2021 river basin management plans

Chemicals	Published: October 2019

Contents

1. Summary

Cosmetics, furniture, cleaning products, plastics, and toys: there is little in our modern world produced without chemicals, and without doubt they have brought enormous benefits to people and society. We use pesticides and herbicides to protect our crops and increase food production for our growing populations. We wear clothes made with chemical dyes and flame retardants. We rely on drugs to treat illnesses such as cancer, depression, tuberculosis and malaria.

The numbers are staggering. There are approximately 150,000 different chemical substances in commercial use today[i] and their number and applications continue to grow.

However, our knowledge about the effects of chemicals and their use is increasing. Despite their benefits chemicals can also pollute and contaminate. They are everywhere: in the air, water, and soils. They have been found in the Arctic and at the bottom or our oceans.

The presence of chemicals does not always mean they represent a risk but chemicals in the water environment at or above levels of concern may harm aquatic life and other wildlife that these environments support. Exposure over time to even low levels of some chemicals may affect the health of animals and fish, such as interfering with the endocrine system, which affects reproduction. Other chemicals have a more immediate impact on aquatic life because of their short-term toxicity if certain thresholds are exceeded.

Some chemicals can be persistent as they don't break down easily in the environment and accumulate in our bodies as well as those of animals and fish. Some of the higher risk substances may contribute to increased risk of cancer, reproductive problems, and damage DNA.

Chemicals are produced by industry and generally enter the environment from diffuse sources such as sewers and run-off from roads and farmland. They are also widespread in the environment from past use. For example, historical mining activity has led to significant emissions of metals from below the ground into surface waters, and these have continued even after mining has stopped.

Chemicals used in homes, businesses and industry can be released directly into the water environment, and some of those chemicals are harmful if people are exposed to them in sufficient quantities. To reduce the risk from harmful chemicals in drinking water, expensive treatment is needed to remove them.

The number, size and sources of significant pollution incidents have been reduced. Wildlife is returning to previously contaminated waters. Our challenge now, however, is to understand whether low levels of chemicals in the environment are causing more subtle effects, limiting the potential that could be achieved for future generations.

Over recent years water quality monitoring for many of these chemicals has shown levels remaining consistent despite good progress in some areas, for example, in managing discharges from abandoned metal mines.

There is growing evidence to suggest this underestimates the pressures we face, particularly for persistent substances that build up in food chains. Our evidence is also now pointing to emerging risks from other chemical substances.

When we published the River Basin Management Plans in 2015, 97 per cent of surface water bodies and 53 per cent of groundwater sources were achieving good chemical status[ii]. Hazardous chemical substances were a minor contribution to surface waters failing to achieve good status overall.

We use environmental quality standards (EQSs) to assess the quality and stresses on the aquatic environment. These are derived from the Water Framework Directive (WFD) and include specific standards for chemicals.

However, in 2013 twelve new priority substances (pollutants presenting a significant risk to drinking water or the aquatic environment) were introduced through the Priority Substances Directive[iii], along with tighter standards for some existing regulated substances, such as the insecticide cypermethrin.

Certain persistent and toxic substances are widespread in the aquatic environment. Setting environmental standards based on concentrations in aquatic animals (measured in fish, crayfish and blue mussels) allows us to assess the potential impact on the whole food chain, including predators such as otters, herons, fish and of course people. We now have several years of data to be able to make robust assessments of risks of substances that accumulate in biota.

Whilst concentrations in biota are below EQSs for many substances, mercury and two Persistent Organic Pollutants (POPs), polybrominated diphenylether (PBDE; used as flame retardants) and perfluorooctane sulphonic acid (PFOS; a textile stain repellent and fire-fighting chemical) are often found at elevated levels. Although these substances are now banned or restricted in the UK, they break down very slowly so can remain in the environment for decades.

Maximum allowable concentrations (MAC) of these substances, which are used to assess any short-term effects are generally rarely exceeded. However, one specific polycyclic aromatic hydrocarbon (PAH), benzo(g,h,i)perylene, is often found at elevated levels, particularly in estuarine waters. Although PAHs are produced naturally, they are also common urban pollutants, particularly from combustion of fossil fuels and wood.

In the future, without appropriate mitigation measures, population growth and climate change will increase the pressure on the water environment from chemicals. The market for chemicals is predicted to double worldwide by 2030 compared to 2017[iv]. Population growth is likely to increase the use of chemicals increasing their release into the environment. This will be further exacerbated by the impact of climate change. Higher intensity rainfall events will wash more chemicals into water bodies from sewers or land. Periods of drought will be more common, resulting in less dilution in rivers.

Our strategic approach to the management of chemicals in waters aims to:

- protect aquatic life from exposure to chemicals
- reduce humans and wildlife exposure to chemicals in the food chain
- protect surface and groundwaters where chemical contamination may compromise their use for drinking water

It identifies chemicals of national, local or emerging concern and prioritises these for action through sustainable cost beneficial solutions for people and wildlife. The approach is designed to be dynamic and responsive to scientific developments and potential emerging chemical issues. As a result it ensures a continuing high level of environmental protection in the future.

2. The chemical pressure

2.1. Introduction

Chemical production and consumption has increased hugely over recent decades, with approximately 150,000 substances in commercial use today[v]. There is a lot more information on chemicals than ever before, but there is still a lot of uncertainty about whether we have the right data, and that risks have been properly assessed in all cases. The European Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation[vi] (REACH) addresses the production and use of chemical substances, and their potential impacts on both human health and the environment. It requires many chemicals used in the EU to be registered. It also controls the use of substances of very high concern. In some cases chemicals can be restricted or banned, requiring companies to find safer alternatives. Chemical used in homes, businesses and industry can be released directly into the water environment. However, increasingly they come from diffuse sources such as sewers and run-off from roads and farmland.

Some chemicals are widespread in the environment as a result of past use. For example, historical mining activity has led to significant emissions of metals from below the ground into surface waters.

All chemicals are potentially harmful to people if they are exposed to them in sufficient quantities. To ensure drinking water is safe, expensive treatment is needed to remove chemicals.

Chemicals in the water environment can be harmful to aquatic life and other wildlife which these environments support. Exposure over time to even low levels of some chemicals can impact the health of animals, such as interfering with the endocrine system, which affects reproduction. Other chemicals have a more immediate impact on aquatic life because of their acute toxicity.

We have reduced the occurrences and impact of gross pollution of waters from significant polluting sources and events. This means wildlife is returning to previously polluted waters. Our challenge now, however, is to understand whether low levels of chemicals in the environment are causing more subtle effects, limiting the potential that could be achieved for future generations.

New and more rigorous standards for chemicals are being introduced. They present a specific challenge as many chemicals are ubiquitous, difficult to control at source and highly persistent in the environment.

2.2. Environmental quality standards

EQSs measure the quality and stresses on the aquatic environment. The 2021 river basin management plans will report how well water or biota levels comply with the relevant EQSs.

2.3. The chemical status of water: priority substances and priority hazardous substances

The management of chemicals in the water environment focuses on those chemicals posing the greatest risk to people and wildlife. We use EQSs, which are regularly reviewed, to assess these chemicals. We consider two categories of chemicals when assessing the chemical status of surface waters:

- **Priority substances**: emissions of these substances must be progressively reduced to meet the EQSs in all water bodies. A water body achieves good chemical status under the WFD when the concentration of each priority substance is below EQS thresholds.
- **Priority hazardous substances**: a subset of priority substances, considered to be extremely harmful. As well as meeting EQSs to achieve good chemical status, the aim is ultimately to cease or phase out emissions, discharges and losses of these substances.

2.4. The chemical status of water: specific pollutants

In the UK we also classify specific pollutants – a different category to European-wide priority or priority hazardous substances. These are pollutants released in significant quantities to UK waters. UK water quality standards are set in accordance with EU technical guidance. The precise values for standards have been set with advice from the UK Technical Advisory Group (UKTAG).Where environmental levels do not meet EQSs, the water body does not achieve good ecological status rather than good chemical status.

2.5. Failure of EQS

Our monitoring programmes for water and biota in freshwater and saline waters allow us to assess EQS compliance. Since 2016, approximately 12,000 surface water samples at over 1,000 sampling points, and over 100 biota samples from almost 100 sampling locations have been collected and analysed.

Mercury and two POPs, polybrominated diphenylether (PBDE; historical use as flame retardants) and perfluorooctane sulphonic acid (PFOS; a textile stain repellent and fire-fighting chemical) are ubiquitous and exceed biota EQSs at many of the sites sampled. Although these substances are now banned or restricted in the UK, they are slow to break down and are still found in the environment.

Maximum allowable concentrations (MAC) of these substances, which are used to assess any short-term effects are generally rarely exceeded. However, one specific PAH, benzo(g,h,i)perylene, is often found at elevated levels, particularly in estuarine waters. Although PAHs are produced naturally, they are also common urban pollutants, particularly from combustion of fossil fuels.

2.6. Emerging challenges

Many chemicals have been in use prior to the rigorous regulations we have today. New chemicals continue to be developed and used in our day to day lives. Analytical techniques are advancing rapidly, allowing detection at ever lower concentrations. It is inevitable that we will detect an increasing range of chemicals at very low levels in our workplaces, homes and the environment. Many of these will not represent any risk. However, assessing the risks of more subtle longer-term effects is a challenge and we do not fully understand the potential effects mixtures of chemicals, with similar properties, have on the environment.

We are developing a prioritisation and early warning system to gather intelligence from monitoring. We participate in international networks to identify concerns early. This allows us to direct our efforts to investigate emerging challenges and act on them quickly.

2.7. Priorities

Our focus on the protection of our freshwaters, estuaries and coastal waters is driven by:

- chemicals used to assess water quality status
- the presence of chemicals putting Drinking Water Protected Areas at risk

Where we find elevated levels of chemicals they can often be addressed through local action. However, where we identify widespread issues we adopt a national strategic approach, taking co-ordinated action either nationally or internationally to reduce levels in the environment in the most cost effective way.

2.8. Persistent, Bio-accumulative and Toxic (PBT) substances

A number of chemicals have been identified across the EU as a potential risk to human health or wildlife when they accumulate via the food chain. These are substances that are persistent in the environment, have a high potential to build up in plants and animals (bio-accumulate) and are harmful (toxic) at certain concentrations - known as 'PBT' substances.

Early action to eliminate and restrict future inputs of PBTs is vital to protect our environment. Once widespread in the environment they can be present at elevated levels, decades after inputs have ceased. Some are identified as POPs, under the Stockholm Convention, partly because of their potential long range spread around the planet. This requires international cooperation to reduce levels across the world.

2.9. Ubiquitous Persistent, Bio-accumulative and Toxic (uPBTs) Substances

Some of these PBT substances have been identified as 'ubiquitous' (uPBTs) because they are widespread globally as a result of historical use. They can affect animals remote from their point of entry to the environment. For example, there is concern killer whales may no longer be breeding in UK waters because of the accumulation of chemicals that might have originated from land based sources.

Because of the widespread exceedance of the uPBTs thresholds across the EU, Member States are allowed to present two assessments of chemical status, one including uPBTs and one excluding them so that uPBTs don’t mask progress on other chemicals.

2.10. Chemicals in groundwater

Groundwater has traditionally been seen as a predominantly clean source of water, requiring little treatment before use. However, since the middle of the 20th century, a range of chemicals have started to be found in groundwater. Whilst concentrations of these chemicals are often very low, they can cause environmental problems.

Chemicals enter groundwater from a variety of sources including industry, agriculture, waste discharges and from urban areas. Our monitoring data collected between 2009 and 2017 confirms a wide range of chemicals are present in groundwater[vii]. The most frequently detected compounds in groundwater are industrial compounds, pesticides and their metabolites, pharmaceuticals, personal care products, polycyclic aromatic hydrocarbons, halogenated solvents and plasticisers. Although some of these chemicals are known to be toxic, they are typically present in groundwater at very low concentrations. Further work is needed to understand the risk these chemicals present to human health and the environment.

When groundwater becomes contaminated it can take many decades to recover, even when the inputs of the chemicals cease. For example, the pesticides atrazine and simazine were both withdrawn from use in the UK in 2003, but they continue to be detected in groundwater due to very slow degradation rates.

The chemicals PFOS and perfluorooctanoic acid (PFOA) are also frequently found in groundwater. These substances had a wide variety of uses in firefighting foams, waterproof membranes and as stain repellents in a range of products such as carpets, furniture, paper, textiles and leather. Today they only have a few restricted uses but will remain in groundwater for many decades as a result of their persistence.

3. Addressing the challenge

3.1. Managing chemicals: understanding and interventions

Chemical impact on the environment is complex, needing a range of interventions to manage the effects, from voluntary initiatives to direct regulation; and from safer use of chemicals to banning some chemicals completely.

Chemicals can persist in the environment and become widely dispersed throughout freshwater and marine systems. An understanding of the current environmental quality and trends in emissions, alongside the environmental response to reductions, enables the effectiveness of control measures to be evaluated and reviewed.

Much of our understanding about chemical risks, and the subsequent controls to manage those risks, comes from an EU and international level. The UK shares knowledge and expertise with a range of political and scientific institutions. We do this to ensure a good balance between trade and environmental benefits is achieved, and so decisions are taken on a risk basis. Exchanging knowledge and expertise helps ensure the priorities and approaches agreed to deliver international solutions also reflect what is important in the UK.

3.1.1. EU and international initiatives

International and EU chemical initiatives and regulatory regimes generate new information on chemicals. Since many actions to deal with harmful chemicals are determined internationally, and have implications for trade as well as environmental protection, we engage with partners across the world on chemicals with widespread risks. Exchanging knowledge and expertise helps ensure the priorities and approaches agreed to deliver international solutions also reflect what is important in the UK. In many cases measures to reduce chemicals in the environment stem from national implementation plans to deliver international agreements.

EU laws help control the manufacturing, use and supply of chemicals through regulatory instruments such as the European REACH Regulation, the Plant Protection Products Regulations 2011[viii] and the Biocidal Products Regulations[ix]. These laws set the same high standards across all Member States. They improve understanding of chemical risk, ensure safer use and restrict some chemical uses.

3.1.2. Environmental permitting

All significant direct sources of chemicals to the environment are controlled through the Environmental Permitting Regulations. Permits require operators of certain activities to limit or stop releases of chemicals, as well as reduce risk of incidents.

To tackle diffuse pollution for the highest priority chemicals, we determine whether voluntary initiatives are sufficient or whether regulatory controls are required. We seek and support sector initiatives to reduce levels of chemicals entering the environment, such as Integrated Pest Management in the agriculture sector. Catchment-based initiatives help bring together stakeholders, such as water suppliers, charities and environment bodies, and form partnerships to develop initiatives to tackle local and national problems.

3.2. Strategic approach to managing chemicals

The risk to the environment from any single chemical, or combination of chemicals, is not only based on how hazardous they are, but on the nature and extent of exposure. Therefore, understanding the fate of chemicals in the environment, and the likelihood of an impact, is critical to determining the level of control needed.

Our broad approach to managing chemicals in the environment under river basin planning is set out in Table 1. It aims to protect:

- aquatic life (fish, plants and invertebrates) from exposure to chemicals
- human health and wildlife from exposure to chemicals in the food chain
- surface and groundwaters where chemical contamination may compromise their use for drinking water

This approach identifies chemicals of national, local or emerging concern and prioritises these for action through sustainable cost beneficial solutions for people and wildlife. It provides consistency by ensuring actions to reduce chemical pressures are appropriate and proportionate to meet WFD objectives. It is designed to be dynamic and responsive to scientific developments and potential emerging chemical issues, ensuring a continuing high level of environmental protection in the future.

Table 1: Strategic approach to chemicals for river basin planning

Level of Concern	Approach
If the chemical is not of concern	No action
Data indicates the chemical has a potential to cause harm, but we are not confident there is a problem or, if there is one, about the source of the chemical	Take a precautionary approach, supporting interim 'no-regrets' actions and gather additional data
For chemicals of local concern, such as those causing isolated exceedance of EQSs, Drinking Water Protected Area objectives, or localised potential deterioration	Local decision making and action to: Investigate local sources and undertake source control options appraisal work Seek and support voluntary and/or catchment-based initiatives where these are likely to be most cost effective Require improvements to point source discharges, if they are cost-effective Enact regulatory pollution controls to prevent deterioration e.g. permitting, prevent or limit entry to groundwater

Level of Concern	Approach
For chemicals of widespread concern	Nationally co-ordinated approach with actions depending on the sources of the chemical and its pathways to the environment

3.2.1. Chemicals of local concern

Chemicals of local concern are those for which there are few isolated issues and that are best dealt with at a water body or catchment level rather than through a national approach. Catchment partnerships including business, local authorities, water companies, non-governmental organisations, the agricultural sector and government agencies, have a role to inform catchment and river basin management planning for chemicals of local concern. This includes helping identify chemical pollution issues and agreeing appropriate remedial action.

For example, water companies are encouraged to work innovatively with other stakeholders to reduce particular chemicals entering the sewer system. This may be working with local businesses or health services.

3.2.2. Chemicals of widespread concern

For chemicals of widespread concern the risks are widely distributed and are best addressed through a cost-effective national approach. Management options should focus on significant emissions of such chemicals and their pathway to the environment.

Intervention close to the source of the chemical is usually the most cost-effective solution. However, pollution control measures implemented by farmers, other businesses and the general public can help minimise discharges to the sewer or environment. Such measures only work when there is widespread take-up by the relevant stakeholders. This approach requires concerted and active engagement between all involved.

Improving wastewater treatment alone is unlikely to be the most cost-beneficial solution to achieve environmental improvements for chemicals of widespread concern and is often energy intensive. It is better preventing or minimising their entry to sewer in the first place rather than relying on treatment to remove them. Maintenance of the sewer network, appropriate controls on trade discharges into the sewer and engagement with customers on best practice or behavioural change can all help reduce the reliance on removal through treatment. This has the additional benefit of reducing pollutants in the sludge from sewage treatment, which is usually spread on land.

Where these options are not available or do not deliver the necessary improvement within an agreed timescale, there may be cases where additional treatment solutions at sewage works can reduce inputs of a range of chemicals. In these situations the multiple benefits may justify the costs incurred.

3.2.3. Chemicals of emerging concern

Chemicals of emerging concern do not have statutory EQSs, groundwater quality standards or formal threshold values. There is, however, sufficient evidence or international concern about these chemicals to retain a national overview.

We are part of an international network of 70 organisations who collaborate to share information on emerging environmental chemicals - the NORMAN network[x]. Developing analytical methods, gathering and sharing data and developing an assessment approach are key challenges for emerging chemicals. The European Chemicals Agency (ECHA) is currently developing and trialling a framework to identify chemicals requiring better risk management. We will maintain an awareness of this work to inform our approach to emerging substances.

As part of an early warning system to identify emerging chemical issues, we are developing a process to identify, screen and prioritise action for emerging chemicals based on information sources we can readily access. In the longer term we intend to include other stakeholder views and build a wider network, exchanging information on emerging substances across the UK.

Alongside this, the EU has established a Watch List of potentially polluting substances to inform future priority substances designation. The Watch List includes substances which show evidence of, or are suspected of, posing significant risk to the water environment. EU Member States monitor for these substances across Europe. The monitoring data confirms whether these substances are of widespread concern and should be proposed as future priority substances.

We monitor the Watch List substances at twenty one sites chosen to reflect a range of different land use types and habitats. We have collated the data collected between 2016 and 2018 across all sites, and compared the annual average values against the EC predicted no effect concentrations (PNECs) derived for this purpose. Only three substances exceed the PNECs:

- Imidacloprid (a neonicotinoid insecticide and veterinary medicine)
- 17α-ethinylestradiol (EE2) (a hormonal treatment)
- Tri-allate (a herbicide)

Progress is being made to establish a similar watch list for groundwater. The first substances for the list were agreed in 2019. This will help identify substances, including emerging chemicals, for which groundwater quality standards or threshold values should be set. Substances will be prioritised based on the likelihood to enter groundwater, their hazard potential and available monitoring data.

3.2.4. Legacy chemicals

Legacy chemicals are those that have been tightly controlled for many years, but which continue to remain at high levels in the environment. These include mercury and Persistent Organic Pollutants (POPs) such as certain brominated flame retardants (PBDEs) and polychlorinated biphenyls (PCBs). Such substances are often subject to a complex range of measures, often agreed internationally, to reduce a wide range of sources and inputs over time.

We reduce legacy chemicals by implementing these international agreements. This includes the UK's plan for POPs under the Stockholm Convention and the strategy to reduce emissions of mercury in the UK under the Minamata Convention. We will engage internationally to actively promote our approach to chemical management.

3.3. Looking forward - the 25 Year Environment Plan and chemicals

'A Green Future: Our 25 Year Plan to Improve the Environment', the 25 Year Environment Plan[xi], sets out what we will do to improve the environment within a generation. The need to manage our exposure to chemicals is highlighted in the Plan: "We will make sure chemicals are safely used and managed, and levels of harmful chemicals entering the environment (including through agriculture) are significantly reduced". Four goals are set out:

- Seeking in particular to eliminate the use of Polychlorinated Biphenyls (PCBs) by 2025, in line with our commitments under the Stockholm Convention
- Reducing land-based emissions of mercury to air and water by 50 per cent by 2030
- Substantially increasing the amount of Persistent Organic Pollutants (POPs) material being destroyed or irreversibly transformed by 2030, to make sure there are negligible emissions to the environment
- Fulfilling our commitments under the Stockholm Convention as outlined in the UK's most recent National Implementation Plan

3.4. Progress since the 2015 river basin management plans

When a chemical fails to meet an EQS the water body is classified as "failing to meet good chemical status" for priority and priority hazardous substances, or "failing to meet good ecological status" for specific pollutants.

Our report 'Update to the river basin management plans in England'[xii] published in 2015 stated the percentage of all surface water bodies at good chemical status in 2015 was 97 per cent. For groundwater, 53 per cent of water bodies met good chemical status.

The changing and improving approach to chemical monitoring and assessment make it difficult to compare results between years. Since 2009 there have been a number of changes to the substances assessed, as well as our assessment methods. These include the introduction of biota standards and EQSs based on the bioavailability of metals, as well as improved analytical techniques.

We can now measure lower and more environmentally relevant concentrations. This additional understanding enables us to better classify water bodies, but means that we are observing more water bodies failing the chemical standards. This shows an apparent reduction in chemical quality, although the actual quality has changed very little.

To supplement biota standards, which look at chemical concentrations that build up in animals over longer periods in time, we use EQSs expressed as MACs to make sure impacts arising from high exposures of chemicals for short durations are not missed. These standards are useful for highly toxic substances used over short durations such as pesticides. Our data show the majority of substances generally comply with their MAC standards.

Whilst we rarely see exceedance of the biota EQS for PAHs in freshwater crayfish and mussels, a number of surface water bodies have elevated levels of the PAH benzo(g,h,i) perylene in water above the MAC. This is particularly where substances have historically accumulated in muddy sediments in estuaries.

Overall, despite a number of changes, we are seeing a similar level of failure of EQSs in the water column today to that observed in 2015. However, we are observing consistently high failures of biota EQSs for a limited number of substances across our biota monitoring network developed over a number of years. Although this is a cause for concern, the failure rate does not reflect an actual deterioration in water quality. Instead it reflects an improved approach to assessing these types of chemicals in our waters.

3.5. Compliance with standards

3.5.1. Metals

In the 2015 river basin management plans 'bioavailable' EQSs were introduced for copper, zinc, lead, nickel and manganese. These better reflect the actual risk to flora and fauna. We don't anticipate a significant change to the levels of these metals in the water environment.

3.5.2. Polycyclic aromatic hydrocarbons

PAHs are ubiquitous pollutants arising from urban sources including combustion sources and traffic. The group of PAHs under the WFD refers to five substances that have large molecular structures. For this group, we no longer assess failure against annual average water column concentrations. Instead we use the concentration of benzo[a]pyrene, a substance within this group, measured in mussels (in saltwater) and crayfish (in freshwater) as a long-term indication of the potential of the PAH group to accumulate in food chains. We supplement these with short-term MAC standards to guard against elevated levels that could harm aquatic life.

Fluoranthene is a PAH with a smaller molecular structure. It is covered separately under the WFD and has its own biota EQS.

In previous river basin management plans a number of water bodies had concentrations of PAHs exceeding water EQSs, especially benzo[a]pyrene and fluoranthene. Our biota monitoring now shows full compliance with the fluoranthene biota standard and 99 per cent compliance with the benzo[a]pyrene biota standard.

Most sites also comply with the MAC standard for PAHs. However, we have seen a widespread exceedance of the MAC standard for benzo(g,h,i)perylene especially in estuarine waters. The indicated higher risk for benzo(g,h,i)perylene is a result of a lower MAC EQS rather than a difference in exposure to the different PAHs.

The long-term accumulation of chemicals in muddy sediments in estuaries poses a particular challenge. Sediments can contain a high level of benzo(g,h,i)perylene. This can be released into the water during dredging in estuaries to maintain navigation, causing exceedance of the MAC. Sediment is also disturbed naturally during strong storms, which are predicted to increase with climate change.

3.5.3. Other chemicals

A range of organic chemicals consistently meet the water EQSs. However, there are a number of other chemicals, including nonylphenol, di(2-ethylhexyl)phthalate (DEHP), triclosan and phenol, that have failed to meet the water EQSs in a small number of water bodies in recent years.

The analytical method for assessing levels of tributyl tin has improved making any comparison of change over time difficult. For the 2021 river basin management plans it will only be appropriate to consider the 2018 monitoring information.

3.5.4. Pesticides

The majority of pesticides monitored, including some banned pesticides, consistently meet the water EQSs in all water bodies. There are a small number of water bodies (in low single figures) that occasionally fail to meet EQSs for some pesticides. These are: diuron; hexachlorocyclohexane (lindane); the 'drins' (aldrin, dieldrin, endrin and isodrin); DDT (total); para-para-DDT; diazinon; and 2,4-dichlorophenoxyacetic acid (2,4-D). All of these pesticides have been withdrawn from use except 2,4-D. The failures are typically associated with historical contamination in very localised areas. They do not require national scale risk management.

The Priority Substances Directive introduced dichlorvos as 'new' priority substance. A small number of water bodies fail to meet the EQS for dichlorvos.

The Priority Substances Directive also introduced a lower, more stringent EQS for cypermethrin when it changed from being a UK specific pollutant to a priority substance. Monitoring data for cypermethrin show approximately 10 per cent of water bodies sampled fail to meet the EQS for cypermethrin. Cypermethrin has a wide range of uses not only as a pesticide but also as a biocide for both amateur and professional use and as a veterinary medicine. We are investigating to better understand the cause of these failures and to identify appropriate risk management measures.

Metaldehyde is the pesticide that most commonly causes water bodies identified as surface water Drinking Water Protected Areas (DrWPAs) to be 'at risk' of not meeting WFD objectives which include meeting the standards set out in the Drinking Water Directive (see Section 4.2.1). Metaldehyde is not, however, identified as a specific pollutant or priority substance under the WFD. Therefore there is no specific WFD EQS set for it.

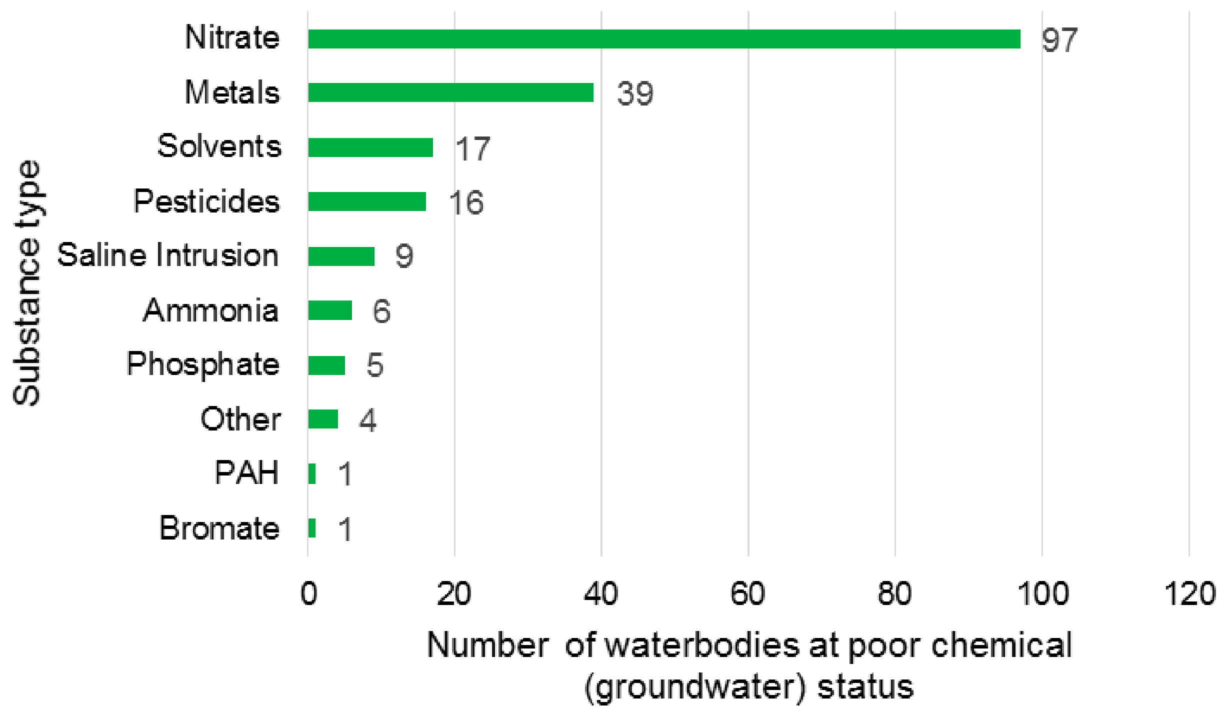
3.5.5. Surface water

In the 2015 river basin management plan we reported fewer than 3 per cent of surface water bodies failing chemical status. Our classification approach for assessing chemical status for the 2021 plans will change to ensure we are making the best use of new information and better represent the scale of risks we are observing for substances with the potential to accumulate in food chains.

3.5.6. Groundwater

In the 2015 river basin management plans, 47 per cent of groundwater water bodies were at poor chemical status. The reasons for poor chemical status are given in Figure 1. After nitrate, metal pollution, particularly from abandoned mines, presents the most widespread problems, followed by solvents and pesticides. The solvent issues are often a result of historic industrial and contaminated land pollution. Pesticide pollution is often the result of agricultural activities. Actions are in place in the 2015 river basin management plans to improve relevant groundwater water bodies from poor status to good status. However, given the long residence time of groundwater, it may take several river basin management cycles for these actions to deliver the required outcomes.

Figure 1. Substances causing poor groundwater chemical status in the 2015 river basin management plans



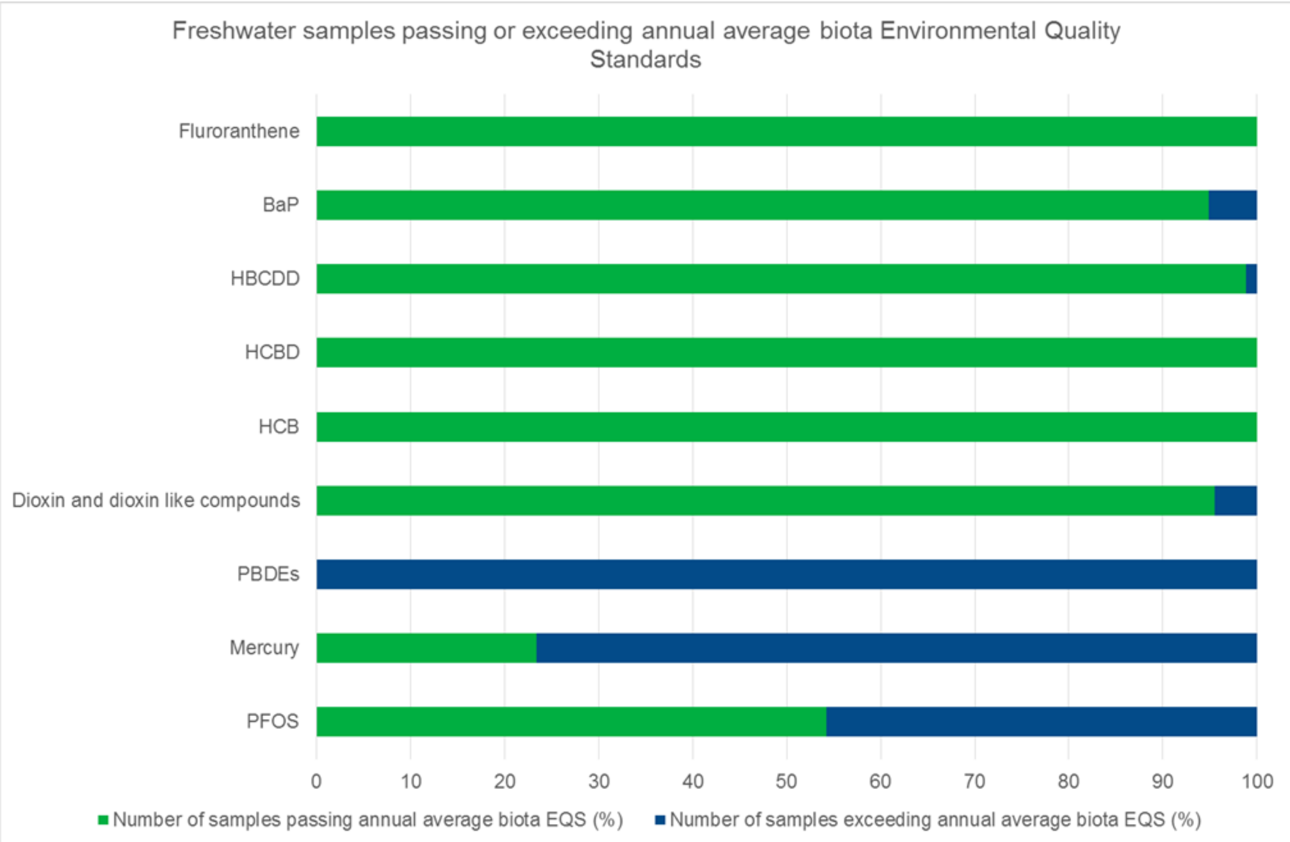
3.6. Biota standards

Chemical status is mostly assessed through water monitoring. This remains the case for most substances. However, for those substances that persist and bioaccumulate, it is more appropriate to use an EQS specified in biota. The Priority Substances Directive sets biota EQSs which will be used in the 2021 classifications.

There are a number of challenges when sampling biota, such as availability of sufficient fish of the required size and weight. To address this a network of biota sampling sites has been established across our freshwater management catchments and water bodies in estuaries and coastal waters. A long-term monitoring network at about 20 freshwater sites has also been established to enable us to monitor trends. We have been gathering biota data since 2014 from over 100 sites across England.

Figure 2 shows our current understanding of the percentage of freshwater samples passing or exceeding annual average biota EQSs. Biota concentrations of fluoranthene, hexachlorobutadiene and hexachlorobenzene are below the EQSs in all samples. Nearly all freshwater sites sampled for hexabromocyclododecane, dioxins and dioxin-like compounds, and benzo-a-pyrene are below the EQSs.

Figure 2: Freshwater samples passing or exceeding annual average biota Environmental Quality Standards (per cent)



There is, however, widespread failure of the biota EQSs in freshwater fish evident in samples taken between 2014 and 2018:

- of 465 samples 46 per cent fail PFOS biota EQS
- of 666 samples 77 per cent fail mercury biota EQS
- of 306 samples 100 per cent fail PBDE biota EQS

We are currently assessing our data for estuarine and coastal waters. It is, however, expected to follow a broadly similar pattern to that seen in freshwaters.

3.7. New priority substances and revised EQS

The Priority Substances Directive introduced twelve new priority substances in 2018: dicofol; PFOS; quinoxyfen; dioxin and dioxin-like compounds (certain PCBs); aclonifen; bifenox; cybutryne; cypermethrin; dichlorvos; hexabromocyclododecane; heptachlor and heptachlor epoxide; and terbutryn; increasing the number of priority substances from 34 to 45. Cypermethrin ceased to be a UK specific pollutant and has been a priority substance since 22 December 2018, with a lower EQS.

The EQSs for seven existing priority substances were also revised. In some cases these were lowered; in other cases they were replaced by bioavailable standards, which better reflect the actual risk to flora and fauna.

The aim is that the revised EQSs for existing priority substances should be met by the end of 2021; EQSs for new priority substances should be met by the end of 2027 unless the deadlines are extended.

3.8. Specific pollutants

Specific pollutants are hazardous pollutants released in significant quantities to UK waters. The 2015 WFD Directions[xiii] set out a revised list of specific pollutants. Ten substances were added: benzyl butyl phthalate; carbendazim; chlorothalonil; 3,4-dichloroaniline; glyphosate; manganese; methiocarb; pendimethalin; tetrachloroethane; and triclosan; giving a total of twenty-eight Specific Pollutants. The substances were considered in the 2015 river basin management plans. The EQSs of some existing specific pollutants were also revised.

4. Future challenges and actions

4.1. Emerging pressures - climate change, population growth and land-use change

By 2050 the population in England is projected to rise to 62 million; an increase of 12 per cent from 55.3 million in 2016[xiv]. Growth is expected to be greatest in London and the South East. More people will live in urban areas. A growing population, smaller family units and one-person households means the number of households is forecast to increase by 17 per cent over the next 25 years, from 22.9 million in 2016 to 26.9 million in 2041[xv]. This scale of growth has significant implications for protecting the quality of our water environment, even if chemical use per person or per household remains unchanged.

The United Nations Global Chemicals Outlook II Synthesis report[xvi] states that the projected doubling of the global chemicals market between 2017 and 2030 will increase global chemical releases, exposures, concentrations and adverse health and environmental impacts unless the sound management of chemicals and waste is achieved worldwide.

The population is also aging. A study commissioned by the German Association of Energy and Water Industries (BDEW), considered pharmaceutical residues in the water environment. It found an aging population is a principal cause in the increase in pharmaceutical consumption[xvii]. The study predicted consumption of medicines in Germany may rise by 70 per cent in the next 30 years in the worst case scenario.

Land use is also changing[xviii]. More intensive agricultural land use to feed a growing population will result in greater livestock densities, with larger housed farm units and waste storage facilities. There will be changes in the types of crops grown, with loss of permanent pasture in favour of increased fodder crop production. Biomass production for fuel is also expected to increase. Alongside this, is a projected increased urbanisation including housing, commercial developments, transport infrastructure and drainage networks.

Our report on Climate Change Impacts and Adaptation[xix] explains our climate is changing and this is set to continue. The UK Climate Change Projections (UKCP18)[xx] predict: hotter, drier summers; milder, wetter winters; rising sea levels and more extreme weather events. As atmospheric temperatures rise, so will river temperatures. Rainfall patterns will change; winter rainfall will occur in heavier events whilst summer rainfall will decrease, but summer storm events will increase.

The water environment is already under considerable pressure from a range of human activities and a growing population. Climate change adds to this pressure through changes to river flow, groundwater recharge and water temperatures.

Decreasing summer river flows will concentrate levels of chemicals in rivers, impacting on the river's ability to support healthy aquatic ecosystems. The frequency of heavier rainfall events will increase pollutant runoff from land to water, increase storm discharges from sewers and disturb sediments, releasing chemicals like persistent organic pollutants contained within them.

Warmer temperatures are likely to bring an increase in the variety of insect pests to England and allow increased pest survival rate over-winter. This may lead to an increase in insecticide use. Herbicide use may also rise, to control an increase in invasive plant species, both native and non-native. Fungicide use may also increase to combat fungal problems on crops linked to warmer summers. The types of crops that can be grown, and associated pests, may change and require the use of different or new pesticides.

Reducing the pressure from chemical pollutants, where possible, can help habitats become more resilient and better able to adapt and cope with stress from other pressures, such as the impacts from a changing climate.

The use of nature-based solutions, such as phytoremediation, can help build greater resilience into our environment by providing multiple benefits for people and nature. Phytoremediation is the use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environment. The plants can also help prevent wind, rain, and groundwater flow from carrying contaminants away from the site to surrounding areas or deeper underground[xxi], as well as provide carbon sequestration benefits[xxii].

Whilst it is an emerging technology, it is thought to be cost effective, increase soil health and yield[xxiii] and leave the environment in a more natural state.

4.2. Chemicals creating the challenge

4.2.1. Pesticides

Pesticides are used for different purposes. For example, a pesticide can be used as a home and garden product, entering the environment through sewage effluent, as well as having an agricultural use and entering the environment through spray drift or run-off following rainfall.

Some catchments are more vulnerable to surface or groundwater pollution because of the intense agricultural use of approved pesticides at certain localities, at particular times of the year.

So that the use of pesticides can be retained it is important to:

- adopt integrated pest management practices
- promote and adopt codes of good practice and engage with product stewardship schemes
- develop catchment-based initiatives to protect drinking water sources and the environment

Partnerships at both a UK and local level are needed to deliver improvements. Where problems persist despite such initiatives, then regulatory options will be explored and, if justified, put in place.

Under the WFD water bodies used to supply drinking water are identified as DrWPAs. Water entering supply must meet pesticide standards set by the Drinking Water Directive[xxiv].

Pesticides are the most common reason surface water DrWPAs become 'at risk' from meeting the WFD objectives which require:

- that treated water meets the Drinking Water Directive standards
- aim to avoid deterioration in the quality of a DrWPA in order to reduce the level of purification treatment required in the production of drinking water

Removing chemicals from the drinking water supply often requires additional treatment.

Metaldehyde is the most common pesticide causing DrWPAs to be 'at risk'. However, a group of herbicides (propyzamide; carbetamide; clopyralid; quinmerac; metazachlor; MCPA; mecoprop-P; 2,4-D; and chlortoluron) also cause a significant number of DrWPAs to be 'at risk'. The pesticides isoproturon, linuron, and diazinon, which are no longer approved for use, also impact DrWPAs due to their historical use. Some surface water DrWPAs are at risk for more than one pesticide.

Pesticides are found to a lesser extent in groundwater DrWPAs. Those most frequently found are bentazone, metaldehyde and mecoprop-P, which are all currently approved for use. Atrazine and diuron, which have been banned from use for over a decade, are also found in groundwater, as a legacy of historical use.

Further information can be found in the ‘Drinking Water Protected Area’ section of the consultation.

Authorisations for pesticide use consider the risks of individual pesticides. We observe a complex mixture of pesticides in the environment. The possibility chemicals with similar modes of toxic action are cumulatively toxic when present together, cannot be ruled out and will be investigated in future. However, we conduct both chemical and ecological monitoring at some sites and these provide evidence of impacts from combinations of chemicals.

4.2.1.1. Carbetamide, clopyralid, metazachlor, propyzamide, and quinmerac

These herbicides are widely used in oilseed rape and winter wheat. Monitoring data shows levels of the herbicides carbetamide and metazachlor are decreasing, which is supported by trends in pesticide usage data[xxv]. Conversely, increases in the number of detections of propyzamide in the environment coincide with a four-fold increase in its use in the last fifteen years[xxvi].

Water company analyses of water abstracted for drinking water supply prior to treatment suggest that the average detected concentrations of clopyralid and quinmerac have decreased, though the maximum detected levels of quinmerac have increased since 2011. While these two herbicides are frequently monitored in the context of drinking water (owing to challenging treatment and removal), they are detected at much lower overall frequencies than carbetamide, metazachlor, and propyzamide. The increased detection and usage of propyzamide is in due to managing the problem weed blackgrass in winter cereal crops.

This group of herbicides is targeted under the Voluntary Initiative, a scheme which focuses on their application to oil seed rape. However, these herbicides are in fact applied to a variety of crops including winter wheat and barley, vegetables and amenity grassland and ornamental plants. This highlights the importance of an integrated approach to their future management.

4.2.1.2. Chlortoluron, MCPA, mecoprop-P, and 2,4-D

Other national priority pesticides falling under the variety of voluntary initiatives have also been examined. Water company data indicates that levels of chlortoluron have decreased, likely in response to the phased revocation of this product. Conversely, the levels of MCPA have increased, which coincides with an increase in the use of this substance over the same time period. Levels of mecoprop-P do not appear to show a consistent trend.

4.2.1.3. Cypermethrin

Cypermethrin is a pesticide of concern at a national scale. Cypermethrin can be harmful at very low concentrations, and therefore has a very low EQS. Consequently, very small amounts of cypermethrin entering the environment can cause an EQS exceedance.

Our monitoring between 2016 and 2018 shows that around 10 per cent of freshwater sites monitored exceed the EQS. Analysis of such low concentrations is exceedingly challenging and currently, it is not possible to assess estuarine waters as analytical detection is not possible down to the saline EQS.

In the past the occurrence of cypermethrin in the environment was linked to its use at high concentrations in sheep dip. Cypermethrin use in sheep dip has now been stopped. Today agricultural sources of cypermethrin come from the use of pesticides applied to crops and veterinary medicines, typically applied as pour-on products, predominantly to sheep to prevent fly strike. The key pathways to surface water are likely to be surface runoff from arable land and from mixing areas on hard standings in farmyards.

The potential urban sources of cypermethrin can be split between industrial and domestic sources. Industrial sources of cypermethrin are wool scouring, textile processing, and the paper and pulp industry. Potential domestic sources include inappropriate cleaning and disposal associated with amateur use of wood preservatives and insecticides containing cypermethrin. However, the lack of information received from the industry and on consumer behaviour relating to biocides (i.e. insecticides and wood preservatives), means clear benefits on source control options remain difficult to quantify. We are working with stakeholders on options to reduce emissions to the environment and manage releases of cypermethrin at a local level.

Further information can be found in the supporting cypermethrin narrative.

4.2.1.4. Bentazone

Bentazone is one of the most frequently detected pesticides in the environment, frequently at levels above the Drinking Water Directive standard of 0.1 µg/l. It is not, however, very toxic to aquatic life and does not currently present a threat to aquatic ecosystems. It has also been detected in six groundwater Safeguard Zones, requiring control measures to be established at these locations.

It is expensive for water companies to remove bentazone from drinking water to meet the drinking water standard and inevitably adds to the overall cost to customers. Further action is therefore needed to reduce bentazone concentrations in some DrWPAs across England and better uptake of the current bentazone stewardship scheme by all manufacturing companies will be required.

4.2.1.5. Metaldehyde

Products containing metaldehyde are used to control slugs and snails on farms, in gardens and in amenity situations. Metaldehyde levels frequently exceed the Drinking Water Directive standard limit in rivers and reservoirs during autumn, winter and early spring. These levels are an obstacle to meeting the legal standards for drinking water as it is not easily removed from abstracted water by normal drinking water treatment.

Following advice from the UK Expert Committee on Pesticides, restrictions were announced in December 2018 on the phasing out of the outdoor use of metaldehyde due to its potential effect on wildlife. However, following challenge in the High Court, the restrictions, due to be in place in 2020, have been withdrawn.

4.2.2. Polycyclic Aromatic Hydrocarbons (PAHs)

Most PAHs are unintentional by-products from combustion. Industrial sources, including the production of steel, iron and aluminium, rubber tyre production and road paving and asphalt manufacture also release PAHs. Controlling environmental releases of PAHs is difficult because of the very high number of diffuse sources producing them.

They persist in the environment and accumulate in the sediment as well as within biota and food chains. They have potential adverse effects on aquatic life and humans, including carcinogenic properties. With the exception of benzo(g,h,i)perylene, the PAHs that we regulate are designated POPs.

Our monitoring information shows most sites sampled meet the new biota based standards. However, there is widespread failure of the MAC standard for the PAH benzo(g,h,i)perylene particularly in estuarine waters.

Further information can be found in the supporting PAH narrative.

4.2.3. Persistent organic pollutants (POPs)

Some organic chemicals are designated as POPs. Once released into the environment these remain intact for many years and become widely distributed around the globe, including in areas where POPs have never been used. They bioaccumulate through the food chain and are toxic to humans and wildlife.

The Stockholm Convention[xxvii] contains global commitments to reduce emissions of POPs through measures that eliminate or restrict the production and use of these substances. Early identification and action on POPs is a priority. Once POPs enter the environment it can take many years for levels to reduce, as seen for polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs) and perfluorooctane sulfonic acid (PFOS). These substances remain in sediments and biota for many decades and respond very slowly to interventions.

The challenge is dealing with consumer goods containing POPs that were legally used at the time they were sold, but have subsequently been identified as POPs and banned from future use. They contribute to domestic release of POPs to the environment, for example from dust adhering to clothes discharging into the sewer when washed. These consumer goods will also, in due course, become discarded and managed as waste.

There is a target within the 25 Year Environment Plan[xxviii] to increase the amount of POPs material being sent for destruction at the end of its useful life. We are developing approaches to better track POPs in waste to achieve this objective.

We enforce restrictions on the use of POPs under the European REACH and POPs Regulations.

Polybrominated diphenyl ethers (PBDEs), used as flame retardants in a wide range of products including electrical and electronic equipment, textiles and foams are POPs. There are national and international measures to prevent the use of PBDEs in products. Despite use restrictions, there are widespread failures of the biota standards for PBDEs. Whilst emissions from wastewater treatment works are declining rapidly and are predicted to be negligible within 10 years, our modelling suggests there will be very slow recovery in environmental levels. Advanced treatment could be considered at wastewater treatment plants to further reduce emissions of PBDEs. However, even if this is technically feasible, it would be very costly and energy intensive.

Further information can be found in the supporting PBDE narrative.

Poly- and perfluoroalkyl substances (PFAS) are a group of several thousand organic chemicals used in a range of products because of their oil, water and stain repellent properties. They are extremely persistent in the environment and are detected worldwide.

Perfluorooctane sulfonic acid (PFOS) was widely used in firefighting foams and as a stain repellent in carpets and textiles, and is subject to international restrictions. Use of perfluorooctanoic acid (PFOA) will be restricted under REACH after July 2020 (with some time-limited exemptions). It is likely to become a POP under the Stockholm Convention. A restriction proposal for six further PFOA-like substances is being considered by the Stockholm Convention, as well as perfluorohexanesulfonic acid (PFHxS)

Further information can be found in the supporting PFOS narrative.

4.2.4. Metals

Metal and coal mining have a major part in our industrial history. Whilst most UK mines closed over 100 years ago, abandoned metal mines are a significant source of metals to surface waters. Cadmium, zinc, iron, lead, copper, manganese, nickel and arsenic are all released from abandoned metals mines. Of these, zinc, cadmium, lead and copper most commonly have an environmental impact. Tackling this metal pollution is a priority in the 25 Year Environment Plan and protects aquatic organisms and delivers economic and environmental benefits for local communities.

The ‘Pollution from abandoned mines’ section of the consultation contains further information on mine waters.

Mercury is a highly toxic, naturally occurring metallic element and is a ubiquitous, persistent, bioaccumulative, toxic (uPBT) substance. Mercury arises predominantly from past industrial and domestic uses. Mercury-containing thermometers, batteries, electrical switches and relays and blood-pressure monitors are banned. Other uses of mercury are severely restricted in favour of safer alternatives.

These restrictions help limit the build-up of mercury in the food chain. A range of actions are taken to reduce mercury levels in products and to phase out emissions, many of which are co-ordinated under the EU Mercury Strategy[xxix].

In August 2017 the international Minamata Convention[xxx] on mercury came into force. Its key objectives are protecting human health and the environment from the anthropogenic releases of mercury. The Government’s 25 Year Environment Plan[xxxi] commits to reducing land-based emissions of mercury to air and water by 50 per cent by 2030.

The single largest industrial use of mercury in England was at a chlor-alkali plant located in the Northwest. It was used for the continuous production of chlorine, sodium hydroxide and hydrogen by electrolysis of a brine solution using ‘mercury cell’ technology. This was required to cease by December 2017 and was replaced by a membrane process which does not involve the use of mercury.

Trace amounts of mercury are found in coal and are released to atmosphere during combustion. The move away from coal-fired power stations in England will contribute significantly towards the targets set out in the 25 YEP. However, atmospheric fall out of mercury in the UK from overseas sources will remain significant.

Dental amalgam is a further important source of mercury. It contains approximately 50 per cent mercury and is the most widely used form of dental filling in the dental profession. Waste amalgam must be carefully managed and cannot be flushed down sinks or drains. The EU Mercury Regulation[xxxii] sets out stricter measures to reduce this source. The use of dental amalgam in children under 15 years of age and pregnant or breastfeeding women was restricted from July 2018. High performance filters, known as amalgam separators, prevent water contamination by dental clinics and became compulsory in January 2019.

Further information can be found in the supporting mercury narrative.

4.2.5. Endocrine disrupting compounds

Certain natural and man-made chemicals can interfere with the normal functioning of endocrine systems of both humans and animals. The strongest evidence for effects of such endocrine disrupting chemicals in wildlife is widespread feminisation of male fish present in lowland rivers, and some estuaries, reported in fish populations globally.

Pioneering studies carried out in UK rivers have shown widespread feminisation of roach (*Rutilus rutilus*) associated with exposures to wastewater treatment works effluents. The main chemicals associated with these effects are natural and synthetic oestrogens originating from human use. Oestrogen mimicking alkylphenols, derived from the breakdown of industrial detergents, are also associated with the effects.

The severity of feminisation appeared to depend on the relative amount of wastewater treatment works effluent in the rivers in which the fish resided, as well as the size and age of the fish. Moderately intersex fish had reduced fertility, but more recent studies have not found evidence for a reduced breeding population size in effluent contaminated stretches of a few selected English rivers.

Results from recent field surveys confirm that feminisation in male roach is still a widespread phenomenon and that the frequency and severity of the feminised condition at the majority of sites did not differ significantly from that found in the historic studies.

4.2.6. Pharmaceuticals and anti-microbial resistance

Low levels of pharmaceuticals in the environment are under increasing scrutiny because of their potential role in anti-microbial resistance (AMR) and the effects of long-term exposure to pharmaceuticals on wildlife.

In March 2019, the European Commission published its 'Strategic approach to Pharmaceuticals in the Environment'[xxxiii]. Diffuse discharges of pharmaceuticals via wastewater treatment works and veterinary medicines in livestock transferred into manures are considered the most significant routes to the environment. The EU strategy also considers both the potential effects of low level exposure to pharmaceuticals and their potential contribution to AMR.

AMR is a significant and complex global issue with profound implications for our ability to fight infections in the future. It is projected to overtake cancer as a major cause of deaths worldwide by 2050. Although the greatest increase will be in countries which lack the similar high standards of hygiene and regulation in the UK and the EU. The relative significance of domestic sewage in either contributing to the development of resistant micro-organisms or transmitting them to the environment is yet to be determined.

Co-operation is needed on a global scale to tackle the threat of AMR. The European Union wants to be a leading region for best practice. At an international level, the UK takes a leading role and advocates a 'One Health'[xxxiv] approach to tackling AMR. The need to better understand pathways of AMR to the environment is gaining momentum. In January 2019, the UK's 20 Year Strategy for AMR[xxxv] and its Five Year National Action Plan for AMR[xxxvi] were published. Through this we will improve our understanding of AMR transmission routes to the environment, and subsequently from the environment to humans.

Under the next Chemical Investigations Programme, water companies are planning a substantial 12 month investigation to understand the potential for wastewater treatment works to transmit or produce anti-microbial resistant genes. The 2020 study will look for the presence of other factors which could influence selection of resistant genes/bacteria, such as antibiotics and other pharmaceuticals.

The water industry has previously investigated about twenty pharmaceuticals, including antibiotics, analgesics, anti-hypertensives and antidepressants. The concentrations of these substances were determined over the course of a year in wastewater treatment works' influent and effluent. This helped provide an indication of the effectiveness of treatment processes and the possible risks posed by discharges. The majority of substances studied are removed to a high degree in the wastewaster treatment. Removal through treatment was less effective for: ethinylestradiol, diclofenac, propranolol, and the macrolide antibiotics, fluoxetine, tamoxifen and carbamazepine.

The EU is gathering data on a number of pharmaceuticals including the oestrogen ethinylestradiol, diclofenac, and macrolide antibiotics, to decide whether they should be priority substances in the future. Our monitoring indicates elevated levels of ethinylestradiol, diclofenac, and clarithromycin in urban areas. Monitoring of other antibiotics is ongoing.

4.3. River basin planning challenges and chemicals

There are a number of key sources and sectors that release chemicals to the environment. These include the water industry, rural areas including agriculture, urban areas and abandoned metal mines. Each of these has its own challenge narrative written as part of the Challenges and Choices Consultation.

4.3.1. Pollution from water industry and wastewater

We use a vast array of substances and chemicals in our everyday lives. These enter sewage systems via our homes, businesses and road runoff. They enter the water environment by passing through wastewater treatment works, surface water outlets to rivers or from storm overflows during heavy rain. If chemicals are not broken down they are likely to be present in sewage sludge. Section 4.9.3 provides further information on materials to land including sewage sludge.

4.3.1.1. Water industry national environment programme

The 2020 to 2025 water industry national environment programme (WINEP3) includes obligations on the water industry to reduce chemicals discharged to the environment, funded through customer bills. There are 503 separate measures for chemicals, which includes 330 chemical investigations, with an anticipated cost of £200m, around 0.4 per cent of the total programme cost of £4.9 billion. The measures are source control or end of pipe control.

The chemical investigations, which include the Chemicals Investigation Programme (see Sections 4.8.3 and 5 below), will increase our knowledge of sources of chemicals and their impacts. These include: investigations into sources of specific chemicals in sewer catchments and rivers, studies of the concentrations of chemicals in surface waters, groundwaters and sludge, monitoring of chemical removal by existing and new technologies, studies of the concentrations of emerging chemicals in effluents, and investigations to increase our understanding of microplastics and AMR in sewage effluents (and sewage sludge). It also includes innovative approaches to seek to reduce inputs of pharmaceuticals to sewer by working with local communities.

These will inform decisions on investment in improved treatment or further investigations in the next water industry price review in 2024.

The ‘Pollution from water industry and wastewater’ section of the consultation contains further information on the water industry.

4.3.1.2. Learning from the Chemicals Investigation Programmes

Over the past 10 years we have worked collaboratively with water companies on the Chemicals Investigation Programmes (CIPs).

Further information can be found in the case study in Section 5.

At this stage we do not advocate advanced treatment technologies at wastewater treatment works on a national scale. Such improvements are unlikely to be the most cost-beneficial solution to achieve widespread environmental improvements of specific chemicals. The exception may be where complementary treatment solutions reduce inputs of a range of substances and multiple benefits justify the costs incurred.

Good maintenance of the sewer network, appropriate trade effluent controls and engagement with customers on best practice or behavioural change can all help to reduce the need to remove chemicals through treatment. These provide additional benefits in reducing pollutant loads in sewage sludge going to land. We need time to measure the effectiveness of interventions to actively reduce inputs to sewer. Where these measures fail to reduce chemicals input, we can then focus on end-of-pipe treatment at wastewater treatment works.

Under the WINEP3, advanced treatment technologies will be installed on individual sewage works where local chemical issues have been identified. Water companies will monitor emissions to surface waters, work to reduce locally elevated inputs to sewer and optimise treatment where needed.

Through the latest CIP programme, water companies are monitoring a range of chemicals in treated effluent and their impact on groundwater. This will provide important information to help protect and improve our groundwater bodies.

4.3.2. Pollution from agricultural and rural areas

4.3.2.1. Pesticides, biocides and veterinary medicines

Chemicals entering the environment from rural areas arise mainly from pesticide and veterinary medicine use, diffuse pollution and from chemicals in materials spread to land. Additionally, in rural areas not served by a public sewerage network, private domestic sewage treatment systems (package treatment plants and septic tanks), can be a source of chemicals. Once in the environment, chemicals can also bind to sediment particles and enter water through soil erosion, compaction and run off.

Pesticides play an important role in food production. However, water bodies can be vulnerable to pesticide pollution. Pesticide manufacturers and the agricultural sector need to continue to promote good practice. They should continue developing voluntary, catchment-based initiatives with water companies and others, to protect drinking water sources and the environment. Local and national partnerships are essential to improve water quality. Where problems persist national regulatory options will be considered.

Withdrawing high risk chemicals from certain uses can be the most effective way of reducing their presence in the environment, provided this can be justified on environmental and economic grounds. However, environmental recovery is slower for those pesticides that persist in the environment for a number of years. Some substances also have multiple uses such as veterinary medicines and as biocides for professional or home use. The significance of these uses and pathways to the environment may mean that restricting agricultural pesticide use in isolation will not return the environment to the desired levels.

The illegal use of pesticides following a ban is rare. There have been examples of banned pesticides being found in farm chemical stores, but they are unlikely to be in actual use. Catchment Sensitive Farming data[xxxvii] shows that 36% of the pesticides monitored for, and in current usage, have been detected in rivers above a threshold value of 0.1 µg/l on at least one occasion since 2014. This threshold value derives from the Drinking Water Directive and applies at the point of supply. It is used here for comparative purposes.

Pesticide active ingredients are reviewed by the Health and Safety Executive. This can result in the removal from the market of older more hazardous active ingredients leading to the new pesticides of lower risk to the environment.

4.3.2.2. Sediment

Some substances can bind to sediments, remaining there for many years with a direct impact on sediment-dwelling organisms. These chemicals can be released from sediments when it is disturbed by heavy storms, coastal erosion or dredging. Even if we control the original source of the chemicals, there is still long term exposure to chemicals as they are released from sediments.

4.3.2.3. Materials to land (land spreading)

Materials to land links directly to the objective in the Government's 25 Year Environment Plan of maximising resource efficiency and minimising environmental impacts at the end of life by improving management of residual waste. Undertaken appropriately, waste materials to land supports the Defra objective for Healthy Soils. Use of waste as a substitute fertiliser (containing nutrients) or a soil conditioner (containing organic matter or lime) increases a soil's natural capital. This leads to wider benefits of more sustainable agriculture, cleaner water and air, climate change mitigation and reduced flood risk.

However, the potential risks posed by spreading inappropriate material are significant and can impact upon the water, air and soil environments, human and animal health, and the food chain. Many of the risks are associated with the chemicals we use and discard every day. Chemicals ranging from different metals, personal care products, pharmaceuticals, and POPs, such as flame retardants, are all found in the materials that are spread to land. This includes from domestic and industrial sources and runoff from roads.

The chemical pressures from the land spreading of sludge and other waste materials have largely been focussed on a narrow range of metals, also called potentially toxic elements (PTEs). Regulatory intervention to control release of PTEs in sewage sludge is contained in the Sludge (Use in Agriculture) Regulations[xxxviii], which are now over thirty years old. Sludge investigations are in the latest phase of the water industry's CIP and will add to our knowledge around the chemical complexity of sludge that goes for land-spreading. They will also look at the contribution of sludge to the release of AMR and microplastics into the soil and wider environment. This will inform our Sludge Strategy which will set out how we regulate the beneficial use of materials on land, without them presenting an unacceptable risk to soil health, water quality, human health or the wider environment.

The 'Pollution from agriculture and rural areas' section of the consultation contains further information.

4.3.3. Pollution from towns, cities and transport

4.3.3.1. Consumer and industrial use

Towns and cities are a source of many chemicals that enter the environment. These arise through our use of products in our homes and gardens, such as cleaning products and garden pesticides and biocides, our use of medicines and personal care products as well as through chemicals in house dusts and on our clothes. Transport, drainage from our town and cities and current and past industrial land use are also sources of chemicals. For example, there are a number of groundwater Safeguard Zones established for solvents primarily related to historical use, such as pollution from airfields, dry cleaning or metal processing.

Some chemicals that accumulate in the environment have had their use tightly controlled for many years. However, they remain in the environment due to their long-term industrial legacy and use in household consumer items that have a long in-use life.

These persistent chemicals are often subject to a complex range of measures, often agreed internationally, to reduce a wide range of sources and inputs over time.

4.3.3.2. Land contamination

Land can be contaminated by chemicals such as the heavy metals (arsenic, cadmium and lead), oils, tars, solvents and pesticides from current or former use. Land contamination can be a blight on communities and may present unacceptable risks to people and the environment.

Preventing our land from becoming polluted is the best way of making sure future generations do not inherit a legacy of contamination. We partly achieve this by permitting those activities with the highest potential to pollute. We also regulate other activities using chemicals, including chemicals in waste.

However, we need to tackle a legacy of historic contamination. In 2005, we estimated around 2 per cent of the land area of England was likely to have been affected by industrial activities of a type that could have caused contamination[xxxix]. Most of the affected land is cleaned up on a voluntary basis, either by land owners or by developers via the planning regime, where the aim is to make the land suitable for a new use.

Where contamination cannot be dealt with via any other means, the Contaminated Land Regime under Part 2A of Environment Protection Act 1990, provides a statutory mechanism for resolving these issues. This will include land which is either unsuitable for development or wasn't cleaned up to satisfactory standards when it was re-developed.

The legal definition of ‘contaminated land’ includes land where substances are causing or could cause significant harm or significant pollution of surface waters or groundwater.

The most recent survey on Part 2A activity[xl] in 2016 showed good progress on remediating contaminated land sites has been made since 2000, when the contaminated land regime came into force. Local authorities have inspected more than 11,000 sites, of which 511 were identified as contaminated land and requiring remediation to make them suitable for their current use. Of these 511 sites arsenic, lead and benzo(a)pyrene are the most common substances causing contamination. However, a further 10,000 sites still need to be inspected to identify any risks they pose. Progress has slowed following the withdrawal of Government grants to local authorities in 2015.

The highest risk contaminated land sites are classed as ‘special sites’, and are regulated by the Environment Agency. This includes land that seriously affects drinking waters, surface waters or important groundwater sources. There are currently 48 designated 'special sites'. This includes two historic landfills near Peterborough where leaching pesticides is polluting eight square kilometres of groundwater and impacting a drinking water abstraction for 25,000 homes.

4.3.3.3. Roads and highways

We have worked alongside Highways England on plans to invest just over £50 million by 2021 to reduce flooding and environmental impacts from the existing Strategic Road Network. A proportion of this will address pollution, including chemical pollution, from highway run-off. Further investment will be made available by Highways England for similar environmental schemes through the next Road Investment Strategy (RIS2) to 2025.

The ‘Pollution from towns, cities and transport’ section of the consultation contains further information on roads and highways.

4.3.4. Pollution from abandoned mines

Abandoned metal mines are responsible for a number of failures of chemical status and impacts on aquatic ecology. Metals, including zinc, cadmium, lead, copper, and nickel are the main reason.

In 2011 the Water and Abandoned Metal Mines programme was set up by Defra in partnership with the Coal Authority and the Environment Agency to begin to address metal pollution from mine waters. Nobody is liable for water pollution from mines abandoned before 2000.

The Environment Agency identifies the main sources of metals in impacted catchments and assesses whether cleaning up the sources will improve water bodies to good status. All impacted water bodies should be assessed by 2021. The Coal Authority leads studies to identify feasible remedial measures at priority sites. Where funding is available, and the environmental and economic benefits outweigh the costs, they work in partnership to build mine water treatment schemes. The scale of interventions required vary from multi-million pound treatment schemes and civil engineering projects for major discharges, too much smaller scale “green” interventions and drainage control.

The ‘Pollution from abandoned mines’ section of the consultation contains further information on mine waters.

5. Case study

Case study: Chemical Investigation Programmes (CIPs)

Water companies have spent over £150 million on research to quantify and manage the environmental risks posed by chemicals in sewage effluent. This has improved our knowledge on chemicals, including those of emerging concern. The CIPs have shown that:

- some chemicals are ubiquitous in sewage effluent and the environment. Other chemicals are a localised issue
- many chemicals are removed effectively by traditional sewage treatment even though the treatment was never designed to do this. Other chemicals may require further management
- chemicals from households are generally the most dominant source. Previously we thought the dominant source of these chemicals was non-domestic (e.g. trade-effluents). However, some non-domestic sources still contribute significant amounts in certain location.
- there is no “one size fits all” sewage treatment technology that provides effective removal for all chemicals
- Investigations on treatment technology on a wide range of chemicals show different removal efficiencies, with no one-preferred solution. Source control can be more cost effective than improvement of wastewater treatment works.
- Recent results from the CIP have shown a promising downward trend in some chemicals, such as the brominated flame retardant PBDEs and triclosan, an antimicrobial biocide found in personal care products (such as hand washes). Further monitoring will confirm the direction and extent of any trend. This may mean additional treatment does not need to be considered for particular substances in some locations, as legal and voluntary restrictions have reduced their use, and subsequently their presence in waste waters.
- Levels of PBDEs, increasingly restricted from 2003, declined between 2013 and 2016 by over 30 per cent. If this continues levels in effluent will have declined by roughly an order of magnitude by 2027, posing lower environmental risk. This assumes a continued decline owing to control measures in place.
- Downward trends have also been observed for DEHP (a plasticiser in PVC) and tributyltin (a contaminant in PVC stabilisers).

We are working with water companies on the next set of investigations and will continue to learn from this research to inform our management of the environment and regulation of the water industry.

6. Choices

Question 1: What can be done to address the challenge of chemicals in the water environment?

Question 2: Do you support the Environment Agency's proposed strategic approach to managing chemicals as referenced in the Chemicals in the Water Environment challenge document? If not, what changes would you make?

Question 3: What balance do you think is needed between current chemical use, investing in end-of-pipe wastewater treatment options and modifying consumer use and behaviour?

7. Contacts

If you have any feedback or comments on the evidence contained in the summary then please contact:

enquiries@environment-agency.gov.uk

8. References

---

[i] European Environment Agency (2019) Contaminants in Europe's seas: Moving towards a clean, non-toxic marine environment No 25/2018

[ii] Environment Agency (2015) Update to the river basin management plans in England. National Evidence and Data Report

[iii] Priority Substances Directive (2013/39/EC)

[iv] http://www.saicm.org/Portals/12/Documents/meetings/OEWG3/inf/OEWG3-INF-19-GCOII-Summary.pdf

[v] European Environment Agency (2019) Contaminants in Europe's seas: Moving towards a clean, non-toxic marine environment No 25/2018

[vi] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (as amended)

[vii] http://nora.nerc.ac.uk/id/eprint/524322/

[viii] Plant Protection Products Regulations 2011

[ix] Biocidal Products Regulation (EU) (528/2012)

[x] https://www.norman-network.net/

[xi] https://www.gov.uk/government/publications/25-year-environment-plan

[xii] Environment Agency (2015) Update to the river basin management plans in England. National Evidence and Data Report

[xiii] Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

[xiv] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2016basedstatisticalbulletin#main-points

[xv] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/pop

ulationprojections/bulletins/2016basedhouseholdprojectionsinengland/2016basedhouseholdprojectionsinengland

[xvi] https://wedocs.unep.org/bitstream/handle/20.500.11822/27651/GCOII_synth.pdf?sequence=1&isAllowed=y

[xvii] https://civity.de/en/publications/pharmaceutical-usage-in-the-context-of-demographic-change/

[xviii] https://www.theccc.org.uk/wp-content/uploads/2018/11/Land-use-Reducing-emissions-and-preparing-for-climate-change-CCC-2018.pdf

[xix] Environment Agency (2018) Climate change impacts and adaptation

[xx] https://www.metoffice.gov.uk/research/collaboration/ukcp

[xxi] Environmental Protection Agency: A Citizen Guide to Phytoremediation: https://clu-in.org/download/Citizens/a_citizens_guide_to_phytoremediation.pdf

[xxii] Khanzad Gul Zazai, Owais Ali Wani, Aamina Ali and Mamta Devi. (2018). Phytoremediation and Carbon Sequestration Potential of Agroforestry Systems: A Review. Int.J.Curr.Microbiol.App.Sci. 7(01): 2447-2457. doi: https://doi.org/10.20546/ijcmas.2018.701.295

[xxiii] Yahia A. Othman & Daniel Leskovar (2018): Organic soil amendments influence soil health, yield, and phytochemicals of globe artichoke heads, Biological Agriculture & Horticulture, DOI: 10.1080/01448765.2018.1463292 https://doi.org/10.1080/01448765.2018.1463292

[xxiv] Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

[xxv] Pesticide usage data obtained from Kynetec Agri Insight

[xxvi] Pesticide usage data obtained from Kynetec Agri Insight

[xxvii] http://chm.pops.int/TheConvention/ThePOPs/tabid/673/Default.aspx

[xxviii] https://www.gov.uk/government/publications/25-year-environment-plan

[xxix] http://ec.europa.eu/environment/chemicals/mercury/index_en.htm

[xxx] http://www.mercuryconvention.org/

[xxxi] https://www.gov.uk/government/publications/25-year-environment-plan

[xxxii] The Control of Mercury (Enforcement) Regulations 2017 (EU 2017/58) (repealing regulation (EC) 1102/2008)

[xxxiii] http://ec.europa.eu/environment/water/water-dangersub/pdf/strategic_approach_pharmaceuticals_env.PDF

[xxxiv] http://www.onehealthinitiative.com/index.php

[xxxv] https://www.gov.uk/government/publications/uk-20-year-vision-for-antimicrobial-resistance

[xxxvi] https://www.gov.uk/government/collections/antimicrobial-resistance-amr-information-and-resources

[xxxvii] https://www.gov.uk/guidance/catchment-sensitive-farming-reduce-agricultural-water-pollution

[xxxviii] Sludge (Use in Agriculture) Regulations 1989

[xxxix] Environment Agency: 2005: Indicators for Land Contamination.

[xl] Environment Agency: 2016: Dealing with Contaminated Land in England