; ammonia (un-ionised); arsenic; chlorine; copper; cyanide; iron; permethrin; and zinc. It is proposed that the existing standards for these substances are retained for the first planning round[3] and that the current standards for a further 12 dangerous substances are also retained on this basis. The additional 12 substances are: bentazone, biphenyl, 4-chloro-3-methylphenol, chloronitrotoluenes, 2-chlorophenol, dichlorvos, fenitrothion, malathion, 1,1,1-trichloroethane, 1,1,2-trichloroethane, triphenyltin, and xylene. As none of these chemicals are designated as SPs, they will not be used to determine good ecological status.

Finally, UKTAG has also considered aluminium, manganese and tetrachloroethane, for which there are no existing EQS; no formal recommendations have been made, but standards may be proposed in the future.

This CEA is restricted, however, to the nine substances currently identified as SPs. Further costs will arise as a result of introducing further SPs depending on the standards to be set.

## 2.4 Other Objectives

For both surface and groundwater bodies there is a 'no deterioration in status' objective. This aims to prevent deterioration from 'good' to 'less than good' for surface water bodies and from 'good' to 'poor' chemical status for groundwater bodies.

The Groundwater Daughter Directive requires the programme of measures to include 'all measures necessary to prevent inputs into groundwater of any hazardous substances…'. For other pollutants, the Daughter Directive requires '…all measures necessary to limit inputs into groundwater…'. The 'prevent or limit' objective ensures that the regime established by the original groundwater directive (80/68/EEC) is maintained when it is repealed by the WFD in 2013. The main difference is the move away from listed substances (Lists I and II) to hazardous and non-hazardous substances. In practice, this results in no significant change to current regulatory practices for chemicals. If all the 'prevent or limit' requirements are met, all the other WFD objectives for groundwater quality (and some for associated ecosystems) will naturally follow. That is, the groundwater body would be at good groundwater chemical status, would not show any significant and sustained upward trends and would meet protected area requirements, including those under WFD Article 7 (Drinking Water Protected Areas).

The WFD requires that specific Article 7 objectives should be set for each drinking water protected area where necessary. The overriding aim of Article 7 is to "ensure the necessary protection for the bodies of water identified with the aim of avoiding

3 The UKTAG will put forward standards for this second set of chemicals when there is adequate scientific evidence for these purposes. In the meantime, measures are being put in place to fill the existing data gaps. Note that the costs associated with such measures have been taken into account in the investigation costs included here for the Environment Agency.

deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water". Local objectives may vary depending on the risks within a catchment and the level of treatment already installed. For pesticides, at a national level, it is considered that the risk of exceeding 0.1 ug/l should be the benchmark for initial risk assessment since any exceedance could trigger the need for treatment. However this initial assessment will then need to be moderated by local factors including the extent of any treatment, the ability to remove different pesticides and the potential for peak values to impact plant operation. Importantly, compliance with Art 7 objectives will be assessed at the point of abstraction, not at water body level, and thus it will be permissible for attenuation mechanisms within the catchment to be taken into account in deploying remedial measures.

# 3. PRESSURES AND TRENDS

## 3.1 General Considerations

Previous work has identified a number of substances for which there is a large gap or a high estimated extent of failure, and for which existing measures (under other Directives and initiatives) will not be sufficient to ensure EQS compliance. An EA study (*Provisional List of Substances for Regulation 16 Supplementary Plans, 2007*) has estimated the extent of failure based on current EA monitoring data held on its Water Information Management System (WIMS). Specific pollutants have been studied in a recent UKTAG report (UKTAG, 2007), which provides the likely implications of introducing (or revising) EQSs in terms of failure of standards at existing freshwater monitoring sites. There are also EA strategic assessments and other reports providing an account of emerging pollutants, and other on-going work attempting to define the risks of failure associated with certain pollutants.

The diffuse nature of the main sources of certain chemicals (e.g. pesticides in agricultural run-off, heavy metals in urban run-off and mine drainage, etc.) means that it is difficult for the existing monitoring network and sampling frequencies to adequately capture the impact on surface water quality. Instead existing data provide a snapshot of water quality at specific times throughout the year (due to reliance on spot sampling). Therefore, there is significant uncertainty associated with extrapolating the monitoring data. Additional monitoring (e.g. seasonal or more frequent) may be required for substances with significant failures in order to prove/disprove compliance issues.

Additional complexity arises when considering metals; these are not created or destroyed within the natural environment but rather exist in various forms and states, some of which are more bio-available, toxic and hazardous than others. Again much of the available freshwater quality monitoring data do not differentiate between the various states and toxic forms of heavy metals. There is a wide range of sources of metals, from industrial and manufacturing processes to domestic uses and disposal of consumer goods, corrosion, agriculture, mining activities, waste disposal sites and urban/highway run-off. The use of monitoring data is further limited when considering metals, as background concentrations tend to depend on the underlying geology and are therefore catchment specific.

These factors, combined with the fact that many of the restrictions and other regulatory measures that will act to limit emissions, discharges and losses of these substances have not yet or have only recently come into effect, makes it difficult to establish a clear 'gap' in terms of current status versus good status in 2015.

## 3.2 Pressures and Trends for Priority Substances

Some of the above issues are summarised in Table 3.1 which details the pressures facing a number of PS and SPs, observed (and predicted) trends in their usage and the extent of anticipated EQS failure by 2015 (indicated as *high, medium, low*) based on forecast usage and availability of monitoring data.

| **Table 3.1: Pressures, trends and anticipated extent of failure by 2015** | | |
|---|---|---|
| **Substance** | **Pressures / Trends** | **Estimated Extent of EQS Failure** |
| Alachlor (PS) | Banned and not used in UK for several years. | Expected to be *low* |
| Anthracene (PHS) | Present at 1% in crude coal tar. Declining diffuse inputs; creosote use restricted. Restrictions on use of extender oils. Industrial sources now have to report to EA (since 2007). Detected downstream of industrial sources and old housing estates.<br>See comments on PAH. | Likely to be medium in first and subsequent plan period, as there may be long-term legacy issues. However PPC action at coke ovens/coal tar distilleries and other source control will lower existing failures. Diffuse sources appear to be of low priority |
| Atrazine (PS) | Herbicide. Failed Annex I approval. Usage to cease by 2007. No current standards exceedances. Most commonly found plant protection product exceeding 0.1ug/l in groundwaters. | Expected to be *low* in the first plan period as shown by declining concentrations in water. |
| Benzene (PS) | A combustion by-product, contained in motor fuels and used in some industrial processes. High EQS leads to <1% exceedances. Need to ensure EQS is met at PPC sites (e.g. oil refineries, steel manufacture, coal fired power plants, etc.) as it tends to be a localised pollutant. | Expected to be *low* in first plan period as shown by current low levels of failure. |
| Cadmium and its compounds (PHS) | Naturally occurring substance which may be present as a ‘contaminant’ in emissions from various processes. Restricted use in some industrial and professional applications (as a colourant, as a stabiliser, for some metal plating applications). Large diffuse sources (agriculture, mines, road runoff). Usage in phosphate detergents likely to reduce (though not so for dishwasher detergents). | Likely to be *medium* in first and subsequent plan periods due to expected ongoing use of P fertilisers and detergents in the future. However, diffuse agricultural sources may be limited in the future should the EU introduce proposals to restrict cadmium content in fertilisers. |
| Chlorfenvinphos (PS) | Uses about to cease in UK. All usage to completely cease by 2009. No recorded exceedances. | Expected to be *low.* |
| Chloroalkanes (C10-13) or Short Chain Chlorinated Paraffins (SCCP) (PHS) | Banned in metalworking and leather processing due to persistence, toxicity and bioaccumulation potential, with phase-out occurring in 2004. Updated EU risk assessment showed the available data not adequate to justify risk reduction measures and suggested that further information and testing was necessary; as a follow-up the Commission is preparing a regulation to oblige industry to provide the missing data. Currently, a single SCCP producer in the UK (production of 2,500 ton in 2002); main use as a plasticizer/flame retardant. Use has declined significantly in recent years as SCCPs have been proposed as Persistent Organic Pollutants to be completely banned. | EA (per comm.) indicates that all emissions are less than the LOD of 1 µg/l in water industry monitoring. Failure rates are therefore expected to be *low* by end of first plan period due to phasing out and only a single source in UK. |
| Chlorpyrifos (PS) | Annex I substance and up for re-registration in the UK next year. Usage could be subject to restrictions by 2015, although still being considered by PSD. No downward trends in pesticide usage surveys. Few EQS exceedances. | Likely to be *low* by end of first plan period due to few current exceedances. However some uncertainty over on-going usage and no authorised alternatives at present. |

| Table 3.1: Pressures, trends and anticipated extent of failure by 2015 | | |
|---|---|---|
| **Substance** | **Pressures / Trends** | **Estimated Extent of EQS Failure** |
| Chromium VI (and chromium III) and its compounds (SP) | Naturally occurring substance which may be present as a 'contaminant' in emissions from various processes. Used as a catalyst and other chemical industry applications, in leather tanning and textile dyes, metal alloys, and metal plating industry, but also found in runoff and mine drainage. Added to animal feeds. Use no longer possible in wood treatment products. Limits on content in sewage sludge, restrictions on use under ELV and RoHS Directives. Local emission sources in the UK result in some failures (see Table 3.2). | Expected to be *medium* for first and second plan periods at least due to continuing usage and historic sources. |
| Cypermethrin (SP) | Widely used insecticide (sheep-dip, agriculture and forestry); tends to sorb to sediment. Use in sheep dip products suspended in the UK in February 2006, and subject to Sheep Dip PRP. Exceedances are often recorded (see Table 3.2)<br>Plant Protection Uses: Listed on Annex I and products currently being re-registered at UK level. | Likely to be *low/medium low* (if its use in sheep dip remains suspended). Presently no evidence to suggest impacts from use in agriculture and forestry but this could be verified by further targeted monitoring (e.g. seasonal). |
| Diazinon (SP) | Organophosphorus insecticide used in veterinary applications (e.g. sheep dip). Suspended from 1999 to 2002 due to human health concerns but current available. Low levels of failure (see Table 3.2), but there are localised EQS breaches in sheep farming areas (e.g. in the River Aire which receives most of the UK treated wool scouring effluent). | Expected to be *low* due to current low levels of failure (despite substantial usage). However, further monitoring data need close observation to confirm trend (Note: If cypermethrin is withdrawn then diazinon would the only alternative dip product, therefore contamination risks may go up). |
| 1,2 dichloroethane (PS) | Used as an intermediate and in paint strippers. Usage will decline due to proposed restrictions on use in paint stripper. Less than 0.2% failures recorded. | Expected to be *low* in first plan period due to restrictions on use and current low levels of failure. |
| Dichloromethane (PS) | A common solvent and cleaning agent. Used in the pharmaceuticals and food industry, as well as a solvent in paint strippers. Proposed restrictions on use in paint stripper. Low levels of EQS failure. | Expected to be *low* in first plan period due to restrictions on use and current low levels of failure. |
| Di(2-ethylhexyl) phthalate (or DEHP) (PS) | Used in textile, paper and plastics industry. Diffuse leaching from plastic pipes. Outdoor uses may be restricted in future (e.g. PVC in contact with water). Commission is to re-evaluate measures in 2010. Very limited monitoring to date. A UKWIR study identified significant releases from newly built housing estates. | Likely to be *medium/high* in first plan period due to ubiquitous uses and uncertainty over future restrictions; risk may reduce in future periods depending on action at the EU level. Further monitoring data needed. |
| Dimethoate (SP) | Widely used insecticide. Listed on Annex I, with re-registration of existing products forthcoming. No information on proposed restrictions in use. No evidence of exceedances (see Table 3.2). | Likely to be *low*, but some uncertainty remains due to wide usage; further monitoring needed. |
| Diuron (PS) | Many amenity, urban and engineering applications. Significant decline in UK usage and subject to phase-out (UK use to cease) by 2009. Some EQS exceedances recorded, including some one off incidents which resulted in temporary closure of drinking water intakes. | Expected to be *low* due to forthcoming ban. |

| **Table 3.1: Pressures, trends and anticipated extent of failure by 2015** | | |
|---|---|---|
| **Substance** | **Pressures / Trends** | **Estimated Extent of EQS Failure** |
| Endosulfan (PHS) | Formerly widely used organochlorine pesticide, but very significant decline in UK in recent years (only one company approved to use it in production). Relevant products will be phased out in June 2007, and EU-wide ban expected. No recorded exceedances. | *Low* in first plan period due to falling usage and applications and phase-out. |
| 2,4-D ester and non-ester (SP) | One of the most widely used herbicides with many agricultural and amenity uses. No information on proposed restrictions in use. Listed on Annex 1 and products have passed re-registration at UK level. Only occasional failures reported (see Table 3.2). | Uncertain but likely to be *low* as shown by few current failures (and despite heavy usage). More monitoring data are needed to confirm. |
| Fluoranthene (PS) | No specific controls on use. Few recorded exceedances. See comments on PAH. | Likely to be *low*. Ongoing monitoring to confirm. |
| Hexachlorobenzene (PHS) | Worldwide ban in 2004. No recorded exceedances. | *Low* |
| Hexachlorobutadiene (or HCBD) (PHS) | No production in the UK or EU. May be present in the environment due to unintentional sources (e.g. landfill deposition, manufacture of solvents and chlorinated hydrocarbons). UK EQS compliance was 98.8% in 2003. | *Low* as shown by available monitoring data and falling trends. |
| Hexachlorocyclohexane (or Lindane) (PHS) | No current uses in UK. All usage expected to cease by 2008. Persistent organic pollutant. May be available through imported products (seeds, textiles) but this will decline to zero by 2015. | Expected to be *low* due to restricted use. Availability from legacy use expected to cease, as already steadily declining trend in EU waters. |
| Isoproturon (PS) | Major uses as pesticide in wheat and cereals in UK; few - if any- cheaper alternatives. Listed on Annex I but failed UK re-registration process. Will be phased out (UK use to cease) by 2009. Commonly detected in surface waters but few EQS failures at current UK EQS. | *Low* due to expected restrictions/ban. Some uncertainty as EQS failures are being recorded despite reasonably high EQS. |
| Lead and its compounds (PS) | Naturally occurring substance which may be present as a 'contaminant' in emissions from various processes. Numerous industrial, agricultural, and non-agricultural diffuse sources. Concentrations in tap water are likely to be reduced to 10 µg/l by 2015.<br>Use of lead stabilisers to have ceased by 2015 (circa 85,000 tpa for the EU as a whole), with the potential for other measures in response to ESR risk assessment. | *Medium/high* in first plan period at least, as it is a natural element that will always be present in diffuse sources. Uncertainty over the potential for restrictions at the EU level and effect these may have in subsequent planning periods. |
| Linuron (SP) | Common herbicide. No information on proposed restrictions in use. Listed on Annex I and products have passed re-registration at UK level. Very low level of failures (see Table 3.2). | Likely to be *low*, but some uncertainty remains; further monitoring data are needed |
| Mecoprop (SP) | Common herbicide with agricultural and amenity uses. Identified by EA as a potential substance of concern in groundwater. No information on proposed restrictions in use. Listed on Annex I and products have passed re-registration at UK level. Commonly found in surface waters but fewer failures of current UK EQS (see Table 3.2) compared to diuron and isoproturon. | Likely to be *low*, but some uncertainty remains; further monitoring data are needed. |

| Table 3.1: Pressures, trends and anticipated extent of failure by 2015 | | |
|---|---|---|
| **Substance** | **Pressures / Trends** | **Estimated Extent of EQS Failure** |
| Mercury and its compounds (PHS) | Naturally occurring substance which may be present as a 'contaminant' in emissions from various processes. Extensive withdrawal from market (batteries, industrial discharges, electrical equipment); compulsory fitting of dental amalgam traps under OSPAR and hazardous waste regulations. UK chloralkali plant due to convert to mercury-free technology by 2020 under the EU mercury strategy. Measures also taken to reduce atmospheric emissions of mercury, e.g. from crematoria and large combustion plants.<br>Exceedances recorded; some uncertainty with measurements below LOD. | Likely to be *low/medium*, decreasing by the second plan period as there will still be some usage by 2015, atmospheric emissions will continue due to the presence of these compounds as contaminants in coal and also due to natural occurrence. |
| Napthalene (PS) | Some industrial PPC sources. ESR substance but site specific risks only identified for the environment. Proposed measures aimed at protecting worker safety may reduce emissions to the aquatic environment. Combustion by-product.<br>Relatively few exceedances recorded, but additional control may be required. | Likely to be *low* in the first plan period, but some uncertainty over diffuse inputs and industrial uses needs to be resolved through more studies/monitoring data |
| Nickel and its compounds (PS) | Naturally occurring substance which may be present as a 'contaminant' in emissions from various processes. Subject of ongoing ESR, but no known specific controls imposed. Some failures recorded. | Likely to be *medium* in first plan period due to uncertainty over diffuse inputs, legacy issues (e.g. mine drainage) and lack of controls. Measures at EU level may reduce risks in subsequent periods. |
| Nonylphenols (PHS) | Extensive restrictions on use. Maximum 0.1% in products as of 2005. Further phasing out expected. Some exceedances, but expected to go down as restrictions are being applied. | Expected to be *low* due to restrictions and declining trend. |
| Octylphenols (PS) | Some restrictions expected to be imposed in future. Lower usage than nonylphenols. No evidence of EQS failures. A risk reduction strategy has been proposed by the UK. | Expected to be *low.* |
| Polyaromatic Hydrocarbons (or PAH) (PHS) | Unintentional products; subject to air emission controls for a variety of industrial processes but also non-anthropogenic combustion sources. Declining trends in EU, but expected to tail off by 2015 mainly due actions taken to comply with UK air quality strategy. Lack of sufficient monitoring data. Significant diffuse emissions from road run-off may prevent achievement of good status, although limits on PAHs in oils used in tyre manufacture come into force in 2010 across the EU. | Likely to be *low* but some uncertainty due to lack of production control and some natural and diffuse inputs (e.g. runoff). Further studies/monitoring data are needed to reduce uncertainty. |
| Pentachlorobenzene (PHS) | No production in the UK or EU. Banned since 2001. There may be imports as wood treatment and textile preservation agent. May be present in the environment due to unintentional sources (e.g. as a contaminant in hexachlorobenzene) | Expected to be *low* due to ban, but monitoring data needed to verify. |
| Pentabrominated diphenylethers (or PeBDE) (PHS) | Some expected decline as it is banned from use in furniture since 2005. Low confidence in monitoring data, as these tend to report total brominated diphenylethers (penta, octa and deca). | Likely to be *low/medium* (and declining over time) due to sources from old furniture and other diffuse sources; also very low EQS. However, risk should reduce over time as furniture is removed from use. |
| Pentachlorophenol (PS) | Restricted use (M&U restrictions), complete withdrawal by 2009. No evidence of failures. | Expected to be *low* |

| **Table 3.1: Pressures, trends and anticipated extent of failure by 2015** | | |
|---|---|---|
| **Substance** | **Pressures / Trends** | **Estimated Extent of EQS Failure** |
| Phenol (SP) | Widely used in manufacturing and process industry. Readily biodegradable in water. Ban on use in cosmetic products from 2006 and use expected to decline under the VOC Directive. Some failures (mainly in Wales; see Table 3.2) despite relatively high EQS. | Likely to be *low*, but some uncertainty remains; further monitoring data are needed. |
| Simazine (PS) | Usage to cease by 2007. Commonly detected in surface waters but very few recorded failures of UK EQS. | Expected to be *low* due to phase-out. Monitoring data needed to clarify any effects due to persistence from heavy historic use. |
| Toluene (SP) | Extensive use in manufacturing and process industry. Biodegradable in water. Restrictions on use in adhesives and spray paints intended for general sale came into force in 2007. Losses to the environment also affected by a range of other legislation, such as IPPC and VOCs Directive. No information on proposed restrictions in use. Low levels of failure. | Likely to be *low*. More monitoring data are needed to confirm. |
| Tributyltin (or TBT) (PHS) | Not produced in the UK (however, production in Germany, Italy and Netherlands). Banned under the Biocidal Products Directive from being marketed in the EU for biocidal purposes. Numerous potential sources to the environment, as emissions may arise from waste disposal and/or other activities that disturb stocks of TBT in the environment. Present as contaminant in PVC. Potential presence in imported goods (e.g. textiles, treated wood products). Historical sediment contamination may be a key issue for continuing EQS failure. One of the most damaging, persistent and widespread pollutants.<br>Additional measures currently being assessed at the EU level. | *High* in first plan period as identified by regular EQS breaches. Historic legacy of contamination is slowly declining, but high persistence and bioaccumulation. |
| Trichlorobenzene (PS) | Restrictions on maximum concentrations in preparations across all uses, excepting as a chemical intermediate and as a process solvent in closed reactions. There may legacy issues from contaminated land. No failures recorded. | Expected to be *low.* |
| Trichloromethane (Chloroform) (PS) | Present in pharmaceutical and CFC manufacturing. Unintentional by-product in pulp and paper industry. May also be generated in sewers (i.e. some potential for diffuse sources). Restrictions on use in in consumer products, and/or in diffuse applications in surface cleaning and fabric cleaning. Exceedances are commonly recorded. | Likely to be *medium/high* due to uncertainty over future restrictions, unintentional production and diffuse sources. |
| Trifluralin (PS) | Many current uses as herbicide for low margin crops, as it is cheap and effective. Expected to be withdrawn by 2009. Very few exceedances. | Expected to be *low*. Monitoring data to confirm, as there may be some effects from current applications and current steady trend in usage. |

## 3.3 Pressures and Trends for Specific Pollutants

The projected failures of Specific Pollutant standards in England and Wales for surface waters, as reported by UKTAG, are presented in Table 3.2 below. The response to anticipated failures of standards will be part of the UK's Programmes of Measures developed by the Environment Agency under the WFD and will be informed by the water quality policies. Cypermethrin and phenol (in Wales only) have the highest projected extents of failure; chromium failure in saltwater sites is also notable.

**Table 3.2: Projected extent of failure for Specific Pollutants in England and Wales (UKTAG, 2007)**

| Substance | England *Face Value and 95% confidence* | | Number of sites monitored | Wales *Face Value and 95% confidence* | | Number of sites monitored |
|---|---|---|---|---|---|---|
| | **Per cent of monitored freshwater sites Not Good** | | | | | |
| 2,4-D ester and non-ester | 0.4 | 0.0 | 509 | 0 | 0.0 | 23 |
| Chromium | 5 | 2 | 2424 | 7 | 2 | 236 |
| Cypermethrin | 21 | 1.9 | 316 | 19 | 0 | 257 |
| Diazinon | 4 | 1.7 | 485 | 8 | 1 | 247 |
| Dimethoate | 0.0 | 0.0 | 348 | 0.0 | 0.0 | 200 |
| Linuron | 0.2 | 0.0 | 480 | 0 | 0 | 67 |
| Mecoprop | 2.4 | 0.1 | 619 | 0.0 | 0.0 | 78 |
| Phenol | 1.6 | 0.3 | 681 | 17 | 6 | 103 |
| Toluene | 2 | 0.0 | 378 | 0.0 | 0.0 | 67 |
| | **Per cent of monitored salt water sites Not Good** | | | | | |
| 2,4-D ester and non-ester | 0 | 0 | 77 | - | - | 0 |
| Chromium | 21 | 3 | 788 | 10 | 2 | 105 |
| Cypermethrin | 6 | 0 | 16 | - | - | 0 |
| Diazinon | 5 | 0 | 88 | - | - | 0 |
| Dimethoate | 0.0 | 0 | 114 | - | - | 0 |
| Linuron | 0.0 | 0 | 72 | - | - | 0 |
| Mecoprop | 3 | 0 | 73 | - | - | 0 |
| Phenol | 0 | 0 | 64 | 29 | 0 | 24 |
| Toluene | 0.0 | 0 | 111 | 0 | 0 | 3 |

## 3.4 Most Likely EQS Failures

The following 11 substances have been highlighted by the Environment Agency and the other previous work as having a medium or high potential of failing WFD EQS in 2015:

- Anthracene;
- Cadmium;
- Chromium;
- Cypermethrin;
- DEHP;
- Lead (based on the current interim standards);
- Mercury;
- Nickel (based on the current interim standards);

- Tributyltin;
- Trichloromethane; and
- PentaBDE.

Copper and zinc have been raised as concerns by the water industry in particular as having the potential to give rise to failures in the future should tighter water standards be set, due to their many everyday uses and number of sources. As no new standards have been proposed by the UKTAG, these substances remain outside the scope of this analysis. Any current failures in relation to these pollutants must therefore be linked to failures to comply with current (i.e. baseline) policy requirements.

With regard to groundwater, the chemical pollutants (including hazardous substances) of most concern are those related to pesticides and veterinary medicines, minewaters and mine spoil runoff. This is likely to include some of the above substances, but may also relate to other hazardous substances.

## 3.5 Implications of Measures and Regulations

When forecasting the extent of failures of EQS in 2015, it should be born in mind that a number of measures, such as bans, restrictions on uses or no approvals for use, will have a significant effect on the trends in usage of certain substances; it can therefore be reasonably expected that certain measures will help reduce the present gap between existing EQS failures and the WFD targets by 2015.

In particular, most pesticides on the EU priority list will be withdrawn from the EU market by 2009 as a result of review work under the Plant Protection Products Directive (only three of the pesticides are currently approved for use - chlorpyrifos, endosulfan, and trifluralin – and these approvals are currently subject to review). The latest information on pressures and trends in pesticides, insecticides and herbicides is contained in the Agriculture pCEA Working Group Supporting Document on pesticides. The document states that the precise size of the compliance gap between the current levels of pesticides (both priority substances and the specific pollutants) in water and the position needed in 2015 to meet WFD requirements cannot be accurately described at present due to a lack of environmental information on pesticides[4]. The EA's surface water monitoring programme is being reviewed to give a more representative programme, and risk mapping is being undertaken to improve knowledge of the gap.

Whilst some substances are being withdrawn and will stop being detected in rivers, for the remaining ones the risk levels of contamination may go up as their percentage share of the market increases. Changes in cropping patterns as a result of CAP reform, climate change or other factors are also a major influence on the types of pesticides used and therefore the levels detected in freshwater. For example, pesticides used on oil seed rape are now being found more frequently and at higher levels as the market for biofuel crops

4 In addition the European Parliament is currently seeking to extend the pesticides list by adding other substances of concern including glyphosate, its main metabolite AMPA, quinoxyfen and bentazone.

expands. A proposed EU directive on the sustainable use of pesticides is under discussion.

Other measures that are under way, about to be implemented or under consideration include:

1. Dental amalgam traps at dentist practices under Hazardous Waste Regulations.

2. Phosphorus and ammonia removal at Wastewater Treatment Works as part of AMP4 and AMP5; some co-removal of priority substances may be achieved in tertiary treatment (e.g. cadmium).

3. Existing Substances Regulation risk reduction strategies and other limitations or restrictions on use: e.g. EU Mercury Strategy, the proposed risk reduction strategy for zinc and chromium VI and potential restrictions on organotins, lead and nickel in the future in response to EU risk assessment conclusions; current restrictions on cadmium and lead in stabilisers; restrictions on PAH content in oils used in rubber tyre manufacture, etc.

4. Potential categorisation of endosulfan and trifluralin as Persistent Organic Pollutants (POPs) under the UN Protocol.

5. Replacement of PeDBE in new furniture (and other similar replacement actions in various household items/products).

6. REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals. This applies to all substances produced or imported into the EU over 1 tonne. Substances have to be registered according to a phased timeline. Substances of most relevance to the WFD due to high toxicity or used in large volumes have to be registered by 2012. If these substances are dangerous, a chemical safety assessment has to assess the any risks from all known uses throughout the supply chain, including disposal. Risk management has to be proposed and communicated down the supply chain to address these risks. Subsequently, the most dangerous substances have to be authorised for their use to continue. These include persistent, bioaccumulative and toxic substances (as a number of PHS are likely to be). The assumption is that these substances cannot be adequately controlled; specific uses can still be authorised on socio-economic grounds but the registrant has to bring forward plans for phasing out.

7. Extension of Environmental Stewardship and English Catchment Sensitive Farming Delivery Initiative (ECSFDI) countrywide.

8. Environment Agency Sector Plans setting out strategic objectives for certain sectors they regulate (e.g. chemical industry) and for certain key sectors they want to work in partnership with (e.g. retail and construction sectors).

9. Revision of the Integrated Pollution Prevention Directive and other amendments to specific BREF documents to take into account measures proposed under other legislative processes such as ESR.

10. The EC Thematic Strategy on the Sustainable Pesticides, which includes a proposed new Directive on the Sustainable Use of Plant Protection Products, and replacement of the existing authorisations Directive (91/414) for plant protection products with a Regulation. This Strategy focuses on the use phase of pesticides, ensuring that they are applied only where necessary, with appropriate equipment and according to authorised use conditions by trained or well informed users. The directive contains a specific provision relating to the protection of the aquatic environment and drinking water supplies.

11. Pesticides Voluntary Initiative together with other industry initiatives directed at minimising adverse environmental impact of pesticides, such as the Voluntary Initiative, Farm Assurance, etc.

12. UK Strategy for the Sustainable Use of Plant Protection Products, and its associated action plans (including one on water). Development of alternative pesticides, herbicides, cleaning agents etc. using less persistent and toxic substances.

13. Memorandum of Understanding with Network Rail on use of plant protection products on railways and stations.

14. Potential introduction of an EC Directive on cadmium in fertilisers.

15. Commissioning of additional studies and monitoring programmes (by Defra, EA, UKTAG etc) to better understand the fate, toxicity and pathways of certain pollutants (e.g DEHP, heavy metals, pesticides etc) and the efficiency and affordability of treatment methods (e.g. membrane technology, Biological Aerated Filters etc).

16. Measures to control accidental production/release of unintentional by-products in industry.

17. The EU Mercury Strategy which includes a commitment by industry to convert the UK chloralkali plant to mercury-free technology (by 2020) and commitments to reduce mercury emissions from crematoria by 50% by end 2012.

18. A range of air quality legislation aimed at reducing, emissions of metals (mercury, cadmium and nickel) and other pollutants (e.g. benzene and PAHs) from large combustion plant, etc.

19. Possible introduction of Water Protection Zones (similar designation to Nitrate Vulnerable Zones).

20. NADIP controls including measures associated with landfills, contaminated land clean-up, mine spoil run-off, oil and waste storage, application of sheep dips, etc.

21. Sustainable Urban Drainage schemes, which would reduce sediment borne contamination.

Because many of the above measures have only come into effect in the recent past or are still being implemented/debated, the magnitude of the gap that will exist for several of the individual substances is highly uncertain. Predicting the likely gap is therefore difficult for the purposes of this pCEA (and for the other studies it draws upon). It is particularly complicated where the substances have been previously used in consumer products, as these may remain in circulation for several years hence (e.g. pesticides sold for consumer use) even though use is no longer permitted; or due to a currently poor understanding of the contribution of atmospheric emissions to concentrations of some of the substances to levels in the aquatic environment. These difficulties not only affect our ability to determine the level of action required but also the most appropriate or cost-effective set of measures for addressing the gap.

# 4. APPORTIONMENT AND UNCERTAINTY

This section consolidates the findings and information contained in various reports, such as the UKWIR report, Working Group pCEA reports, the UKTAG and EA PRP reports, which relate to apportionment issues between the various sectors and identified levels of uncertainty for specific substances.

Table 4.1 summarises the uses and sources of selected substances for each of the main sectors and highlights gaps in knowledge and uncertainties. The table firstly lists substances with an identified gap or with a medium / high estimated extent of EQS failure by 2015 (see Table 3.1), followed by all remaining substances that can be considered as having good certainty of achieving EQS compliance.

It is important to note at this stage the overlaps that exist between the substances considered in this chapter of the pCEA and those considered in other chapters. This includes, for example, cadmium and lead which are contained in fertilisers (including manures), and which will also be affected by measures aimed at addressing nutrient pressures (see the nutrients chapter). Key sources of cadmium, lead and nickel will include historically contaminated sites and minewaters. The measures proposed in relation metal mines are considered in the minewaters chapter. Some contaminated land sites are picked up here where they are related to current industrial activities. Historic problems associated with contaminated land sites are not covered by this assessment but clean-up is likely to be driven in the first instance by the Contaminated Land Regulations. In addition, no measures specific to preventing or limiting pollutant inputs to groundwaters have been included here.

| Table 4.1: Sources of Pollutants and Uncertainties | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| **SUBSTANCES OF CONCERN (with a potentially large gap)** | | | | | | |
| Anthracene (PHS) | Coal tar production from coke ovens; coal tar distillation; carbon black manufacture using anthracene oils; industrial wood preservative (creosote) | | Present in old housing (due to creosote use) | Leachate from creosote coated objects; combustion of organic matter; road runoff due to incomplete combustion of fossil fuels | | The presence of anthracene in liquid effluent from coke ovens and coal tar distillation has yet to be confirmed. Although amateur use of creosote is banned, industrial use is still permitted and as a Part B PPC or non-prescribed process releases are not regulated to water. Releases of anthracene to water from creosote-treated objects and coal tar have not been quantified. Anthracene is always detectable due to some natural inputs. |
| Cadmium and its compounds (PHS) | Users of phosphate; municipal solid waste incineration; combustion for power generation; other industry (pigments, metal plating, batteries); transport | Users of phosphate/ detergents; traces in other industry | Domestic use of detergent phosphates; may be associated with zinc and other metals from plumbing etc | Road runoff; impurity in detergent phosphates; landfill leachate; mining and abandoned mines | Application of biosolids (sewage sludge), manures, inorganic fertilisers, industrial wastes and compost | Cd is trace contaminant of phosphate; major source of Cd to land is P fertiliser, pig manures etc – a large knowledge gap concerns the extent to which Cd is deposited on, or released to, land and transferred to the aquatic environment. Domestic sources require further investigation; Cd load from abandoned mines and closed landfills is uncertain; natural element therefore will always be present as a diffuse source (though EQS failures are decreasing) |
| Chromium (hexavalent) and its compounds (SP) | Extensive use in plating industry and leather tanning; metal finishing and alloys; oxidising agent and catalyst; numerous other uses | Potential waste chemical from industrial sources | | Ubiquitous, found in urban runoff; mine drainage; intermittent sewer discharges | | The only significant sources are anthropogenic – natural sources are insignificant. EQS speciated so certain industrial effluent (tanning and plating) will be an issue. Diffuse sources not of great concern. Decreases associated with industry are stable. Cr(III) is less toxic than Cr(VI) and its low solubility in water limits its availability. |

| Table 4.1: Sources of Pollutants and Uncertainties | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Cypermethrin (SP) | Sheep farming and wool industry (sheep dip) | | | | Sheep dip; other insecticide uses (e.g. forestry) | Following the suspension of cypermethrin dip products in February 2006, a fall in pollution incidents from sheep dip was observed. There are concerns that permanent removal of cypermetrhin dip products may increase resistance of sheep gastro-intestinal worms through increased usage of alternative medicinal products currently used for both worm and scab control. Reintroduction of products would require tougher pollution control measures and restrictions to be put in place on farms |
| Di(2-ethylhexyl)-phthalate or DEHP (PS) | Textile industry; paper and pulp manufacture; manufacture of chemicals and plastics (plasticizer in soft PVC) | Potential waste chemical from textile industry, paper and pulp manufacturing, and manufacture of plastics | Leaching from plastic products such as pipes and garden furniture | Leaching from plastic products such as pipes | | Inconsistent treatment removal, high levels entering WwTW, ubiquitous use, and diffuse leaching sources make it a priority. An ESR substance but no currently agreed risk reduction strategy; measures still under discussion |
| Lead and its compounds (PS) | Range of manufacturing industries such as batteries, pigments, alloys, ammunition, weights, PVC stabilisers (but use to cease by 2015); combustion processes in industry and energy production | Potential waste chemical from a range of manufacturing industries, combustion processes and energy production | Lead in old water supply distribution pipes, migration from use as a stabiliser in PVC, and use of lead sheeting for roofing, flashing and other building related applications | Numerous diffuse sources including mine drainage; fishing weights; ammunition; landfill | Sludge, compost, fertiliser and manure application | Natural element – will always be present as a diffuse source but decreasing continuously and relatively few EQS failures; industrial inputs also declining; a large knowledge gap concerns the extent to which Pb is deposited on, or released to, land and transferred to the aquatic environment. See also nutrients chapter with regard to measures affecting fertiliser and manure application. |

| Table 4.1: Sources of Pollutants and Uncertainties | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Mercury and its compounds (PHS) | Chemical industry – mercury cell chloralkali installations; dental industry (dental amalgam); batteries; lighting; measurement and control equipment (thermometers); electrical control and switching equipment; coal burning/ combustion processes | Potential waste chemical from a range of manufacturing industries, dental surgeries, coal burning/combustio n processes | Tooth wear/erosion of dental amalgam fillings; also thermometers and batteries | Road run-off; disposal of wastes to landfill; spillage or breakage of mercury-containing equipment. Also some natural sources. | Mobile machinery and combustion. | The UK chloralkali plant is due to convert to mercury-free technology by 2020; there are some uncertainties regarding estimation of releases. Natural sources might be significant but decreasing and relatively few EQS failures. Compulsory fitting of dental amalgam traps at dentist surgeries. Restrictions on future use of mercury in thermometers and barometers to be introduced at the EU level |
| Nickel and its compounds (PS) | Manufacture of chemicals and metal products (e.g. alloys); thought to be present in more than 300,000 products. Also, combustion for industry and power generation. One UK nickel refinery | Potential waste chemical from a wide variety of industries; combustion for industry and power generation | | Leachate from nickel-coated products/landfill; runoff; mining and abandoned mines | Manure, compost and fertiliser use | A large knowledge gap concerns the extent to which Ni is deposited on, or released to, land and transferred to the aquatic environment. Ni load from abandoned mines and closed landfills is uncertain. Also some naturally occurring sources |

**Table 4.1: Sources of Pollutants and Uncertainties**

| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
|---|---|---|---|---|---|---|
| Pentabrominated diphenylethers (PeBDE) (PHS) | Flame retardants | | Present in domestic sewage (e.g. transfer to clothes etc) from use as a fire retardant in fabrics and upholstery | Thought to be present in diffuse sources (due to legacy/historic uses) | | Marketing and use now banned in the EU. Slow replacement of home furnishings will see die away with time. Very low solubility means rarely detected in water but very low EQS leads to exceedance. More likely to be an issue in biota. |
| Tributyltin compounds (TBT) (PHS) | Industrial processes such as stripping TBT from ship hulls; wood preservative; possible contaminant in other chemical plants. May be present in imported textiles. | Contaminant in effluent from industrial processes, such as textile, wood preservative, other chemical plants | Potential release from use of other tin compounds (contaminated with TBT) in PVC in contact with water. Possible domestic releases from imported textiles (minor). | Boats and ships (antifouling paint) – now banned; runoff from timber yards; contaminated sediments; leaching from affected products/landfill sites and waste disposal | May be present in sewage sludge used as fertiliser (likely to be minor) | Extent of releases to the aquatic environment is uncertain. TBT can be present at low levels as an impurity in PVC stabilisers and catalysts. Regular EQS breaches due to historic legacy of contamination and some diffuse sources; this is slowly declining, but TBT has high persistence and bioaccumulation. Present information on levels of TBT in sewage sludge and sediments is limited. |
| Trichloromethane (or chloroform) (PS) | Chemical intermediate in pharmaceuticals and CFC manufacture. Potential releases from pulp and paper industry due to use of chlorine as bleaching agency (and in situ synthesis). Minor use in laboratories. | Contaminant in localised industrial inputs (e.g. pharmaceuticals). Evidence that it may be generated in situ in sewers (reaction of chlorine). | Limited potential domestic uses. | Potentially present in intermittent sewage discharges (due to in situ production in sewers). | | Some uncertainty over sewer inputs, future restrictions on use and unintentional uses/sources. |

| Table 4.1: Sources of Pollutants and Uncertainties | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| **SUBSTANCES OF LOW CONCERN (with a small gap)** | | | | | | |
| Alachlor (PS) | | | | | Historic herbicide use | Removed from UK market for some time. Few – if any- occurrences expected. |
| Atrazine (PS) | | | | Historically used as a herbicide for verge side spraying but no longer used. Its persistence means that it is still detected, especially in groundwater. | Herbicide use | Agricultural issue only, usage will cease by 2007. Persistence and heavy historical use will make die away slower. Sporadic occurrences in WwTW effluent. |
| Benzene (PS) | Chemical industry, including unintentional presence in a number of products as a result of combustion. | | | Detected in petroleum, so may be detected as a result of spillage. Natural emission sources include volcanoes and forest fires. | | Marketing restrictions, volatility and relatively high EQS for solvents should not place this as a priority. |
| Chlorfenvinphos (PS) | | | | | Agricultural use as a pesticide | To be banned from 2008, rapid decrease expected. Agricultural issue only. |
| Chloroalkanes C10-13 (or Short Chain Chlorinated Paraffins – SCCP) (PHS) | Metalworking fluids; leather processing (these uses have been banned since 2004); plasticizer/flame retardant | Possible contaminant in effluent from plasticizer/flame retardant production | | | | Banned in metalworking and leather processing due to persistence, toxicity and bioaccumulation potential. Concentrations should decrease; low solubility, relatively high EQS means low priority. |

| Table 4.1: Sources of Pollutants and Uncertainties | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Chlorpyrifos (PS) | | | | | Agricultural use as a insecticide | Under review, so not heavily restricted, not used in urban catchments. Usage expected to cease by 2009. Has applications in both major and niche markets and there are a number of crop/pest situations in which there is no currently authorised alternative. Less toxic and persistent than most insecticides. |
| 2,4-D ester and non-ester (SP) | | | Some limited domestic herbicide usage | Amenity herbicide usage | Widely used herbicide | Few current EQS failures despite heavy usage. More monitoring data are needed to confirm extent of potential failure. |
| Diazinon (SP) | Sheep farming | | Some domestic uses, e.g. to control ants | | Organophosphorus insecticide with veterinary medicine applications. | Suspended from 1999 to 2002 due to human health concerns. Currently available. Woolscouring effluent presently causes some EQS breaches, but overall low levels of failure. If cypermethrin sheep dip products remain permanently suspended or banned, diazinon is the only alternative active ingredient used in dips, thus levels of use may increase. |
| 1,2-Dichloroethane (PS) | Manufacture of dyes, plastics (PVC production), paints (paints stripper); industrial cleaning. | Possible contaminant in effluent from manufacture of dyes, plastics, paints. | Potential domestic uses (e.g. paint stripper, dyes etc) | | | Proposed restrictions on use in paint stripper. Volatility and relatively high EQS for solvents should not place this as a high priority. There may be localised issues with industrial inputs. |
| Dichloromethane (PS) | Range of potential industries including: solvents, cleaning agents, aerosols, foam blowing agents | Potential waste chemical from a range of chemical, plastic and rubber industries. | Potential domestic uses (e.g. cleaning agents, aerosols, paint stripper etc) | | | Proposed restrictions on use in paint stripper. Volatility and relatively high EQS for solvents should not place this as a high priority. |
| Dimethoate (SP) | | | | May be potentially present in road runoff | Widely used organophosphate insecticide | Some uncertainty remains due to wide usage. Further monitoring needed, though no evidence of exceedances. |

| **Table 4.1: Sources of Pollutants and Uncertainties** | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Diuron (PS) | | | Domestic pesticide usage. | Amenity use as a pesticide, e.g. used as a weed killer next to railways. | Commonly used as pesticide. | Significant decline in UK usage and subject to phase-out by 2009. May be sporadic failures due to current heavy usage and lack of existing alternatives. |
| Endosulfan (PHS) | Only one company approved to use it in production | | | | Widely used in the past; now minor use in UK as organochlorine pesticide. | Under review, so not heavily restricted, but limited use within UK. According to the most recent data from the Pesticides Safety Directorate (PSD), there is only one company with approval in the UK for the use of endosulfan in pesticides. Falling usage and expected phase out of relevant products to begin in 2007. |
| Fluoranthene (PS) | A PAH associated with combustion plants (by-product), tar-based paints, fluorescent and vat dyes. | Possibly present as by-product in trade effluent. | | Associated with incomplete combustion of fossil fuels, therefore potentially found in road runoff. | | No specific controls on use, but very few recorded exceedances. (Also see comments on PAH). |
| Hexachloro-benzene (PHS) | Historic use, now banned (since 2007); unintentional by-product in PVC | | | Potentially present in leachate from waste sites | Contained as a contaminant in pesticides and chlorinated organics | No recorded failures. Only potential issues from contaminated land. |
| Hexachlorobuta-diene (HCBD) (PHS) | Historic use, now banned; unintentional by-product from chlorinated hydrocarbon and solvent manufacture | | | Potentially present in leachate from landfills and waste sites | | Very low extent of failures. Only potential issues from contaminated land. HBCD will continue to be produced in trace quantities as an (undesired) by-product of the PVC process. |

| **Table 4.1: Sources of Pollutants and Uncertainties** | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Hexachlorocyclo-hexane (Lindane) (PHS) | No current uses in UK. Potentially available through imported products. | | | | Formerly used as insecticide, now banned. | Not expected in urban catchments, potentially residuals from rural catchments. No current uses in UK. All usage expected to cease by 2008, so that should see further reductions. May be available through imported products (seeds, textiles) but this should decline to zero. |
| Isoproturon (PS) | | | | | Agricultural use as a pesticide (wheat and cereals) | Isoproturon is, at present, the mainstay of weed control in cereals in the UK and also the most commonly used herbicide active substance in wheat. It is considered the most effective substance for a range of pests and is inexpensive compared with alternatives. Expected to be phased out by 2009. |
| Linuron (SP) | | | Some limited domestic herbicide usage may be expected. | | Commonly used herbicide | Very low levels of failure, but some uncertainty remains; further monitoring data are needed. |
| Mecoprop (SP) | | | Some domestic herbicide usage. | Amenity use as a herbicide in public areas. Also, commonly identified in landfill leachate arising from inappropriate disposal (following domestic use) | Commonly used herbicide | Fewer failures than diuron and isoproturon. Sometimes present in groundwater. Some uncertainty remains; further monitoring data are needed. |

| Table 4.1: Sources of Pollutants and Uncertainties | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Naphthalene (PS) | Typically 10% in coal tar. Potential use in chemicals and metals industries; combustion by-product; wood preservative | Potentially present as contaminant in effluent from chemicals and metals industries and manufacture of grinding wheels | Limited potential domestic uses (e.g. mothballs). | Sometimes detected in run-off; found naturally in fossil fuels | | Some uncertainty as to the extent of natural/unintentional sources. Only one industry (grinding wheels manufacture) identified as posing unacceptable risk. Potential reduction of OELs for industrial uses which may affect environmental emissions. |
| Nonylphenols (PHS) | Chemical intermediate; industrial detergent | Detergent and wash waters from industry | | Present in runoff particularly from light industry and car washes | | Extensive restrictions on use. Maximum 0.1% in products as of 2005. Further phasing out expected. |
| Octylphenols (PS) | Chemical intermediate; industrial detergent | Detergent and wash waters from industry | | Potentially present in runoff | | Lower use than NP/NPE therefore not the same magnitude of problem |
| Polyaromatic hydrocarbons (PAH) (PHS) | Combustion by-products; bitumen industry, metal treatment | Potential waste chemical from combustion plants and bitumen industry | | Road run-off; aerial deposition; other unintentional sources | | Uncertainty over extent of unintentional production. Some natural inputs mean that PAHs will always be detectable; insoluble, so more of a concern in solids/sediments; slow decrease as cleaner fuels used |
| Pentachloro-benzene (PHS) | Intermediate in quintozene production; unintentional sources (e.g. as a contaminant in hexachlorobenzene) | | | Leaching from contaminated land | | Might be present in contaminated land – banned since 2001. It might be present in limited imports, such as wood treatment and textile preservation agent. |
| Pentachloro-phenol (PS) | Restricted use as biocide in wood and textiles | | | | | Marketing and use restrictions make it a low priority beyond specific industrial (legacy) inputs – complete withdrawal by 2009 |

| **Table 4.1: Sources of Pollutants and Uncertainties** | | | | | | |
|---|---|---|---|---|---|---|
| **Substance name** | **Industry** | **Water Industry – Trade effluent** | **Water Industry - Domestic** | **Non-agricultural diffuse pollution** | **Agricultural sources** | **Uncertainties / Comments** |
| Phenol (SP) | Widely used in manufacturing and process industries | Possible traces in industrial trade effluent | | Sometimes detected in landfill leachate. | | Some uncertainty remains due to wide usage; further monitoring needed |
| Simazine (PS) | | | | | Agricultural use as a herbicide | Agricultural issue only. Usage expected to cease by 2009. Persistence and heavy historical use will make die away slower. Sporadic occurrences in WwTW FE. |
| Toluene (SP) | Extensive use in manufacturing and process industries | Possible traces in some industrial trade effluent | | | | Low levels of current failure, but more monitoring data are needed. |
| Trichlorobenzene (PS) | Chemical intermediate and process solvent | | | Leaching from landfills/ contaminated land | | Some legacy issues may be expected from contaminated land. |
| Trifluralin (PS) | | | | | Agricultural use as a herbicide | Agricultural issue only, expected to be withdrawn by 2009. Trifluralin is used on cereals and on a wide range of minor crops, including beans, vegetable and animal feed brassicas, carrot, lettuce, etc. Some of the alternatives are generally less effective and more expensive. |

# 5. MEASURES TO MEET WFD OBJECTIVES

## 5.1 Substances and Measures Considered

The following substances have been identified in Section 3 as having the greatest potential to cause EQS failures in 2015 (and thereby affect WFD water body classifications): anthracene, cadmium, chromium, cypermethrin, DEHP, lead, mercury, nickel, TBT, trichloromethane and PeBDE.

Thus, the focus of activities in the first planning round is likely to be linked to measures targeting these substances. It is believed that all remaining substances have a substantially smaller or no compliance gap to close, as they are subject to existing (or agreed) controls, restrictions, bans and other regulations. Trends are generally downward and the extent of EQS exceedance is low at present and expected to be further reduced by 2015. Some substances may require further investigations and monitoring data to confirm the trends and low levels of failure, as previously highlighted in Table 3.1.

This does not mean, however, that there may not be some costs of meeting the proposed EQS for these substances. Because the costs to individual sites associated with emissions of particular substances (e.g. benzene emissions from two or three chemical industry sites, phenol emissions from a range of sites) may be significant, these are also included in this report. This is consistent with the approach taken to the Partial RIA for the Priority Substances Daughter Directive, but generally these are site specific issues outside the scope of the national CEA.

The types of measures that have been identified include a range of actions from waiting for existing controls to take effect, to end-of-pipe controls, other site-based clean-up/remediation measures, limits on concentrations of substances in end-products, other forms of source controls and product restrictions. At the present time, there is a lack of reliable information on source control measures in terms of both their potential effectiveness and likely cost. As a result, the analysis below tends to focus on end-of-pipe control of point source discharges. Alternatives to end-of-pipe measures need to be considered more fully when planning pollutant reduction programmes for individual substances.

However, in identifying the potential need for such controls, care has been taken to consider the likely changes in emissions, discharges and losses as indicated by the trend analysis presented in Section 3. This explicit attempt to account for the impact that existing and planned controls will have on environmental concentrations is likely to lead to some of the differences between what is considered to be required here compared with some of the studies undertaken previously.

At this point, it is important to again refer to the other pCEA reports produced concurrently with this study on chemicals, specifically those focussed on agriculture and mine waters, each of which contain relevant cost information. To avoid doubling counting costs when aggregating all studies together and to maintain consistency across studies, any such costs or measures relating to mining and agriculture (i.e. cadmium in fertilisers and contaminated minewaters) have been omitted from this report.

Measures are not designed to take account of further identification of PS or SPs, though such future designations may influence the appropriateness of the measures identified here.

## 5.2 The Options

As indicated in Section 2, two options are considered as part of this pCEA. These options both assume that site investigations, monitoring and other research that has been identified as essential by the Environment Agency is undertaken as a minimum. In addition, the options then assume:

- **Option 1**: Limited phasing – introduce the measures required to meet the standards as far as possible by 2015 (unless technically infeasible); and

- **Option 2**: Phased action – allow for a programme of investigations, phasing and more innovative measures to achieve standards by 2027.

The emphasis of Option 1 is on actions that can be implemented immediately, using available technology and resources; this is likely to involve best available technologies (e.g. PPC controls) and end-of-pipe treatment. This option defines the maximum investment likely to be required to achieve WFD objectives relating to chemicals.

Option 2 acknowledges that certain measures are likely to be either of lower cost or more effective with a phased approach to implementation. This may be because of uncertainties as to the technical feasibility of a measure, or due to lack of knowledge on the compliance gap (e.g. due to lack of monitoring data or poor understanding of the fate and pathways of pollutants) or currently insufficient technology (e.g. end-of-pipe treatment unable to remove chemicals to EQS levels).

Option 2 is based on a managed risk approach where, initially, only obvious cost-effective measures are implemented. It relies on initiating additional investigation and monitoring programmes to increase both the certainty of estimation of compliance gaps and the certainty about source apportionment. Very importantly, it includes a higher reliance on source control measures. This scenario defines the minimum investment likely to be required to achieve WFD objectives relating to PS, PHS and SPs.

Measures previously proposed in consultations and sector pCEAs available at the time of this study refer to specific substances or groups of substances and these have been taken forward. Additional measures have been added, with these taken from a range of published sources.

It is important to highlight that there are multiple sources and sectors (domestic, agricultural, trade and other industry) for many of the pollutants of concern here. Work carried out by Haskoning[5] involving the development of a matrix of measures, pollutants and associated sources concluded that it is difficult to isolate individual pollutants and sources so as to enable legislative measures to effectively control discharges. For example, a source control measure introduced to restrict the availability of rubber tyres containing extender oils is unlikely to solve the problem of PAHs, anthracene and benzene emissions to the environment. Such a measure only covers a single source of discharges and does not account for its impact regarding other substances relating to the use and manufacture of those tyres. A coordinated approach is therefore required to assess all potential routes to water from various sources and any overlaps between different substances that may exist. Actions and impacts can then be apportioned appropriately, improving the effectiveness and affordability of the control measures proposed. The Pollution Reduction Programmes (PRP) being developed by the Environment Agency are an example of this approach in action.

## 5.3 Overview of Measures

Table 5.1 presents a summary of the types of measures considered for each Option and for each major source. The approach taken to defining measures for this final report varies somewhat to that adopted for the draft final version. In particular, the aim has been to identify, in the first instance, those measures that may be required to address the gap between current quality and the proposed standards. This is prior to any considerations of disproportionate costs (i.e. economic efficiency or affordability). The issue of affordability, in particular, is then addressed separately.

**Table 5.1: Measures Applied in Options**

| Sector | Limited Phasing (Option 1) | Phased Action (Option 2) |
|---|---|---|
| Direct industrial discharges | End-of-pipe controls | Potential reduction in end-of-pipe controls due to greater reliance on source control and better data on levels of reduction required; phased investment up to 2027 |
| Diffuse industrial discharges to the aquatic environment | Measures aimed at collecting and treating diffuse emissions (e.g. run-off from sites) | Phased investment in measures for collecting and treating diffuse emissions (e.g. run-off from sites), linked to site works, plant renewal, etc. up to 2027 |
| Industrial discharges to air | Potential for further controls on key atmospheric sources, e.g. crematoria and other industrial combustion sources | Investigation into source apportionment and monitoring of impacts of current/planned legislation on changes in deposition; further controls on atmospheric sources where required |
| Industrial discharges to STW | Possible end-of-pipe controls if cost-effective compared to end-of-pipe control on water industry WwTWs. No specific assessment of measures | Possible end-of-pipe controls if cost-effective compared to end-of-pipe control on the WwTWs; less need for controls compared to Option 1 due to monitoring of reductions achieved by current/planned legislative controls |
| Water industry | End-of-pipe controls for WwTWs at risk (based on a combination of the RIA and the pCEA work) | End-of-pipe control if and where source control will not deliver the required reduction; less need for end-of-pipe and phased investment up to 2027 |

5 Haskoning (2007): **Cost-Effectiveness of Measures - Analysis of Measures to Reduce Non-Agricultural Diffuse Pollution**, for Defra by Royal Haskoning.

| Table 5.1: Measures Applied in Options | | |
|---|---|---|
| **Sector** | **Limited Phasing (Option 1)** | **Phased Action (Option 2)** |
| NADiP | Collection and treatment of contaminated landfill leachate, etc. | Investment into sustainable drainage systems, to capture road run-off, etc. |
| Agricultural diffuse pollution | No specific issues with pesticides, as most are likely to be phased out before 2015. It should be noted that no specific measures for cypermethrin control have been identified or included | No specific issues with pesticides, as most are likely to be phased out before 2015. It should be noted that no specific measures for cypermethrin control have been identified or included |
| Port activities (e.g. sediments) | Changes in dredging practices to avoid sediment release | Change in dredging practice to avoid sediment release |
| Source control of industrial and professional uses | Restrictions on use at source, e.g. creosote for wood in contact with water, extender oils in tyres, etc. | More tailored restrictions on use at source, e.g. in relation to creosote, extender oils. Await action at EU level to identify other CE source controls |
| Source control of consumer uses | | Source control, e.g. restriction on the use of DEHP based PVCs in outdoor products and building products, on the use of certain substances in consumer products, on concentrations of contaminants in consumer products |
| Substance specific | Monitoring and investigation | Detailed research into source apportionment, technical feasibility of source control measures, and impacts of source controls (including consideration of impacts of alternatives), relative cost-effectiveness of measures compared to treatment. On-going monitoring and investigation work |

***Option 1: Limited Phasing***

Because Option 1 is based on the premise that action is taken to meet the standards in 2015, it provides little opportunity for the Environment Agency to undertake the additional monitoring and investigation required to understand how measures that were recently introduced or have not yet been fully implemented will affect emissions, discharges and losses of the 11 substances of prime concern. As a result, it has a focus on the use of end-of-pipe treatment rather than on the use of more innovative methods and source control. It may also result in over-investment in the short-term given uncertainties surrounding the influence that the other policy and legislative requirements will have on levels of the pollutants in the environment in the longer term.

The basic assumptions for Option 1 are as follows:

1. End-of-pipe treatment for industrial direct discharges is undertaken where it is predicted that discharges will exceed the EQS. These estimates are based on the Priority Substances Daughter Directive RIA, the results of work undertaken for this pCEA on specific pollutants, information submitted by industry and data supplied by the EA based on its PRP work. Around 50 sites are captured by the costs presented here which rely on data from the EA Pollution Inventory; although work undertaken

by Atkins for the pCEA suggests that a higher figure of between 100 to 150 industrial installations with direct discharges may require additional treatment.

2. Diffuse industrial discharges have been identified by a number of the consultees, linked to site run-off, etc. It is assumed that measures would be taken to collect and treat such run-off. It is unclear how many installations may be affected, with estimates included here covering only two sites[6]. This may therefore represent an underestimate.

3. There is considerable concern amongst stakeholders operating combustion processes that additional controls on levels of metals and other substances (such as benzene, anthracene and PAHs) in exhaust gases may be required. Consideration was given to the introduction of further controls on crematoria to reduce mercury emissions[7], however, these have not been included due to uncertainty over the impact that the current measures included in the Mercury Strategy will have in relation to the EQS. No requirements for additional emissions control at other combustion plants are assumed either for similar reasons (i.e. the impact of the Large Combustion Plants Directive, IPPC, Air Quality Directive, etc. on emissions and BAT).

4. No measures have been included in the cost assessment regarding industrial discharges to sewer. It is possible that additional pre-treatment of industrial discharges may be more cost-effective than adding tertiary treatment to the WwTWs, however in terms of total costs this is unlikely to have a significant impact. Therefore, although this option should be explored when determining specific local solutions, it is not crucial for the pCEA to determine the extent to which additional pre-treatment may be more cost-effective.

5. For the water industry, the assumption is that about 10% of all WwTWs require additional treatment. This is the assumption used in the RIA for the Priority Substances Daughter Directive. Based on the current standards for specific pollutants, as set out in Section 2, this figure is unlikely to increase significantly. In the UKWIR work, Atkins estimated that the number of works requiring extra treatment could be up to 50% for certain substances; this higher percentage was based on PeBDE. Given that the use of PeBDE has been restricted and concentrations are expected to decrease over time (next three RBMPs) this high percentage of works at risk is considered an overestimate when considering the other pollutants (with nickel becoming the next driver for additional treatment) and recently introduced legislative controls.

---

[6] Based on data from the Pollution Inventory, the analysis carried out for the Partial RIA suggests that cadmium, mercury and benzene are issues for 3 sites each and nickel is an issue for 4 sites (with there being some overlap in these sites). No data were available regarding PAHs.

[7] The issue of mercury emissions from crematoria has been the subject of two consultations by Defra, the Welsh Assembly Government and the Scottish Executive. The latest guidance indicates that 50% of all cremations at existing crematoria are to be subject to mercury abatement and new crematoria should be fitted with mercury abatement, with a deadline of 31 December 2012.

6. For pesticides, it is assumed that no costs are attributable to the WFD as it is unlikely that approvals will be forthcoming for the three PS pesticides that currently have approvals. With regard to the specific pollutants, no costs are included here due to the level of uncertainty surrounding the extent to which the EQS will not be met (variable across the pesticides with 2,4-D currently of most concern given that diazinon is not currently approved for use), and whether or not approvals will be given at the next point of licence renewal (varying between 2008 and 2013). No costs are included here in relation to cypermethrin, although management actions may be required. Management actions in this regard may include general binding rules (GBRs) to introduce statutory codes of practice, voluntary measures and information awareness schemes (and other similar measures summarised in Haskoning, 2007).

7. Measures taken in relation to dredging and disposal activities at sea are based on the draft PRP for TBT. It is assumed here that the most recent proposals from the Commission limit the degree of action that will be required of the ports sector and others involved in dredging to reduce or limit the temporary release of sediments during maintenance dredging[8].

8. Source controls are assumed here to relate to anthracene, DEHP and PAHs.

9. Monitoring and investigation work is undertaken by the Agency as currently set out in its PRPs and other WFD specific reporting. In addition, assumptions have been made as to the number of site investigations that will be required in relation to the end-of-pipe controls, costs of responding to consent reviews, and the costs of preparing additional PRPs in the future.

***Option 2: Phased Action***

In contrast to the above Option, it is assumed here that in addition to the monitoring and investigation activities that would be undertaken as part of Option 1, a programme of research and testing is undertaken, specifically regarding new substances introduced after 2015 which would require PRP type work to be undertaken. The Environment Agency[9] indicates that approximately 28 new substances between now and 2015 are likely to require investigation work, plus a further 10 in the following period as an estimate. The aim of this will be to reduce the existing level of uncertainty surrounding the technical feasibility of the currently available treatment technologies (e.g. sand filters and GAC) to achieve the proposed EQS and to identify and assess the effectiveness of different source control options. In particular, it would allow the water industry to undertake pilot trials of different technologies (which many have identified as being essential and an action that they would support).

[8] Based on a report by ABPMer (2004), the TBT Pollution Reduction Programme provides annual cost estimates of around £1.2 billion for control of TBT releases from dredging activities. This includes not only minimisation of TBT releases from dredging itself but also removal and treatment of dredging wastes...

[9] EA (2007): Personal Communication, 10/09/07

Action would also be phased so as to allow time for current measures to have effect and thus for greater certainty as to the actual gap that exists between the proposed standards and environmental concentrations. For example, it is assumed that only 25% of those water industry WwTW that are at high risk of failing (e.g. the nickel standard) are required to take action prior to 2020, with a further 50% then required to add end-of-pipe treatment after this point - but at the same cost as the first 25% due to improvements in the cost-effectiveness of the available treatment technologies. Most action is assumed to be undertaken by 2020.

1. For direct industrial discharges, it is assumed that possible investment in additional treatment is phased, with for example, action being postponed until 2015 and then being undertaken at a lower cost (i.e. up to 50%) due to better information on the available technologies and on the levels of reduction required at a particular point. This should have the added benefit of ensuring that introduction of new plant can be phased with other retrofitting or changes in equipment/processes.

2. In relation to diffuse industrial discharges, it is assumed that more cost-effective measures are adopted using innovative techniques to deal with issues concerning site-run off from storage areas, etc. In line with the above assumptions, it is assumed that this will lead to a reduction in costs of up to 50%.

3. It is assumed that no action is taken in relation to atmospheric sources of the various emissions, as the effects of current controls are realised and other sources of the various pollutants are reduced.

4. Compared to Option 1, it is assumed that a lower level of additional pre-treatment of industrial discharges to sewer may be required due to the impacts of current/planned controls under other legislation. Again, this would involve delaying requirements for trade effluent treatment, to allow the influence of already agreed measures to take effect.

5. For the water industry, similar assumptions are applied to those for industrial discharges, as described above. Only one quarter of the investment is to be undertaken by 2010, allowing the effects of other measures to feed through into decisions on the action required at other works. It is then assumed that either the number of works at risk is reduced by 50% or the costs are reduced by 50%.

6. For non-agricultural diffuse water pollution it is assumed that sustainable drainage systems are put into place where cost-effective. Although these systems, for example filter strips or detention ponds, can reduce the load of nutrients as well as PSs, it is assumed that they are only installed when overall cost-effective; see section 6 for cost assumptions.

7. For pesticides, it is assumed that no further action will be required, with withdrawal of use stemming from failures to gain approvals from the licensing process.

8. Measures taken in relation to dredging and disposal activities at sea are assumed to be the same as for Option 1, although in this case it is assumed that costs are reduced by 30% based on declining concentrations of TBT in the environment, and improved procedures and management practices.

9. Source control is assumed only for anthracene and PAHs. The outcome of other legislative processes, such as ESR are awaited to establish requirements for DEHP and cadmium in relation to contamination in detergents.

10. In principle additional source controls and/or acceleration of existing source control measures could be used to achieve reductions. It assumed that further source controls will be applied when assessed to be cost-effective; see section 6 for discussion on costs and cost-effectiveness.

11. For key substances, additional investigation and monitoring actions are required to reduce the uncertainty about the gap. Monitoring and investigation work is undertaken by the Agency as currently set out in its PRPs and other WFD specific reporting. In addition, assumptions have been made as to the number of site investigations that will be required in relation to the end-of-pipe controls, costs of responding to consent reviews, and the costs of preparing additional PRPs in the future.

## 5.4 Overview of Measures for Each Substance

The measures that have been identified for Options 1 and 2 on a substance by substance and sector by sector basis are summarised in Table 5.2. These have been based on consideration of the pressures, trends, apportionment and current or planned measures targeting the priority substances. The measures reflect realistic actions that could be taken either in the short term to guarantee compliance by 2015 (Option1), or in the longer term (Option 2) with a potential timeframe of compliance by 2027.

| Table 5.2: Potential Actions under Options 1 and 2 | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| ALACHLOR | PS | No action required | Use of this Plant Protection Product is banned in the EU and all use will end before 2009. |
| ANTHRACENE (direct industrial discharges) | PHS | Upgrade effluent treatment at 7 PPC coke ovens, 1 PPC coal tar distiller. | Upgrade effluent treatment at 7 PPC coke ovens, 1 PPC coal tar distiller. |
| ANTHRACENE (industrial discharges to WwTW) | PHS | May have to upgrade specific WwTWs where a coke oven discharges directly to a WwTW.<br>Bring timber treatment using creosote into Part A PPC or upgrade WwTW receiving from timber treatment works using creosote. (Small number of works using creosote in UK) | |
| ANTHRACENE (Source control) | PHS | Ban remaining industrial use of creosote where the article will be in contact with water. | Ban use of creosote coated wood where the article will be in contact with water, where monitoring indicates problems in meeting EQS<br>Accept residual tail of diffuse pollution from old creosote coated articles such as garden fences<br>Sustainable urban drainage – reduce anthracene releases as assume binds to sediment |
| ATRAZINE | PS | No action required | Use of this Plant Protection Product is banned in the EU and all use will end before 2009. |
| BENZENE (direct industrial discharges) | PS | Immediate action at any EA regulated industrial sources releasing benzene to water and WwTW. May already be below EQS, so may not have an issue<br>Only an issue if we are not meeting the EQS, probable that we are meeting the EQS. | Investigate PPC sites for benzene releases and consider most cost effective way to eliminate releases, for example extract benzene and thereby stop benzene reaching the effluent stream.<br>Only an issue if we are not meeting the EQS, probable that we are meeting the EQS. |
| BENZENE (industrial discharges to WwTW) | PS | Clean up at WwTW | Investigate PPC sites for benzene releases and consider most cost effective way to eliminate releases, for example extract benzene and thereby stop benzene reaching the effluent stream.<br>Only an issue if we are not meeting the EQS, probable that we are meeting the EQS.<br>No domestic sources, NADiP, bit of atmospheric deposition perhaps, trivial issue. |

| Table 5.2: Potential Actions under Options 1 and 2 | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| BROMINATED DIPHENYLETHER (Pentabromodiphenylether) (direct industrial discharges and discharges to WwTW) | PHS | No action required, no industrial use, manufacture or discharge. Marketing and use of this substance is banned by the EU | |
| BROMINATED DIPHENYLETHER (Pentabromodiphenylether) (domestic to WwTW) | PHS | Upgrade only major WwTWs sources – see WW17<br>Accelerate furniture replacement program via £100 grants for the replacement of furniture containing penta, see WW17 report for details of furniture replacement | Do nothing – wait for natural replacement of penta articles, assume all articles containing penta replaced by 2017.<br>If localised sediment issue, just wait for natural decay |
| CADMIUM AND ITS COMPOUNDS (direct industrial discharges) | PHS | Action at PPC sources, in order of priority, WwTW 375kg, iron and steel 40kg, organic basic chemicals 30kg. | Action at PPC sources, in order of priority, WwTW 375kg, iron and steel 40kg, organic basic chemicals 30kg. |
| CADMIUM AND ITS COMPOUNDS (industrial discharges to STW) | PHS | Ban or achieve zero releases from remaining cadmium plating. (Cadmium plating already restricted by EU M&U) | Reduce cadmium releases from remaining plating as required for STW to meet standards. |
| CADMIUM AND ITS COMPOUNDS (domestic to WwTW) | PHS | Ban use of phosphate in detergents – reduce releases by 17kg per year of cadmium | Require zero cadmium in phosphate used for domestic products. |
| CADMIUM AND ITS COMPOUNDS (source control) | PHS | | Ban dispersive uses of zinc if it contains cadmium<br>Review releases of cadmium arising from the use of zinc and consider limitations on zinc coated articles in contact with water<br>Specify maximum cadmium content of zinc at a very low level. |
| CHLOROALKANES C10-13 (Short Chain Chlorinated paraffins – SCCPs) | PHS | Marketing and use of this substance is restricted by the EU – minimal releases | Marketing and use of this substance is restricted by the EU – zero releases<br>REACH, could press for authorisation or complete phase out<br>Wait for listing for an EU POP, 10 year time horizon |
| CHLORFENVINPHOS | PS | No action required | Use of this Plant Protection Product is banned in the EU, and all use will end before 2009. |
| CHLORPYRIFOS (Agricultural source only) | PS | Ban the use chlororpyrifos | Consider whether there is a surface water issue due to run off of this PPP.<br>Guidance on use of chlororpyrifos so that no releases to water.<br>Ban on spraying close to water courses.<br>PSD considering the status of chlorpyrifos; discussions on re-registration of existing chlorpyrifos products will take place in 2008. |
| 1,2-DICHLOROETHANE | PS | No action required | |

| **Table 5.2: Potential Actions under Options 1 and 2** | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| DICHLOROMETHANE | PS | No action required | |
| DI(2-ETHYLHEXYL) PHTHALATE (DEHP) (direct industrial discharges, indirect industrial and industrial to WwTW) | PS | No UK manufacture or release. | No UK manufacture or release. |
| DI(2-ETHYLHEXYL) PHTHALATE (DEHP) (domestic to WwTW, other source controls) | PS | Clean up at WwTWs Note surface water issue may remain as STWs will only treat foul water.<br>Remove PVC containing DEHP in contact with water | Restrict the use of articles containing DEHP in contact with water<br>Change building regulation to ban the use of articles containing DEHP above trace levels in new buildings where DEHP may be released to water<br>Potential voluntary agreement with building trade, EA sector plan.<br>Restrict the M&U of DEHP - must be at EU level. UK could make an evidence based case to expand restrictions on DEHP, or REACH restrictions to authorise or phase out.<br>Sustainable drainage – possible DEHP removal for surface water. |
| DIURON | PS | No action required | Use of this Plant Protection Product is banned in the EU and all use will end before 2009 |
| ENDOSULFAN | PHS | Use of this plant protection product (PPP) will cease in the UK from June 2007. | Use of this PPP will cease in the UK from June 2007. |
| FLUORANTHENE | PS | See PAHs | See PAHs |
| HEXACHLOROBENZENE | PHS | POP – worldwide ban | POP – worldwide ban |
| HEXACHLOROBUTADIENE | PHS | Local issue with regard to landfill in the NW, otherwise no action. | Local issue with regard to landfill in the NW, otherwise no action. |
| HEXACHLOROCYCLOHEXANE (LINDANE) (direct industrial discharges) | PHS | Set zero limit on lindane in imported goods such as seeds, fleeces, cotton etc. This could be done by enforcing the POPs restriction and ensuring levels were at "unintentional trace" amounts.<br>Possible set PPC limits at textiles and food and drink sectors | Assume die off over timescale of WFD.<br>Lindane is subject to a worldwide ban on production, marketing and use. All use should cease within the timescale of the WFD, though there may be a legacy issue as existing lindane stocks are used by countries outside the EU. |
| ISOPROTURON | PS | No action required | Use of this PPP banned in EU, and all use will end before 2009. |
| LEAD AND ITS COMPOUNDS (direct industrial discharges) | PS | Clean up at WwTWs (9000kg per year)<br>PPC action at manufacture of basic organic chemicals (6000kg per year) | Await restrictions on lead stabilisers to come into force<br>Await outcome of EU Risk Reduction Strategy |

| Table 5.2: Potential Actions under Options 1 and 2 | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| LEAD AND ITS COMPOUNDS (industrial discharges to WwTW) | PS | PPC action at manufacture of basic organic chemicals (6000kg per year) | Await restrictions on lead stabilisers to come into force<br>Await outcome of EU Risk Reduction Strategy |
| LEAD AND ITS COMPOUNDS (domestic to WwTW) | PS | | |
| LEAD AND ITS COMPOUNDS (NADiP and source controls) | PS | A potentially significant source but need more data; only limited buildings related applications connected to unacceptable risks in ESR risk assessment.<br>Phosphate dosing to stop lead dissolving from domestic pipes, or remove pipes. | Ban the M&U of lead in dispersive applications which may result in a release to water.<br>Potential for further reductions on lead emissions from large combustion plants if justified |
| MERCURY AND ITS COMPOUNDS (direct industrial discharges) | PHS | Force conversion to mercury free production methods by 2015, ahead of planned schedule under the Mercury Strategy. This would essentially relate to work brought forward under other non-WFD policies<br>All EU/UK caustic to be mercury free in the 2010 to 2015 timescale | Allow conversion to mercury free production methods by 2020, resulting in no costs attributable to the WFD.<br>Wait for all EU/UK caustic to be mercury free by 2020 |
| MERCURY AND ITS COMPOUNDS (industrial discharges to WwTW and diffuse industrial emissions) | PHS | Clean up at WwTWs | Realistically wait until other mercury measures result in an 80% reduction in mercury releases.<br>Allow for predicted 80% fall in use of mercury in dentistry over the next ten years<br>Enforce fitment and use of amalgam traps at dental surgeries<br>Action ongoing for mercury reduction at crematoria |
| MERCURY AND ITS COMPOUNDS (domestic to WwTW) | PHS | Hand in or exchange program for mercury for thermometers and barometers | Ban M&U of all articles containing mercury (happening via EU mercury strategy thermometers and barometers)<br>Note main source of mercury in teeth, release due to abrasion and excretion – no possible action to reduce in short term. Long term ban use of mercury amalgam – see previous article. |
| MERCURY AND ITS COMPOUNDS (NADiP) | PHS | Collection and treatment of run off from coal and ash stocks, including the replacement of piping affected by historic contamination | Collection and treatment of run off from coal and ash stocks<br>Replace piping affected by historic contamination |
| MERCURY AND ITS COMPOUNDS (Professional source control) | PHS | Ban use of mercury in dentistry (as per Sweden and Denmark), i.e. restrictions on dental amalgam containing mercury | Await other actions to come into effect |

| Table 5.2: Potential Actions under Options 1 and 2 | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| NAPHTHALENE | PS | Same action as anthracene at PPC sites (but releases may be below the EQS so no action may be required) | Sources are coke ovens, coal tar distillation, and grinding wheel manufacture.<br>Note one UK production plant in North East England |
| NICKEL AND ITS COMPOUNDS (direct industrial discharges) | PS | Clean up at WwTWs<br>Possible action at PPC Part A(1) nickel refinery at Swansea | Widespread dispersive pollutant used as an alloying agent. No obvious source to hit.<br>Await outcome of EU Risk Reduction Strategy |
| NICKEL AND ITS COMPOUNDS (industrial discharges to WwTW) | PS | Clean up at WwTWs | Widespread dispersive pollutant used as an alloying agent. No obvious source to hit.<br>Await outcome of EU Risk Reduction Strategy. |
| NICKEL AND ITS COMPOUNDS (domestic to WwTW) | PS | End-of-pipe treatment | Ban use of metal alloys containing nickel in contact with water, such as alloy heating elements (see WW17 report) |
| NICKEL AND ITS COMPOUNDS (NADiP) | PS | No obvious sources | No obvious sources |
| NONYLPHENOL (direct industrial discharges) | PHS | Action at 2 PPC sites that release nonylphenol<br>Enforce M&U rigorously<br>See RIA for costs of complete ban £185m | Enforce M&U restriction |
| NONYLPHENOL (industrial discharges to STWs) | PHS | One site, probably not an issue | Ban residual uses of nonyl phenol |
| NONY PHENOL (domestic to WwTW) | PHS | Enforce M&U restriction | Enforce M&U restriction |
| OCTYLPHENOL AND (PARA-TERT-OCTYLPHENOL) | PS | No action required | No evidence of UK use of release<br>Take forward UK Risk Reduction Strategy, PPC resin manufacturers. |
| PENTACHLOROBENZENE | PHS | No known UK production or use of this substance | No known UK production or use of this substance |
| PENTACHLOROPHENOL | PS | No action required. Pentachlorophenol is subject to an EU Marketing and Use restriction with limited exemptions until 31st December 2008. No known UK use. | Pentachlorophenol is subject to an EU Marketing and Use restriction with limited exemptions until 31st December 2008. No known UK use. |
| POLYAROMATIC HYDROCARBONS (PAHs) | PHS | Possible additional abatement at coal fired power stations, but linked to the UK air quality strategy<br>Further restrictions on the use of extender oils containing PAHs from tyres so as limit this source by 2015. | Normal regulatory activities, such as the implementation of PPC at combustion sources and UK air quality strategy, will reduce PAH releases gradually<br>Review impact of EU limits on PAHs in tyres from 2010 onwards. |
| SIMAZINE | PS | No action required. Use of this Plant Protection Product is banned in the EU, and all use will end before 2009 | Use of this Plant Protection Product is banned in the EU, and all use will end before 2009 |

| Table 5.2: Potential Actions under Options 1 and 2 | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| TRIBUTYLTIN COMPOUNDS (direct industrial discharges) | PHS | No sources known | |
| TRIBUTYLTIN COMPOUNDS (industrial discharges to sewer) | PHS | Clean up at WwTWs receiving from timber yards with TBT treated wood. | Ban the M&U of timber treated with TBT (Reported discharges of TBT from stored imported timber)<br>Require special storage for TBT treated wood<br>Not allowed to use TBT to treat timber in the UK (biocide directive) but timber treated with TBT can be imported. |
| TRIBUTYLTIN COMPOUNDS (domestic to WwTW) | PHS | Clean up at WwTWs<br>Still may be a residual issue with surface water run off and leachate from articles containing TBT | Restrict the use of articles containing TBT in contact with water<br>Restrictions on the use of dibutyl tins (which contain TBT as an impurity) in consumer goods<br>Change building regulation to ban the use of articles containing TBT above trace levels in new buildings where TBT may be released to water<br>Ban the use of any compound containing >0.1% TBT<br>Most uses of TBT are now subject to a Marketing and Use Restriction. However, TBT may be present in imported timber, although its use as a biocide (including timber treatment) is not permitted in the UK. |
| TRIBUTYLTIN COMPOUNDS (NADiP) | PHS | Clean up TBT contaminated sediments<br>Active enforcement of requirement that ships should have removed or barrier coated TBT anti-fouling paints<br>Remediation of minewater discharges using chemical treatment | Allow TBT levels to naturally decay |
| TRIBUTYLTIN COMPOUNDS (source control) | PHS | Removal of TBT from PVC as it is present as a contaminant from the use of other tin compounds | Allow TBT levels to naturally decay |
| TRICHLOROBENZENES (1,2,4-TRICHLOROBENZENE) | PS | No action required | No action required |
| TRICHLOROMETHANE (CHLOROFORM) (direct industrial discharges) | PS | Review Pollution Inventory data indicate that no exceedances of the EQS are likely, with the exception of STW | Review Pollution Inventory data indicate that no exceedances of the EQS are likely, with the exception of STW |
| TRICHLOROMETHANE (CHLOROFORM) (industrial discharges to WwTW) | PS | Possible release from Ineos chlor due to formation as an impurity or direct manufacture; probably zero releases as chlorinated waste would be incinerated. | |

| Table 5.2: Potential Actions under Options 1 and 2 | | | |
|---|---|---|---|
| **Substance** | **PHS/PS/SP** | **Option 1 Measures** | **Option 2 Measures** |
| TRICHLOROMETHANE (CHLOROFORM) (domestic to WwTW) | PS | Clean up at WwTWs | Further investigate sources.<br>There is no evidence at present that the source of trichloromethane in surface water is from EA regulated activities; the source of trichloromethane in water may be due to in situ synthesis from chlorine, hypochlorite and organic material.<br>Note M&U restriction on sales of >0.1% to members of the public or use in diffuse pollution applications. |
| TRICHLOROMETHANE (CHLOROFORM) (NADiP) | PS | | |
| TRIFLURALIN | PS | Use of this Plant Protection Product is banned in the EU, and all use will end before 2009 | Use of this Plant Protection Product is banned in the EU, and all use will end before 2009 |

# 6. COST OF MEASURES

## 6.1 Introduction

### 6.1.1 Key Issues in Developing Costs

The costs presented below for the measures comprising Options 1 and 2 have been taken from a range of different sources. These include the most recent draft of the Partial RIA for the Priority Substances Daughter Directive (dated July 2007), estimates submitted by industry to the pCEA working group, work undertaken for UKWIR, and assessments undertaken as part of policy development for other regulatory regimes (e.g. the Mercury Strategy, ESR risk reduction strategies, etc.). Industry has also submitted some data for inclusion in this assessment (as part of a consultation response to this exercise or to the Partial RIA).

Several difficulties arise in trying to draw estimates of cost-effectiveness from such a diverse range of sources, particularly where these have been prepared over fairly long time frames (e.g. references date from pre-2000 to 2007). The key factors determining whether or not particular estimates have been adopted for this analysis are as follows:

- The EQS proposed for the PS substances were revised in the July 2006 Commission proposal, with values for key pollutants such as nickel being relaxed. As a result, studies undertaken to determine the costs of meeting the EQS carried out prior to this date are likely to over-estimate the level of treatment required and hence the associated costs.

- Because there has been no mandatory reporting to the Environment Agency Pollution Inventory (PI) for some of the substances, the available information on the number of dischargers that may be affected by the EQS is highly uncertain. This problem is exacerbated by the fact that many smaller dischargers do not fall within the Pollution Prevention and Control (PPC) regime and thus do not have to report at all.

- Where companies do report to the PI, this is in relation to a reporting threshold. A zero value may therefore mean that a discharge is below the threshold rather than that there is no discharge. Given the very low EQS being proposed for some of the substances, this may mean that some discharges who could incur compliance costs are not included in the estimates (although it may be argued that discharges below the threshold value are unlikely to be significant determinants of whether a water body achieves or fails GES).

- For some of the substances, the proposed EQS is below the current limits of analytical detection (LOD). Different approaches have been adopted in the various studies in relation to these below LOD values. In some studies, it has been assumed that they are of low significance in terms of the potential failure to comply with proposed EQSs while, in others, a certain of percentage of the works have been estimated to fail based on an extrapolation of available data for just a few sites.

- On the same issue, it has been suggested that during sampling and monitoring by companies (for the PI), if a substance is not detected, then the actual concentration is recorded at the Level of Detection (LOD), or a fraction of the LOD. Scaling up, this will in some cases produce a substantial mass release - which may partly explain why reductions in certain substance releases has not been observed.

- In some cases, values reported on the PI are based on estimates rather than on measured data. This could add further uncertainty where the estimation methods are considered problematic for a given substance.

- Although several estimates of the potential costs of meeting the EQS have been generated, the relative cost-effectiveness of many of the measures is significantly more difficult to determine. This is due to a number of factors, with the five key ones being:
  - a lack of information on the relative importance of different sources;
  - uncertainty as to the impact that existing controls will have on usage and emissions in the future;
  - uncertainty as to the effectiveness of the more novel and/or less tried and tested technologies and to novel ways of using existing methods;
  - treatment plant will generally remove a range of pollutants, albeit at different efficiencies, making it difficult to attribute costs across standards (i.e. issue of joint products); and
  - uncertainties as to the role that source control can actually play given that some uses of substances are likely to be essential.

- Finally, some of the data or studies have adopted a baseline for the analysis that is not consistent with the current and expected regulatory trends for the different substances. In some cases, the data attribute costs to the WFD, when the measures have been agreed under other policy drivers. This overlap in regulatory requirements makes it difficult to separate and clearly allocate costs across different legislation, but it is important to do so and not to double-count the costs of particular actions.

### 6.1.2 Source Control Measures

Stakeholder comments on the pCEA identified the lack of discussion on source control measures as a weakness (which also applies to the Partial RIA of the Priority Substances Daughter Directive). Within the limited time available, efforts have been taken to try and address this shortcoming, by identifying any additional information that could be extracted from readily available sources (see Appendix A for more details). This has resulted in the identification of additional measures, which in some cases have been included in the analysis. However, the findings of previous work that there are very high costs associated with some source controls still holds. As does the conclusion that previous experience with source control measures as part of chemicals regulation show that it is possible to reduce or restrict the use of a substance in certain applications at low costs while a complete phasing out of a substance could be very costly.

The source controls that have been considered here are reported in Table 6.1, with different sets of measures assumed to apply under Option 1 and Option 2. In considering these measures, it must be stressed though that the costs and effects of source controls have not been systematically investigated.

**Table 6.1: Source Control Measures Included in Options**

| Substance | Measure | Year Introduced | Duration* | Annual Cost |
|---|---|---|---|---|
| **Option 1** | | | | |
| Anthracene | Ban on use of creosote in treated wood in contact with water | 2010 | Annual until 2062 | £4.4 million |
| Cadmium and its compounds | Ban on use of phosphate detergents | 2010 | Annual until 2062 | £1.7 million |
| PAHs | Ban on the use of extender oils in tyre manufacture | 2010 | Annual until 2062 | £5.6 million |
| DEHP | Restrict use of PVC containing DEHP from uses in contact with water | 2010 | Annual until 2062 | £0.4 million |
| **Option 2** | | | | |
| Anthracene | Ban on use of creosote in treated wood in contact with water, following R&D into alternatives and phased reduction | 2015 | 2015 until 2020 (no further costs due to availability of efficacious alternatives | £4 million decreasing |
| PAHs | Monitoring followed by reduced restrictions on the use of extender oils in tyre manufacture, allowing industry to move gradually to alternatives | 2020 | Annual until 2062 | £2.8 million |

* The costs have been estimated for the period from 2009 to 2062.

For Option 1 it is assumed that measures aimed at achieving the EQS are adopted, even though their relative effectiveness is currently unclear. In this case, the aim is to take action to try and meet the EQS by 2015.

Not all of the source control measures adopted under Option 1 are carried through to Option 2. This is because Option 2 delays action to allow either better information to be collected on the need for action, or for measures at the EU level to either take effect or to be agreed and introduced (e.g. restrictions on cadmium in fertilisers which are currently the subject of discussion within the Commission).

Possible source control measures which have not been included in the options for technical feasibility or other reasons are as follows:

- Ban use of creosote on all treated wood due to cost and durability issues surrounding substitution for articles such as telephone poles;
- Accelerated furniture replacement program via grants due to affordability concerns and difficulties concerning testing and waste disposal programmes;

- Restrictions on the use of SCCPs in PVC due to affordability concerns, given low level of use and current trend away from usage;
- Restrictions on the use of lead sheeting, etc. in building applications, awaiting the conclusions of the risk assessment and any associated risk reduction strategy and thus better information on effectiveness and costs;
- Restrictions on the use NP in remaining applications prior to phase-out under UK Voluntary Agreement and M&U restrictions due to technical feasibility of substitution in some uses (e.g. chemical synthesis) and affordability considerations in relation to the quantities used and associated risks posed by those uses not covered by EU M&U restrictions;
- Ban on the use of mercury in dentistry, due to the predicted costs of such a measure, and instead allowing natural shift to alternatives;
- Removal of TBT as contaminant in PVC from the use of other organotin compounds in production, as the costs are estimated to be exceedingly high and are largely unknown at this stage. This issue is also being investigated at the EU level; and
- Restriction on concentration of hypchlorite in bleaches (5% maximum) as the effectiveness and therefore comparative affordability were deemed inappropriate[10];

A range of other types of potential types of source control measures may be relevant, for example:

- Reducing the addition of cadmium (and zinc in the future) in animal feeds, by ensuring that such essential minerals are included in more bioavailable forms;
- Restricting the sale of consumer products containing priority substances, such as batteries, hard chromium plated decorative items, personal care products and cosmetics, etc.

Although the full range of measures has not been examined to date, it must also be recognized that source control on its own is unlikely to be able to achieve the EQS. This is due to the fact that there are safety critical or otherwise essential uses of some of these substances, such as cadmium and chromium plating applications for the aerospace industry. Furthermore, metals such as cadmium and nickel (and zinc) are essential minerals and will be released as a result of dietary up-take by both man and animals; these metals are also present as unwanted contaminants in a range of raw materials (including drinking water), not all of which it would be appropriate to address through source control.

### 6.1.3 End-of-pipe Controls

End-of-pipe controls have been examined in previous work. For example, granulated activated carbon (GAC) and sand filters are used as the indicative technology to estimate tertiary treatment costs in the UKWIR WW17 report (Atkins *et al*, 2006); however, it is recognised that these technologies are current unproven and may not be capable of ensuring compliance for the levels of reductions required for substances such as PeBDE, DEHP and nickel.

[10] EA (2007): Personal Communication, 09/09/07.

End-of-pipe controls can be applied to both direct industrial discharges and to WwTWs. In the pCEA work, the costs of applying sand filtration at industrial WwTWs and sand filtration and GAC at water industry WwTW at risk of EQS failure have been estimated based on unit costs according to the size of the treatment works. Average costs per works are estimated at around £2m - £3m for whole life costs over a 20 year period. In total annual costs, the equivalent values range from £0.15m to £0.2m.

The Partial RIA for the Priority Substances based its cost estimates on predictions for the level of reductions in discharges that would have to be achieved by individual sites reporting to the PI in order to meet the EQS in the receiving waters. This approach assumes low dilution capacity within the receiving waters (5 to 10 litres/second) and bases the level of reductions required on either consent values or on actual loads as reported by individual sites. Figures on the marginal costs of secondary and tertiary treatment by sector (based on Defra[11], 1999) are then applied to derive figures for the increase in costs over and above current treatment requirements. As noted in the Partial RIA, the methodology suffers from a number of potential drawbacks which may lead to either over-estimates or under-estimates for any given site. These include the lack of dynamism, in that it only reflects the current snapshot of emissions and does not, for example, account for the future changes in emissions because of sectoral compliance with existing or proposed regulations (as discussed in Section 2) or investment in the next generation of treatment technology prior to 2015 due to PPC or other requirements.

Stakeholders have also argued that many direct industrial discharges will need new plant to improve their waste water treatment and that such costs will not be fully reflected in the type of marginal cost-based approach that has been adopted[12].

For these reasons, and the level of uncertainty underlying the current baseline and hence the gap that will need to be addressed, it is important to stress that the costs estimates are also highly uncertain. It must also be noted that not all of the substances are currently monitored for and covered by the PI, and these methods cannot therefore be applied to them. Similarly, smaller companies that fall outside the PPC regime are not required to report to the PI and, hence, are excluded from the analysis.

Table 6.2 sets out the end-of-pipe controls that have been assumed to be implemented under Options 1 and 2.

11 Defra (1999): **Economic Instruments for Water Discharges** produced by ERM UK for the Department for Environment, Food and Rural Affairs, downloadable from Defra website: http://www.defra.gov.uk/environment/water/quality/econinst2

12 Although this argument is valid with regard to a selection of the sites where large reductions in discharges are predicted as being required, it is of note that for many discharges much smaller levels of reductions are calculated as being necessary. In such cases, the marginal cost based approach would appear to be valid.

| **Table 6.2: End-of-Pipe and Other Controls for Industrial Sources** | | | | |
|---|---|---|---|---|
| **Substance** | **Measure** | **Year Introduced** | **Duration** | **Annual Cost** |
| **Option 1** | | | | |
| Suite of substances at STW, driven by nickel | Sand filter and GAC treatment at 10% of STW | 2010 | Annual | £335 million |
| Anthracene | Upgrade specific WwTWs where a coke oven discharges directly to a WwTW (fuel and power, metal sector) | 2010 | Annual | £3.5 million |
| Benzene | Additional treatment of point sources (fuel and power, chemicals industry, metals sector) | 2010 | Annual | £27 million |
| Cadmium and its compounds | Additional secondary treatment of point sources (fuel and power, chemicals industry, metals sector) | 2010 | Annual | £0.25 million |
| Chromium | Additional secondary treatment of point sources (chemical industry) | 2010 | Annual | £3.3 million |
| DEHP | End-of-pipe treatment at soft PVC manufacturing sites | 2010 | Annual | £0.4 million |
| Lead and its compounds | Additional secondary treatment of point sources (fuel and power, metals sector) | 2010 | Annual | £2.7 million |
| Mercury | Additional secondary treatment of point sources (fuel and power, chemicals) | 2010 | Annual | £250,000 |
| | Bring forward date of Ineos Chlor conversion to mercury free production compared to agreement under Mercury Strategy | 2015 | One-off increase in costs compared to planned | £3 million |
| | Collection and treatment of run-off from store/stock yards and | 2010 | Annual | £6.4 million |
| | Replacement of contaminated piping | 2015 | One-off cost | £2 million |
| Nickel | Additional secondary treatment of point sources (chemical industry) | 2010 | Annual | £4.3 million |
| Phenols | Additional secondary treatment of point sources (fuel and power, chemical industry, metals sector) | 2010 | Annual | £226,000<br>£465,000 |
| Tributyltins | Management of capital and maintenance dredging | 2009 | Annual | £185 million |
| **Option 2** | | | | |
| Suite of substances at STW, driven by and nickel | Sand filter and GAC treatment at 10% of STW | 2010 | 25% of works until 2020 and then 50% of works until 2062 | £83.5 rising to £167 |

| **Table 6.2: End-of-Pipe and Other Controls for Industrial Sources** | | | | |
|---|---|---|---|---|
| **Substance** | **Measure** | **Year Introduced** | **Duration** | **Annual Cost** |
| Anthracene | Upgrade specific WwTWs where a coke oven discharges directly to a WwTW (fuel and power, metal sector), cost adjusted for better information gathered from investigation | 2015 | Annual | £2 million |
| Benzene | Additional treatment at selected point sources (fuel and power, chemicals industry, metals sector) | 2015 | Annual | £10 million |
| Cadmium and its compounds | Additional secondary treatment of point sources (fuel and power, chemicals industry, metals sector) | 2010 | Annual | £0.25 million |
| Chromium | Additional secondary treatment of point sources (chemical industry) | 2015 | Annual | £1.3 million |
| Lead and its compounds | Additional secondary treatment of point sources (fuel and power, metals sector) | 2010 | Annual | £1 million |
| Mercury | Collection and treatment of run-off from store/stock yards (one-site only) | 2020 | Annual | £0.4 million |
| | Replacement of contaminated piping, phased with other site work to reduce costs (fuel and power) | 2020 | One-off cost | £1 million |
| Nickel | Additional secondary treatment of point sources (chemical industry) | 2010 | Annual | £2 million |
| Tributyltins | Management of capital and maintenance dredging | 2009 | Annual | £35 million |
| * Costs have been estimated over a 43 year period (18 years to cover the period up to 2027 plus a further 25 years to reflect a 25 year life for assets built in the last planning period). | | | | |

Measures that have not been included in the analysis due to affordability concerns include:

- Aggressive reductions of mercury from crematoria atmospheric emissions, estimated to cost around £100 million (present value); similarly, for both options, it is not assumed that action is taken to remove other substances from atmospheric emissions, as these are regulated by other legislation for combustion plants, vehicle exhausts, etc.;
- Reductions of nickel emissions from particular chemicals and other industrial sites, awaiting the outcome of the ESR risk assessment and risk reduction strategy; it should be noted that the costs for some sites could be high;
- Immediate requirement of sand filters and GAC at all water industry WwTW, instead allowing the impacts of current and planned measures to take effect; and

- Chemical or physical treatment of dredging wastes, or other disposal requirements above and beyond what is currently required.

Under Option 2, measures have been delayed for those substances awaiting recommendations from ESR risk reduction strategies. It is left for those strategies to identify and put forward the most cost-effective programme of measures for reducing risks to the environment (with practicality and proportionality an aspect of the assessments underlying such strategies). Measures are also delayed in some cases for other sources, where it is assumed that this reduces costs by enabling companies to undertake works in line with other capital renewal or site modification programmes. However, in some cases, the measures assumed here are the same as for Option 1 as arguments for delaying action in relation to particular point sources may not be justified.

### 6.1.4 Monitoring, Investigation and Other Administrative Costs

Estimates of the likely monitoring, investigation and administrative costs of implementing the Daughter Directive standards and those proposed by the UKTAG have been developed in discussion with the Environment Agency for England and Wales.

***UKTAG Standards Development and Policy Support***

Costs have been incurred by the Environment Agency in developing the information supporting the standards proposed by the UKTAG. These have been estimated by the Agency at around £400,000 to date. Such work is ongoing in relation to the Part B substances for which existing standards will be used for the first round of River Basin Plans, while further data are collected to allow reliable standards to be set. It is expected that this work will cost around £50,000 per annum up to the end of the second planning round.

In addition to these costs is the work undertaken by the Environment Agency in relation to the EC working groups on the Article 16 Daughter Directive. This includes supporting Defra in negotiations and providing some of the underpinning science and inputting directly into EC technical fora. Such technical work in EC for a is likely to increase in the short-term to resolve outstanding technical issues and is likely to continue during at least the first and second planning rounds as there may be revisions on the standards set for certain substances and as new substances are proposed for inclusion in the list of priority substances. The Environment Agency estimates costs for this work of around £250,000 per annum.

***Monitoring***

The Environment Agency's best estimates at this time of the sampling and analysis costs specific to the priority substances and specific pollutants are £2 million. This would cover both the additional freshwater and marine monitoring activities required on an annual basis. On top of this, there may be additional monitoring based investigations of £1.25 million, with these being carried out at an area level and used to inform PRP development (see below). Note that these investigations are assumed to be a one-off cost; however, such costs are also assumed to arise in each planning period, to reflect the need for investigations to be carried out for additional substances becoming priority substances or for additional substances being designated as specific pollutants.

In relation to the above costs, it should be noted that the costs of documenting a progressive reduction in each compartment, and in particular that there is no increase in the concentrations of substances in sediment and biota for priority substances, could be significant. Monitoring compliance with the standards for three substances in prey tissue of fish, molluscs, crustaceans and other biota could also introduce additional costs. There is currently little monitoring in freshwater sediments or biota and few sites tend to be covered; hence, significant costs may also be incurred from this requirement. In addition, the monitoring implications of mixing zones of exceedance are also highly uncertain at present but could be significant.

With regard to monitoring chemicals in relation to the Groundwater Daughter Directive, no costs are included here. However, the Environment Agency notes that the current network is the minimum necessary.

***Consenting and Site Investigations***

Both Options 1 and 2 include the need for the Environment Agency to review existing consents at a number of water company and PPC sites. For Option 1, it has been assumed that the Environment Agency may review consents at 140 water company sites (although action would be taken at a lower number – around 30 to 40) and at a further 40 industrial dischargers. Under Option 2, these numbers would be halved, with a lower number of consents would actually be revised downwards. These reviews are expected to take between 2 to 3 person days at a cost of around £1,000 per up-dated consent.

There is the potential for industrial dischargers and water companies to challenge any revised consents. It is assumed here that 10% of the revised consents would face such a challenge, with 90% of this figure attracting a cost of £10,000 to the Environment Agency. In two out of ten of these cases, the challenge may result in costs of around £100,000 to the Environment Agency, linked in part to the extended period of time required for monitoring and review work[13].

In addition to the costs to the Environment Agency, a water company (or industrial discharger) may be asked to undertake a desk study investigation and this might cost between £5,000 to £10,000, less frequently they may also be asked to include a self-monitoring programme in the investigation of a given site, with an estimated cost of between £20,000 - £30,000 per site. Occasionally, the Agency may ask a water company to review and monitor a stretch, in which case the costs could be up to around £200,000 to the water company.

Work may also be necessary in relation to specific chemicals and impacts on groundwaters, however, no estimates of the costs involved have been included here.

13 EA (2007): Personal Communication, 07/09/07

***Pollution Reduction Programmes***

The previous discussions have made clear the importance of having a better understanding of the relative contribution of different sources to levels of pollutants in the environment, the impact that current and planned measures will have on concentrations of the various substances in the environment, and on the remaining sources of the substances.

The Environment Agency already has started work on developing Pollution Reduction Programmes (PRPs) for the key PS of concern in England and Wales. Around £100,000 has been spent to date. Such work will need to be expanded to include the specific pollutants identified by UKTAG and to respond to proposals for the second tranche of substances to be included in the priority list by the European Commission.

It has been assumed here that further substances will require the development of PRPs by 2015, and others requiring PRPs for the second and third RBPs. Development of a PRP requires source apportionment studies, risk assessment related work, and studies aimed at identifying the most appropriate set of actions for both the Agency and for other stakeholders. The initial PRPs will identify a range of cost effective measures that can be implemented depending on the use pattern and also information gaps that will need to be addressed to enable future iterations of the PRP in subsequent planning rounds. On this basis, it is assumed that the development of a PRP will cost around £50,000.

In some cases, the Environment Agency may wish to put forward restrictions dossiers under Annex XV of the REACH Regulation. It has been assumed that this will be the case for up to five substances within the first plan period, at a cost of £50,000 each and up to a further five substances in the second plan period, at similar costs.

### 6.1.5 Other Costs

In addition to the compliance costs associated with the above source and end-of-pipe treatment controls, are the potential wider and social costs that such measures may have. With regard to the source controls, these include the potential impacts associated with the substitution of one chemical input by another (e.g. DEHP with another plasticizer, nickel with other substances, etc.) and potential impacts on the quality, durability and availability of consumer products.

With regard to end-of-pipe treatment, the adoption of more sophisticated treatment methods such as GAC will lead to increased energy use and hence increased emissions of greenhouse gases. These costs could be quite significant depending on the end technologies that are adopted and the number of works requiring their use[14]. Note that no estimates of the social costs of carbon have been included in this assessment. This is

[14] For example, Atkins (2007) estimate that GAC based end-of-pipe treatment at over 50% of STWs would produce a 24% increase in greenhouse gas emissions. As only 10% or less of works are assumed under these two options to require action, the increase in greenhouse gas emissions would be significantly less; applying a proportional decrease in emissions suggests an increase of around 5% compared to current levels.

because it is believed that estimates of the costs of the additional water company wastewater treatment requirements will include allowance for the climate change levy as part of opex; thus, some portion of the costs of the carbon externality has already been captured by the estimates presented here. To apply the full shadow price of carbon as per current guidance[15] would result in double counting the carbon impacts. Unfortunately, determining the level of externality that is captured in the estimates has not been feasible within this exercise.

In addition to potentially significant increases in greenhouse gas emissions, industry stakeholders note that extra wastewater treatment will also produce additional waste and potentially hazardous sludge and again the environmental cost to deal with this has not been considered.

In the evaluation of each option and measure, it is also important to account for second tier impacts, specifically financing costs. These are the costs incurred by industry in attaining the necessary finance to undertake capital investment(s) in new or upgraded water treatment facilities, etc. End-of-pipe treatment costs taken from the Defra (1999) study incorporate a higher discount factor of 8% to account for such costs; it is also like that the costs estimates developed by Atkins (2007) for the pCEA, which is based on the Seven Trent cost model to generate opex and capex costs, is based on the costs of capital to the water company. In addition, it should be noted that the Defra (1999) figures have also been updated using the retail price index and with reference to the relevant EU Commission BREF guidance documents in order to bring the costs up to date.

## 6.2 Costs for Each Option

A summary of the cost estimates is presented in Table 6.3, based on the assumptions set out above with regard to the timing of measures and their associated costs. The table gives the total annual costs (sum of the annualised capex and opex) for each scenario and for each main source for a 25 year period and the period up to 2062.

As has been stressed before, there are a number of key assumptions and uncertainties about the cost estimates that should be emphasised. The main cost driver is the possible requirement for additional end-of-pipe controls for the water industry and the increased costs of capital and maintenance dredging works. As indicated in Tables 6.1 and 6.2, the above cost estimates include assumptions concerning the phasing of investment in end-of-pipe treatment, particularly in relation to Option 2.

15 Interim guidance on valuing changes in greenhouse gas emissions using the shadow price of carbon is available on Defra's website: www.defra.gov.uk/environment/climatechange/research/carboncost/index.htm.

| Table 6.3: Summary of costs for Scenarios 1 and 2 (equivalent annual costs in £ million 2007) | | | |
|---|---|---|---|
| **Measure / Sector** | | **Option 1** | **Option 2** |
| | | **Equivalent Annual Value** | **Equivalent Annual Value** |
| **Source Control** | Other Industry (wood treatment, tyres and PVC) | 8.2 | 2.0 |
| **End-of-Pipe Controls** | | | |
| Direct industrial discharges | Fuel & Power: 24%<br>Chemicals: 75%<br>Metal, Waste, Landfill and other: 1% | 46.3 | 12.1 |
| Industrial and trade effluent discharges to WwTW | | No cost estimates developed to date. Additional pre-treatment should be introduced when cost-effective. Will not significantly reduce the total costs. | |
| Water industry | | 328.9 | 130.7 |
| Agricultural diffuse pollution* | | 0 | 0 |
| Navigation | | 181.7 | 34.4 |
| **Monitoring, Investigation and Administration** | | | |
| EA policy implementation and Administration | | 2.5 | 2.4 |
| Water industry self-monitoring | | 0.2 | 0.2 |
| **Total** | | **567.7** | **181.7** |
| * Excluding any actions that will be required for cypermethrin. | | | |

Of particular note from the above table is that awaiting the combination of already implemented restrictions/bans on use and the influence of additional source controls is expected to remove the need for much of the end-of-pipe treatment, reducing annual costs by more than a factor of three. Furthermore, the benefits of further investigations to identify more innovative approaches for achieving reductions in emissions, discharges and losses is highlighted by the savings that are predicted in relation to remediation of end-of-pipe industrial discharges.

Key issues surrounding these estimates are as follows:

- the number of WwTWs at risk which ranges from very low percentages up to 50%. A strict application of the cessation requirement (as opposed to the 'aim' as stated in Article 4 of the Water Framework Directive) could under a worst case scenario mean that more WwTWs would need additional treatment;

- co-removal of substances: it is assumed that 10% of works needs treatment in scenario 1. This implicitly assumes a degree of co-removal and therefore that costs are not additive. If costs prove to be additive, the total costs will be higher;

- it has not been possible to cost the actions required by all industrial dischargers and in relation to all of the priority list substances and specific pollutants due to a lack of data and uncertainty surrounding what will be required;

- the costs of monitoring in line with the proposed EQS are not included, and given that some are below the limit of detection or are very need current limits of detection, there is concern that analytical techniques costs alone could be significant; and

- additional environmental costs (e.g. additional carbon emissions, removal of PHS from sludge etc) are not included.

The key assumption is the number of WwTWs where end-of-pipe control is to be applied. This assumption determines the order of magnitude of the costs. As described in section 5, the assumption is that 10% of works need additional tertiary treatment or upgrade. The Partial RIA initially estimated that the costs to the UK water industry of meeting the proposed EQS by reducing discharges at these 10% of WwTWs would be around £1 billion. This suggests an average whole-life cost of around £2 million per STW. It is worth noting that other comparable studies (such as those for UKWIR (2006) [16] which adopted a different approach to costing based on costs of tertiary treatment of between £0.5m and £10m 'whole life costs') also resulted in average whole-life costs of around £2 million per WwTW. However, on the basis of the revised proposals of June 2007, the costs were estimated to be around £300 million to be incurred at around 100 to 150 WwTW (although this reduction is based mainly on the Article 4 provisions).

## 6.3 Differences in Previous Cost Estimates and Stakeholder Concerns

The key sources of information on measures and costs of measures comprise:

- The partial RIA with recently updated numbers;
- UKWIR WW17 project; and
- Supplementary data provided by stakeholders in submissions as part of the pCEA or in response to consultation on the partial RIA.

The main differences in the approach and the results are explained below.

### 6.3.1 Direct industrial discharges

Additional measures have been included here compared to the partial RIA. In particular, estimates are included for source control measures, as well as costs for end-of-pipe treatment of chromium and phenols at PPC sites. The partial RIA estimated costs to be around £4m equivalent annual value as an upper bound cost, with the revised partial RIA indicating that responses to the stakeholder consultation suggest the costs would be higher. The pCEA work arrived at a figure of £5m, based on an assumed dilution of 1 in 10, which can be considered low for industrial discharges. A sensitivity analysis shows that with a dilution factor of 100, which is often available to industrial discharges, the number of installations requiring additional treatment would be reduced by 50%. That brings the costs within the same order of magnitude[17].

[16] Atkins (2007) states the total costs range between £2bn and £12bn. The range applied in Table 6.1 assumes the range of £2bn to £4bn.

[17] Stakeholders have argued that dilution factors should not be assumed, based on worst case scenarios as to the withdrawal of the provisions related to mixing zones from the Priority Substances Daughter Directive.

As noted above, both sets of estimates are based on several assumptions and therefore subject to significant uncertainty. In terms of their order of magnitude, both cost estimates are fairly moderate compared to the costs for the water industry and the ports sectors.

It should be noted that industry stakeholders are concerned that the costs given here rely heavily on the assumption that the proposals for the Priority Substances Daughter Directive currently under negotiation will result in a position in which technical feasibility, disproportionate costs and mixing zones are retained and interpreted in the UK such that there is little or no consequence to that industry which complies with current BAT [18]. Should the detail of the Daughter Directive vary significantly from the current proposals, the costs could be significantly higher and, as a worst case, could require levels of investment that are not financially viable or result in the cessation of certain activities.

For several of the candidate Specific Pollutants (i.e. the Annex VIII substances), UKTAG are proposing continued use of existing EQSs as an interim position pending further work. Stakeholders are concerned that there is the possibility that the EQSs for these substances may subsequently be made more stringent, with potentially significant consequences for existing and future plant.

Finally, stakeholders have commented that the apparent cost to industry is relatively very low, but that this is largely because the cost has been transferred to the water industry and no estimates have been included of how this will impact on trade effluent dischargers. The increases in costs faced by the water industry will be passed back to their business and domestic consumers.

### 6.3.2 Water Industry Discharges

The main difference in the estimates presented here lies in the assumptions and judgement on the number of WwTWs at risk, with the key factors affecting the assessment of the number of works at risk being:

- The expected effect of existing source controls and their impact on the projected 2015 number of works at risk. A key example is PeBDE, where the RIA assumes that there will be no additional need for end-of-pipe controls given the existing ban on the substance. The pCEA assumes that it will necessary to install end-of-pipe controls to achieve compliance. In previous Atkins work[19] it was assumed that the

As these provisions have been included in the text from the start, we do not believe that this would be a realistic reflection of the likely outcome of the Daughter Directive's requirements.

18 In particular, stakeholders are concerned that a number of the amendments voted by the European Parliament at First Reading may be reintroduced at Second Reading, as they would lead to high costs or site closures if they were included in the final Directive.

19 Atkins Ltd, RPA Ltd and ICF International (2006). Dangerous Substances and Priority Hazardous Substance/Priority Substances under the Water Framework Directive. WW17d Extension Report. Final Report for UKWIR.

number of works at risk would decrease by 2015 compared to the number currently at risk. For PeBDE, the projected number at risk by 2015 was stated as one-third of all works (compared to currently 50% of works at risk).

- The approach to determining the required consents. One reason for the increased number of works at risk appears to be an assumption on how the discharge consent is determined. It is assumed that the consent is based on 10% of the EQS and the dilution available. It has not been possible to explore this assumption further. It has been stated in studies that even small changes to the applicable EQS will have a significant impact on the number of works at risk and thereby on the total costs. Therefore a judgement on whether the consent is based on 10%, 50% or 100% of the EQS will make a significant difference to the number of WwTWs being at risk of non-compliance.

- For metals whether the compliance is based on dissolved metals or total metals. An assessment based on total metals concentrations will result in a higher number of works at risk and it is important to note that the pCEA estimates have been based on total metals. Work undertaken for the partial RIA, which draws on actual discharge consents and relates to dissolved and not total metals, did not arrive at such high estimates of the number of works reporting to the PI as being at risk.

It is important to note that stakeholders believe that the estimates presented here represent significant under-estimates, based on work that they have undertaken. For example, Yorkshire Water report significantly higher cost estimates based on work undertaken by AEA Technology Environment[20], although it must be noted that this study pre-dates the current, less onerous, EQS for nickel and other substances and that it is unclear what baseline assumptions have been made in the study regarding the influence of existing and planned measures under other legislation.

Although any EQS exceedance is a compliance failure, if high costs were to lead to an issue of disproportionate costs, the environmental benefits would have to be assessed. It is likely that the environmental benefits would mostly relate to the total loads of released chemicals rather than individual EQS failures. There are no data in the RIA or pCEA work to substantially address this issue. An illustrative analysis can be based on the number of works at different size bands. In Table 6.4, such illustrative calculations are presented. If it is assumed that the load is proportional to the size of the WwTW measured in p.e., the share of the total load from each size band can be estimated.

20 AEA Technology Environment (2004). The Environmental and Economic Costs and Social Consequences of reducing levels of dangerous discharged from Waste Water Treatment Works in the Yorkshire Water Region.

| **Table 6.4: Potential Actions under Options 1 and 2** | | | |
|---|---|---|---|
| **WwTW size band (p.e.)** | **No of works by size band** | | **Estimated illustrative distribution of load based on p.e.** |
| | **No** | **% distribution** | **%** |
| > 250 | 3126 | 45% | 1% |
| 251 to 500 | 776 | 11% | 0% |
| 501 to 2000 | 1321 | 19% | 2% |
| 2001 to 10000 | 992 | 14% | 6% |
| 10001 to 25000 | 352 | 5% | 6% |
| 25001-50000 | 198 | 3% | 8% |
| 50000-200000 | 166 | 2% | 22% |
| 200000-1m | 89 | 1% | 55% |
| >1m | 0 | 0% | 0% |
| **Total** | 7020 | 100% | 100% |

The above calculation shows that although the smallest works – less than 250 p.e. – comprise 45% of the total number of works they contribute maybe only 1% of total pollutant load. The 3% largest works could potentially contribute up to 75% of the load. While the discharged amounts of the PS are not necessarily proportional to the size of WwTW, it likely that a significant total reduction can be achieved by a targeted approach of installing additional tertiary treatment to selected installations.

The water industry also notes that it is not necessarily the number of works at risk that will drive the costs but that the size of the works will be an important factor to the costs; on this basis, one stakeholder argued that estimates based on % of population equivalent served would be more reliable. Another commented though that high unit costs for the smallest works may mean that they could comprise a large share of the total costs even though their share of the total loads might be very low.

Industry stakeholders also note that sand filtration and GAC may not be the most appropriate end-of-pipe solution for all priority substances, and that there is a need to also take into account the impact that end-of-pipe solutions installed to reduce other pressures may have on the effectiveness of any given technology. In this regard, several supported an approach based on pilot studies of the technologies during the first RBMP with associated monitoring of the STW performance and of the river chemistry and ecology.
Furthermore, there is concern that sand filtration and GAC may not yield sufficient reductions and that more expensive options might be required. Such uncertainties are not quantified or included in the above estimates and, thus, the range of costs provided by different assumptions on the number of works at risk does not represent the overall uncertainty surrounding the estimates.

## 6.4 Cost-Effectiveness Analysis

The previous reports have not explored the costs-effectiveness of alternative measures to a degree that allows firm conclusions to be drawn. The key question is whether source controls are more or less cost-effective than end-of-pipe treatment. Some reports indicate that source controls are not cost-effective while other evidence, such as previous experience, indicates that source controls may be cost-effective. The key point, overall, seems to be that the cost-effectiveness (or not) of source control options is specifically dependent on the substance in question and its use profile.

Further and more substance-specific analysis is therefore required for conclusions to be drawn and it should be carried forward as one of the measures to be taken forward. The large uncertainty about the compliance gap to close and the potentially very high costs of end-of-pipe treatment suggest that more knowledge is needed before committing to any investments. These two factors are the key drivers for including estimates of the costs of developing future PRPs into the administrative and other costs that will be faced by the Agency.

The other aspect of cost-effectiveness is addressing the major point sources and ascertaining whether some degree of co-removal can be achieved. Focusing on point sources which contribute several PS is a possible way forward. However, it must be recognised that end-of-pipe treatment on its own may fail to deliver the reductions required in priority substances and other substances included in the UKTAG standards.

Thus, there is a necessary emphasis on the need to explore source control measures. To a degree, some of these may be driven by international (EU) requirements, but other national measures could be used to focus on controlling major point source discharges through the RBMP management planning.

## 6.5 Assumptions and Limitations

Due to a lack of information on the current and future gap in chemicals compliance with WFD objectives, this analysis has focused on assessment of the potential costs of the measures that will be required to meet the proposed standards for the priority substances and the specific pollutants. This is clearly a deficiency and highlights the need for better information and the importance of site-based decisions with regard to any end-of-pipe treatment requirements.

Most of the substances are subject to a large number of existing controls and there is a great deal of uncertainty about the efficiency of these controls and the closure of the gap that can be assumed prior to 2015. Many studies explicitly indicate a lack of confidence that measures will achieve WFD targets. More generally, the analysis assumes that objectives can be met by upgrading existing facilities; however, it may be the case that entirely new investment is required at far greater cost at a number of sites (the extent of which is unknown).

Most of the Working Group output reports contain very limited or no measures that specifically relate to the 42 substances considered in this synthesis report. This is due to the fact that these substances may have little impact on some market sectors (e.g. flood management). The agricultural working group states that the only pressures of concern were pesticides and that from sheep farming (e.g. cypermethrin). The NADiP working group report proposes generic measures that could potentially apply to some of the 42 substances (see end of Table A for more details), while the mines chapter highlights the importance of some of the metals to minewater remediation measures.

The phasing of actions can often be seen as a cost saving exercise, as certain measures can benefit from having to close a smaller gap if time is allowed for other measures to take effect. However, the main interest is on measures that can be introduced under Option 1 and that can be applied as soon as possible and which do not rely heavily on gap closure by other measures.

A few additional measures have been costed and included in this analysis, but a detailed investigation of possible source control measures has yet to be undertaken. It is the case that there are more appropriate and robust frameworks for undertaking such assessments (e.g. PRPs, RIAs, ESR risk reduction strategies, etc.). It is likely that there are some already funded or agreed measures that will provide benefits such as co-removal of substances and cost savings. For example, the requirement to further reduce phosphorus and ammonia effluent levels (to be addressed during the AMP5 period) by the Water Industry; the upgrading of treatment works and tertiary processes is expected to result in co-removal of cadmium, lead, nickel and some of the organic priority substances. However such synergistic effects cannot be presently quantified or assumed to guarantee EQS compliance for priority substances.

Finally, the analysis presented here does not include consideration of the Part B and Part C substances listed in the UKTAG report. These are substances for which it is proposed to retain the existing standards until further review work has been undertaken, or for which the existing standards are proposed without further review. Of key concern to all sectors is the potential for further substances to be designated are the future EQS that may apply and the costs that may arise in complying with these. The water industry has raised concern over copper and zinc, however, at this stage no decision has been made as to the need for tighter WFD water standards.

# 7. FURTHER CONSIDERATIONS

## 7.1 Measures to Reduce Uncertainty

Uncertainty mainly relates to the extent of the compliance gap and the effectiveness of the proposed measures, as well as, the actual costs of measures as those provided here are indicative or approximate.

Uncertainties referring to the extent of the gap may be the result of limited understanding of the sources, pathways and fate of chemicals (e.g. chloroform, TBT, DEHP) or due to limitations of the existing monitoring system (e.g. insufficient data points, sparse spatial coverage for certain chemicals, or a lack of historic monitoring for others) and EQS standards (e.g. metal speciation/toxicity not adequately reflected in current EQS). There is also a level of uncertainty in extrapolating from past failures of EQSs to future failures. Furthermore, there are uncertainties in the implementation of interim or on-going actions, such as risk reduction strategies, voluntary initiatives (that may have low uptake rates), and REACH (which may not succeed in regulating all sources of chemicals). The effectiveness of end-of-pipe measures, such as tertiary treatment removal efficiency, is the subject of on-going research, field trials, scaling up and transfer of technology (e.g. membranes) to industry and WwTWs.

The above uncertainties can often be reduced by observation of pollution trends and application of technological advances; however, this is subject to resource constraints. Nevertheless, it is vital to monitor pollutant trends pre- and post- implementation of measures already agreed or funded.

For example, nutrient removal by tertiary treatment in the Water Industry may lead to lower effluent levels of cadmium, lead and nickel and some of the organic substances. Close monitoring of pesticide trends is important as there are fast changing pressures relating to the emerging pesticides (that are replacing those banned). Investment in further research and development studies, such as studies of pollutants pathways, co-removal of substances by end-of-pipe methods, analytical laboratory methods with lower detection limits, and field or pilot scale trials of treatment methods, will help to reduce uncertainty. A more extensive monitoring network and more representative and frequent sampling regimes (e.g. targeting seasonal or diffuse pollution) will help obtain more data to improve the gap analysis. Interpretation of the collected data is often difficult due to fast changing patterns (or very slow changing patterns, e.g. in groundwater). Monitoring costs are therefore likely to be significant under the WFD (EA currently estimate these to be in the order of £50,000/year per chemical, but this is very much substance dependant).

## 7.2 Alternative Cost Sharing

It is widely accepted that there are groups of measures that can be applied within one particular sector and provide benefits to all other sectors. End-of-pipe control, either within the industry or the water industry sectors, is generally capable of tackling more than one substance at a time, thereby relieving the pressure on other sectors. For example, it should be technically feasible to set up tertiary treatment processes within WwTWs that remove several heavy metals and/or organic substances in one stage. Taking advantage of the synergies between various measures in one sector can define the potential for alternative cost sharing between sectors. It is evident that the Water Industry has the greatest capacity to employ such combined measures, as it is the recipient of a variety of domestic, trade effluent and diffuse sources of pollutants, and can thereby provide the main target of alternative cost sharing.

Equally, source control within one sector can provide cost savings for other sectors; for example, restrictions in the outdoor uses of DEHP would reduce the incoming loads (from run-off intercepted by combined sewers) in WwTWs and therefore the cost of DEHP removal within WwTWs. Source control would also have the added benefit of reducing loads of substances getting directly into freshwater via diffuse sources.

However, the costs of end-of-pipe control may be complementary (in that more than one substance may be removed simultaneously), whereas the costs of source control are for individual substances and tend to be additive.

Source control is consistent with the Polluter Pays Principle already adopted in the regulation of plant protection products; in that, it ensures that those responsible for emissions, discharges and losses bear the costs of their reduction or cessation. This does not mean, however, that end-of-pipe controls may not also provide the best means of achieving the Polluter Pays Principle. For example, domestic wastes related to dietary inputs are a significant source of metals such as cadmium and nickel; thus, removal of these at WwTW will adhere to the Polluter Pays Principle as one can expect the full costs of compliance to be passed on to domestic consumers. Similarly, one would expect the water industry to pass the costs of treating trade effluents back to those dischargers (or to require a greater level of end-of-pipe treatment prior to discharge to sewer). Concern over the ability of trade effluent discharges to afford such increases in costs has been raised.

Further work is ongoing on charging for trade effluent and controls on surface water discharges. Results of this analysis will need to be considered in terms of alternative cost sharing arrangements.

## 7.3. Other Considerations

It has been stated in a previous study (Atkins Ltd, WRc Ltd and STL Ltd, 2007) that for certain PHS (cadmium, PeBDE and mercury) between 10 and 100% of works may require upgrading in order to meet the complete cessation of discharges. If end-of-pipe control was adopted for WFD substances, at least 50% of WwTWs in England, Wales and Scotland would require additional treatment facilities based on the proposed EQS (at a cost exceeding £11 billion). At the same time there is a lack of data on removal rates for specific (advanced) wastewater treatment methods. Removal rates can be highly variable, as indicated by data on DEHP, nickel, and mercury removal rates. Therefore, there will be some uncertainty as to the effectiveness of end-of-pipe measures.

A further point made in the same study (Atkins Ltd, WRc Ltd and STL Ltd, 2007) is that extra wastewater treatment would produce additional waste and potentially hazardous sludge, and also result in increased energy use and hence greenhouse gas emissions; the negative environmental impact of these should not be overlooked. Calculations, based on additional treatment at more than 50% of WwWTs, indicate that sludge production would be at least 4000 Ml/year, while $CO_2$ emissions from additional treatment may exceed one million tonnes per year (a 24% increase compared to current Water Industry greenhouse gas emissions).

Another consideration is the potential effects of reduced influent concentrations (due to source control, existing bans/restrictions) on treatment removal efficiency. There may be examples of treatment methods that achieve high removal rates only if the incoming concentrations are above a certain threshold. The possibilities of adverse impacts of removing one substance on another substance –although remote– should be considered; e.g. there may be treatment processes that result in heavy metals changing forms and speciation which may be more toxic and persistent when released into freshwaters.

With regard to other sectors, the analysis as prepared to date fails to consider the costs of not allowing an activity to continue, with this due to the uncertainties highlighted above and the national rather than site-specific level of this assessment. However, at the site or geographic level, these costs may be significant. For example, should the costs of cleaning contaminated sediments be prohibitively high and dredging not carried out, this could result in small operations/ facilities going out of business. Such social costs may mean that only a few of the major facilities can remain in operation. The knock on effect of banning a certain chemical also needs to be costed. For example, weed growth on inland lakes and rivers can affect recreational boating activity and will have an associated cost. Such site and use specific issues are likely to require very specific information.

Water Framework Directive Article 7 objectives for drinking water protected areas have not been considered in detail. These could place further requirements on agriculture and some other sectors to protect groundwaters as these can relate to a broader range of hazardous substances, including pesticides, not covered in this report.

Finally, it is possible that the Commission may extend the priority substances list before 2015. The next review of the list of priority substances is scheduled for 2008. It is also possible that the UK may identify additional specific pollutants. These uncertainties have not been considered in this cost evaluation.

# 8. CONCLUSIONS

This synthesis report has collated and assessed proposed measures and actions to achieve WFD compliance from previous and on-going pCEAs and other studies and consultations.

The following 11 substances have been highlighted as having a medium or high potential of failing WFD EQS in 2015 (see Table 3.1): anthracene, cadmium, chromium, cypermethrin, DEHP, lead, mercury, nickel, TBT, trichloromethane and PeBDE. This does not mean that costs of complying with the other standards will not also arise (for example, in relation to benzene and phenols), albeit they are likely to affect a smaller number of discharges. For all 42 substances considered here, the main sources of chemicals within each market sector have been identified (see Table 4.1).

Measures have been ranked and grouped (see Table 5.1 and Table A) according to two options:

- **Option 1**: Limited phasing – introduce the measures required to meet the standards as far as possible by 2015 (unless technically infeasible);
- **Option 2**: Phased action – allow for a programme of investigations, phasing and more innovative measures to achieve standards by 2027.

Substance-specific measures have also been proposed for each sector under the two options (see Table 5.2); however the cost analysis of alternative measures and scenarios was limited by the availability of data. In particular, the costs and effects of source controls have not been systematically investigated. If source control measures prove cost-effective, this will reduce the requirement for expensive end-of-pipe control.

The two main approaches to cost assessment of measures (the partial RIA and Atkins, 2007) were considered; this highlighted the difficulties in reconciling the two approaches due to the underlying assumptions and significant associated uncertainties. Key assumptions surround what the final provisions will be under the Priority Substances Daughter Directive, the extent to which the current gap between environmental concentrations and the proposed EQS will be reduced by already agreed or planned measures, and the number of WwTWs at risk of non-compliance (derived using assumptions on the percentage of EQS that may apply to WwTW discharges to achieve compliance (e.g. 10% EQS to 100% EQS) and the dilution available). Taken together these determine the order of magnitude of the costs.

Estimated total equivalent annual costs for Option 1 are about £568 million for the 43 year period (comprising around: £8m p.a. in source control, £46m p.a. for direct industrial discharges, £329m p.a. for the water industry, £182m for navigation and £2.5m p.a. for Environment Agency policy implementation, monitoring and other administration costs). Total equivalent annual costs for Option 2 are about £182 million for the 43 year period (comprising: £2m p.a. for source control, £12m p.a. for direct industrial discharges, £131m p.a. for the water industry, £34m p.a for navigation and £2.4m p.a. for Environment Agency policy implementation, monitoring and other administration costs).

No estimates are included for industrial and other trade effluent discharges to sewers, while zero costs were assumed for the agricultural sector (as source control of pesticides is expected to close the gap). The data clearly suggest that the larger share of the costs will fall on the water industry and the navigation related industries.

Measures that are covered under other chapters of the pCEA in relation to mine waters and agriculture will also have an effect on levels of the PS and SP in the environment. In particular, some of the costs associated with mine water remediation may be attributable to the 42 chemicals covered here. It should also be recognised that no costs are included here in relation to any contaminated land clean-up that may be required specific to the 42 PS and SP chemicals. Furthermore, no costs are included for any measures required to prevent inputs to groundwaters.

Further analysis is required for firm conclusions to be drawn as to the level of action required and the most appropriate measures; this further work should be one of the short term measures taken forward. The large uncertainty about the compliance gap to be closed and the potentially very high costs of end-of-pipe treatment suggest that more knowledge (about the gap and the costs of source control) is required before committing to any investments. This is likely to require further monitoring and additional studies of pollutants, treatment methods and co-removal potential. Focusing investment on mitigating the main point sources which contribute the most PS is a possible way forward.

Phasing of the investments would reduce the risk of undertaking unnecessary investment and increase the benefits from technological advances. Currently, the treatment options that have been considered in the various studies have not been specifically developed for the removal of PS and SP substances. There is little experience with their use and hence significant uncertainty as to the level of effectiveness that they can deliver. The water industry has identified the need for pilot schemes to reduce these uncertainties and to more accurately assess the energy and carbon implications of such technology. Any such schemes should give consideration to more innovative technologies and measures such as the pre-treatment of industrial discharges.

# 9. REFERENCES

AEP (2007): pCEA Industry Working Group Submission – Costs of WFD for the Fuel and Power Industry, to Defra and DTI by the Association of Electricity Producers UK

Agriculture Working Group (2007): Agriculture pCEA Working Group Supporting Document

Atkins (2006): Implications of the Water Framework Directive to the Water Industry, Briefing note on an impact analysis of the proposed Environmental Quality Standards

Atkins (2007): Partial Cost Effectiveness Analyses for the Water Industry, Industry, and Non-Agricultural Diffuse Pollution

Atkins Ltd, RPA Ltd and ICF International (2006): Dangerous Substances and Priority Hazardous Substance/Priority Substances under the Water Framework Directive. WW17d Extension Report, Final Report for UKWIR

Atkins Ltd, WRc Ltd and STL Ltd (2007): Dangerous Substances and Priority Hazardous Substances/Priority Substances under the Water Framework Directive, Draft Report for UKWIR

CIA (2007): Submission of Comments on draft pRIA and pCEA, to Defra, February 2007

COWI (2004): Advantages and Drawbacks of Restricting the Marketing and Use of Lead in Ammunition, Fishing Sinkers and Candle Wicks, for EU Commission DG ENTR

CSL (2004): Pesticide Usage Statistics, from the Pesticide Usage Surveys by the Advisory Committee on Pesticides (ASD), data available from the Central Science Laboratory & Scottish Agricultural Science Agency website, at: http://www.csl.gov.uk

Defra (1999): Economic Instruments for Water Discharges, report by ERM 1999

Defra (2002): Economic Conditions of Cattle and Sheep Farms in the Hills and Uplands, Statistical Tables from the Agricultural Census Statistics

Defra (2004): Economic importance and dynamics of water use relevant to River Basin Characterisation (England and Wales) by ERM, July 2004

Defra (2006): Regulatory Impact Assessment for proposed Daughter Directive to the Water Framework Directive, Defra, December 2006

Defra (2007): Partial Cost Effectiveness Analysis for the Water Industry, Industry, and Non-Agricultural Diffuse Pollution, final report by Atkins, May 2007

Defra (2007): Partial Cost Effectiveness Analysis Synthesis Report – Mines

Defra (2007): High and low reference cases for preliminary cost-effectiveness analysis

Defra (2007): Note - Consideration of different scenarios for the pCEA in the development of Programme of Measures for the implementation of the WFD

EA & VMD (2006): Sheep Dip Pollution Reduction Programme (PRP), more information available at: http://www.environment-agency.gov.uk/sheepdip & http://www.vmd.gov.uk/General/sheepdip/sheepdips.htm

EA (2005): Briefing Note - Home and Garden Pesticides and Biocides Briefing, April 2005, available at: http://www.environment-agency.gov.uk

EA (2005a): Crop Protection with More Profit – What's in it for Farmers?, available at: http://www.environment-agency.gov.uk/commondata/acrobat/crop_protection_670323.pdf

EA(2006): Pesticides in Surface Water Samples: 1995-2004, downloaded from http://www.environment-agency.gov.uk

EA (2007): An Appraisal of the Options for responding to the Risks and Impacts Associated with Sheep Dip Products, final report submitted by GHK, April 2007

EA (2007a): Pesticides that frequently fail Environmental Quality Standards – sheep dips, available at: http://www.environment-agency.gov.uk/yourenv/eff/1190084/business_industry/agri/

EC (1986): Directive 86/278/EEC on the Protection of the Environment, and in particular of the Soil, when Sewage Sludge is used in Agriculture, European Commission, Office for Official Publications of the European Communities

EC (1996): Directive 96/61/EC on the Integrated Pollution Control, European Commission, Office for Official Publications of the European Communities

EC (1998): Directive 98/8/EC concerning the Placing of Biocidal Products on the Market, European Commission, Office for Official Publications of the European Communities

EC (2000): Directive 2000/53/EC on End-of-life Vehicles, European Commission, Office for Official Publications of the European Communities

EC (2002): Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS), European Commission, Office for Official Publications of the European Communities

ECOLAS (2006): Environmental and Human Health Risk Reduction Strategy: Cadmium metal and Cadmium oxide, Final draft report

Entec UK Ltd (2007): Industry Working Group – Input to Preliminary Cost Effectiveness Analysis, Final Report.

Entec UK Ltd (2007): Initial Regulatory Impact Assessment on Water Framework Directive Regulation 16 Supplementary Plan for Mercury (pilot study) - Accompanies Pilot Plan for Mercury.

Entec UK Ltd (2007): Preparation of Water Framework Directive Regulation 16 Supplementary Plans: Preparation of Pilot Plan for Mercury, Final Report for the Environment Agency.

Entec UK Ltd (2005): Risk Reduction Strategy and Analysis of Advantages and Drawbacks for Trichloroethylene, Final Report (Stage 4) for Defra

Environment Agency (2007): Provisional List of Substances for Regulation 16 Supplementary Plans

Environment Agency (2007): Water Resources - Preliminary Cost Effectiveness Analysis (pCEA) of Water Resources Measures to meet WFD Environmental Objectives

Environment Agency (year): Anthracene – Plan to Meet the Requirements of the WFD.

Environment Agency (year): Pentabromodiphenyl ether - Plan to Meet the Requirements of the WFD.

Environment Agency (2005): Pollution Reduction Programme for Mercury

Environmental Resources Management (2004): Assessing Current Levels of Cost Recovery and Incentive Pricing, Final Report for Defra.

Haskoning Nederland B.V. Water (2007): Cost-effectiveness of measures – Analysis of measures to reduce non-agricultural diffuse pollution. Draft Report (version 2) for Defra.

Haskoning UK Ltd Environment (2007): pCEA for Coastal Defence, Final Draft for Defra

Haskoning UK Ltd Environment (2007): Water Framework Directive - Implications for Planning in England and Wales (pCEA supporting document), Final Report for Defra

Haskoning UK Ltd Environment (2007): **Cost-Effectiveness of Measures - Analysis of Measures to Reduce Non-Agricultural Diffuse Pollution**, for Defra by Royal Haskoning, April 2007.

KEMI (2003): HA Oils in Automotive Tyres – Prospects of a National Ban, the Swedish National Chemicals Directorate, Report No. 5/03, available at: http://www.kemi.es/upload/Trycksalker/Pdf/Rapporter/Rapport5_03.pdf

Oosterhuis, F.H., Brouwer, F.M. & Wijnants, H.J. (2000): A possible EU wide charge on cadmium in phosphate fertilisers: Economic and Environmental Implications, Final Report to the European Commission.

Risk & Policy Analysts Limited (2000): Analysis on the Advantages and Drawbacks of Restrictions on the Use and Marketing of Creosote, for European Commission DG ENTR

Risk & Policy Analysts Limited (2000a): Analysis on the Advantages and Drawbacks of Restrictions on the Use and Marketing of Nonylphenols, for Defra

Risk & Policy Analysts Limited (2005): Risk Reduction Strategy and Analysis of Advantages and Drawbacks for Hexavalent Chromium, for Defra

Risk & Policy Analysts Limited (2005a): Risk Reduction Strategy – Bia(2-ethexyl)phthalate, DEHP, for the European Commission DG Enterprise

Risk & Policy Analysts Limited (2005b): Cost Effectiveness Analysis of the Draft Pollution Reduction Programme for Tributyltin (TBT), Final Report for the Environment Agency

Risk & Policy Analysts Ltd (2006): Regulatory Impact Assessment for Proposed Daughter Directive to the Water Framework Directive, Report for Defra

Sinton, M. & Cartwright, N. (2006): Environment Agency Pollution Inventory – Reporting of Priority Hazardous Substances Guidance for the Water Industry, Interim Report

Sinton, M. & Cartwright, N. (2006): Mercury and its compounds – Plan to Meet the Requirements of the WFD.

Sinton, M. & Cartwright, N. (2006): Nonyl phenol – Plan to Meet the Requirements of the WFD

Sinton, M. & Cartwright, N. (2006): Tributyltin compounds – Plan to Meet the Requirements of the WFD.

Unknown Author (year): Dental amalgam use in the UK – Briefing note (Draft).

Unknown Author (year): Pesticides – Programme of Measures under the Water Framework Directive, Draft.

Unknown Author (2007): Voluntary Initiative Best Practice Guidance (Version 1.2)

Unknown Author (2007): pCEA Working Group Output – Flood Risk Management, Draft Report

Unknown Author (year): Draft European Parliament Legislative resolution on the 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.

Unknown Author (2007): Water Framework Directive pCEA – Water Industry working group Supporting document

Unknown Author (2007): pCEA Synthesis Nutrients Chapter, Draft Report

UKTAG (2007): Proposals for Environmental Quality Standards for Annex VIII Substances – Draft provided to administrations to brief Ministers (SR1 – 2007).

UKTAG (2006): Technical reports on Specific Pollutants, Chemistry Task Team of UKTAG

UKTAG (2007): UK Environmental Standards and Conditions (Phase 2), Final draft: provided to UKTAG for approval (SR1 – 2007)

VMD (2006): Veterinary Medicines Directorate Records, presented to the House of Commons, 14 Feb 2006, part 6, available at: http://www.publications.parliament.uk/pa/cm200506/cmhansrd/cm060214/

WRc plc (2007): Pollution Reduction Programme for TBT – Draft Technical Report, Report for the Environment Agency

WRc plc (2006): Water Framework Directive Pollution Reduction Programme Project Work on Cadmium, Report for the Environment Agency

WRc plc (2006): Water Framework Directive Pollution Reduction Programme Project Work on Lead, Report for the Environment Agency

WRc plc (2006): Water Framework Directive Pollution Reduction Programme Project Work on Nickel, Report for the Environment Agency