A Review of Current Knowledge

Household Chemicals and the Water Environment

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HOUSEHOLD CHEMICALS AND THE WATER ENVIRONMENT

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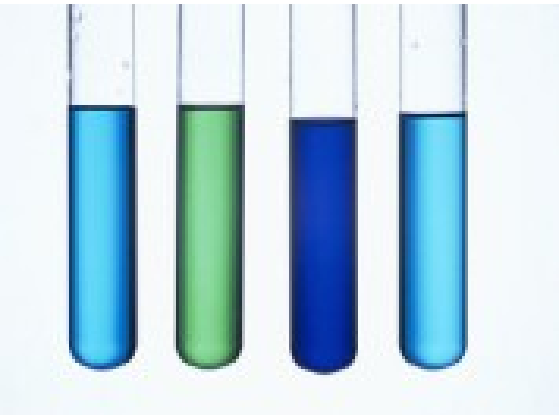
Review of Current Knowledge



Copper ion solution – © Andrew LamberT Photography/Science Photo Library

"Some of the most severe problems caused by chemicals in the environment have been detected by observation rather than assessment techniques."

Royal Commission on Environmental Pollution, 2003

"Every day, we are exposed to chemicals in our environment, at work or in our homes. However, for many of them, we do not know enough about their risks or longer term effects. Our reform proposal, therefore, requires industry to provide public information on the chemicals they produce or import and the risks associated with their use. This will allow the users to choose safer alternatives."

EU Environment Commissioner Margot Wallstrom on REACH (Registration, Evaluation and Authorisation of Chemicals), 7th May 2003

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Abbreviations and acronyms

CHIP	The Classification (Hazard Information and Packaging for Supply) Regulations
CLP	Classification, Labelling and Packaging Regulation
CPA	Crop Protection Association
CRD	Chemicals Regulatory Directorate (part of HSE)
DDT	An insecticide with the chemical name 1,1,1-Trichloro-2,2-bis- (4'-chlorophenyl)ethane
Defra	Department for Environment, Food and Rural Affairs
DWI	Drinking Water Inspectorate
ERA	Environmental Risk Assessment
HSE	Health and Safety Executive
MAPPs	Ministerially Approved Pesticide Products
MHRA	Medicines & Healthcare products Regulatory Agency
MSDS	Material Safety Data Sheets
PAN	Pesticide Action Network
PPCPs	Pharmaceutical and Personal Care Products
REACH	Registration, Evaluation and Authorisation of CHemicals Regulation

1 Introduction

We all use chemicals in the home and garden. Some chemicals, such as cleaning agents and detergents, may be discharged directly and legitimately to the drains and hence enter water bodies. Others, such as paints, solvents or surplus pesticides, may be disposed of with little consideration for the environment, and enter water bodies after diffusing through the soil or via surface water drains.

There is concern that many of the products used by the average household if used inappropriately may pose a risk to health and the environment, especially in the long term. Legislation to protect both health and the environment is being constantly re-evaluated and improved. Nevertheless, we are often ignorant of the chemicals found in household products and what sort of risk they might pose to the environment. General public ignorance is understandable; a vast range of chemicals and formulations of chemicals are used in the home because of their active chemical properties.

This review, intended for non-specialists and those with an interest in promoting environmental responsibilities, considers the number and range of household chemicals. It is confined to products that are deliberately added to water (such as cleaning agents), substances that find their way into water indirectly (such as cosmetics or pharmaceuticals) and those that are not intended to reach water bodies but often do (such as automotive fluids and garden chemicals). The review considers the risks these chemicals may pose to the aquatic environment and our water resources, and the means of controlling these risks. Our aquatic environment includes rivers, streams, lakes, underground aquifers and the sea. These water bodies receive water run-off and percolation from farmland, moorland and urban areas; they may also receive wastewaters treated in sewage and other effluent treatment plants. If the run-off, percolated water or wastewater is polluted the receiving water may be affected rapidly and obviously (e.g. the death of all fish in a river reach by chemicals at toxic levels). However, effects may be less obvious and long-term, affecting the growth and diversity of plants and aquatic fauna; an example is the feminising of fish, which has been reported as a result of the so-called endocrine disruptor chemicals (Ref. 1). Furthermore, some chemicals may jeopardise the use of water bodies in the environment, such as for drinking-water supply, recreational bathing or water sports.

Ninety four per cent of the UK population is connected to a sewer (Ref. 2). A small percentage of households are connected to septic tanks which discharge directly to the environment and which may or may not eventually connect with water bodies. Following treatment, approximately one-third of sewage is discharged to the sea via

outfalls and the remaining two-thirds is discharged to rivers and streams. The substances put down the drain by domestic households are therefore of considerable interest as far as the aquatic environment is concerned. Household chemicals are also of considerable interest to the companies and other organisations in the UK who have the responsibility for treating sewage to the standards required to protect our environment and to the environmental regulators who ensure compliance with these standards (Ref. 3).

However, it is not only water companies who may be concerned by the ever-growing number of substances which are being introduced into households and industry; it must be a matter of concern to all of us. Ever since Rachel Carson's book *Silent Spring* was published fifty years ago (Ref. 4) we have become gradually aware that, despite the clear benefits brought to society by the development and use of a wide range of chemicals, there can also be problems associated with their increasing use. As a consequence, a Royal Commission undertook a study on the long-term effects of chemicals in the environment, which culminated in a report (Ref. 5) where it was noted that:

"The developments in the chemical industry during the last 100 years have brought spectacular benefits to mankind, helping to improve health care and increase agricultural yields, not to mention countless other products that make our lives easier. On the other hand, the manufacture and use of chemicals can create risks to humans and the natural environment, many of which are poorly characterised."

Other regulators throughout the world have also recognized the problem of many chemicals potentially being present in the environment with little information being available on their toxicity or fate and behaviour. For example, the European Union have brought into force the REACH (Registration, Evaluation, Authorisation and restriction of CHemicals) regulation in an effort to collect basic information on chemicals manufactured and used in Europe (see Section 4 for further details).

2 What, and how many, household chemicals could enter the water environment?

On first considering the matter, it might seem that the average household does not discharge many chemicals down the waste pipe or to water bodies. However, it is estimated that there could be as many as 30,000 different chemicals that may be found in products intended for household use. Examples of the range of chemical products that may be found in households are shown in Table 1

Personal care/hygiene products	Make-up, soap, shampoo, hair colourants, perfumes, aromatherapy oils etc
Cleaning agents	Polishes, floor-cleaners, oven-cleaners, washing- machine & dish-washer detergents etc
Pesticides/Fungicides for use in the house	Rat poison, fly-killer, anti-fungal cleaning agents etc.
Home maintenance materials	Paints, strippers, cleaning agents, varnish, wallpaper adhesives, air fresheners and room odourisers etc.
Garden chemicals	Fertilisers, herbicides, pesticides, slug/snail killer, animal repellents
Non-prescription medicines	Aspirin, paracetamol, TCP etc.
Prescription medicines	MHRA[1] approved active ingredients.
Automotive fluids	Fuel, lubricating oils, anti-freeze, windscreen washer fluids, brake fluids etc.
Other	Candles, odour-products (e.g. pleasant-smelling sprays etc), odour-prevention products, vaporising products, swimming pool chemicals, barbecue products etc.

Table 1: Household chemicals that could enter water bodies

3 What are the concerns about chemicals in household products?

The Royal Commission's report (Ref. 5) on "Chemicals in Products: Safeguarding the Environment and Human Health" goes into considerable detail on the matter of chemicals in products in its 291 pages. There is no doubt that some chemicals can contaminate parts of the environment by causing harm to plants, animals and human beings. For example, pesticides are useful in protecting crops and helping to increase agricultural yields, but in excess or in the wrong place (such as in drinking water supplies) they have the potential to affect adversely the health of animals and human beings. Examples of this are discussed in some detail in another publication in this series, concerning "Endocrine Disrupters in the Environment" (Ref. 1).

It is natural that our major concerns about household chemicals centre on whether they pose an immediate threat to human health, either by contact with the skin, swallowing or inhalation. For example, hair colourants carry the warning that they should first be tested for an allergic reaction on a small area of skin. Accidental ingestion of a household product is also of concern and all potentially poisonous

[1] Medicines & Healthcare products Regulatory Agency

substances carry an appropriate warning. Some detergents contain corrosive chemicals and the packets carry warnings to *'avoid contact with the eyes and skin'*, and *'if swallowed seek medical advice immediately'* and the user is advised not to use them for hand washing. Such packets will carry a hazard-warning symbol.

Some substances are flammable such as cigarette lighter fuel, fuels for barbecues and cleaning substances such as paraffin and methylated spirit (which is methanol containing a dye and pyridine to make it unpleasant to drink) and carry appropriate flammability and ingestion warnings.

The symbols in Figure 1 are those specified in European legislation to be used on the packaging of any chemicals or products sold for use in the household. They are incorporated in UK legislation by the so-called CHIP Regulations (see next section on regulation). These will change to the Classification, Labelling and Packaging (CLP) style pictograms under the CLP regulation, which will be fully implemented in 2015 (Figure 2). Full definitions of the different categories are given in the Appendix.

Explosive		Corrosive		Very toxic or toxic	
Oxidising		Harmful or irritant			
Extremely or highly flammable		Dangerous for the environment			

Figure 1: The symbols used as indications of danger and for hazardous substances and preparations (specified in the CHIP Regulation, Ref. 6)

Explosive		Corrosive		Very toxic or toxic	
Oxidising		Harmful or irritant		Longer term health hazards	
Extremely or highly flammable		Dangerous for the environment			

Figure 2: The symbols used as indications of danger and for hazardous substances and preparations (specified in the CLP Regulation, Ref. 28)

We also need to consider the water environment, as something we need to preserve and protect, and as a resource. Even if there is no short-term problem, some substances may bio-accumulate in aquatic plant or animal life resulting in long-term problems. DDT, for example, is relatively non-toxic for human beings but there are long-term effects on wildlife, which did not appear for many years after the insecticide was introduced (Ref. 1 & 4).

Fortunately, domestic treated sewage is a dilute wastewater in comparison with many industrial effluents, and many of the toxic chemicals in household products are sufficiently diluted when present in sewage so they aren't acutely toxic - i.e. their concentrations are mostly below the level at which they are immediately toxic. However, the discharge of treated sewage is normally a continuous process, so even if the small quantities of toxic substances in the sewage are degraded in the environment, there may be a constant long-term exposure to them. Furthermore, if there is any tendency to bio-accumulate, continuous exposure to small concentrations may in the long-term result in potential risks.

The water industry has a particular interest in household chemicals because, as noted in the introduction, most households are connected to a sewer, which means that any household chemicals discharged to drain are conveyed to the sewage treatment plant where they may cause the following problems:

- Interference with the proper operation of the treatment plant.
- Contamination of the treated sewage, which is discharged into the water environment.
- Contamination of a receiving water used to abstract water for drinking purposes and thus causing a problem for the drinking water treatment plant.
- Contamination of the sludges produced as a by-product of sewage treatment thus posing a problem for the subsequent disposal of the sludges. The best example of this is the presence of zinc in sewage: the dominant source of zinc in sewage is the domestic household (Ref. 15). This derives mainly from healthcare products and cosmetics.

Water to be treated for drinking water purposes is frequently abstracted from bodies of water into which sewage, fully treated in accordance with regulations, is discharged. Chemicals from agricultural, industrial and commercial sources may also affect these water bodies. This potential problem has been one of the factors in the widespread introduction by the water supply companies in England & Wales of activated carbon treatment (which adsorbs a wide range of chemicals) at drinking water treatment plants. Ozone may also be used which can help to improve the effectiveness of the removal of chemicals.

4 Regulation of chemicals

REACH (Registration, Evaluation, Authorisation and restriction of CHemicals) is an EU regulation that entered into force in June 2007 (Ref. 31). It replaces over 40 previous chemical regulations in Europe. REACH aims to fill the void of chemical hazard and risk knowledge and subsequently to restrict the use of, or eliminate, harmful chemicals.

The European CHemicals Agency (ECHA, based in Helsinki, Finland) oversees the implementation of REACH. Competent Authorities (CAs) are based in each European Member State. The CAs oversee the running of REACH in their respective country and provide guidance on the regulation.

Any substance that is manufactured or imported into the UK, at >1 tonne/annum, must be registered. Certain exemptions do apply (e.g. food additives). Registration requires the manufacturer or importer to supply certain details about the substance. Physico-chemical, mammalian and ecotoxicity data are required, as is a risk assessment of the use of the chemical. The data required increase with increasing tonnage production. The tonnage bands are 1-100T, 100-1000T and >1000T. Substances manufactured in quantities >10 tonnes require a Chemical Safety

Report (CSR). This is an evaluation of the data and recommended risk management measures.
If a substance was already on the market when REACH entered into force, the manufacturers/importers could pre-register it. They then can take advantage of delayed registration dates. These are 2010 for >1000T, 2013 for 100-1000T and 2018 for 1-100T. However, substances deemed to be of great hazard (e.g. carcinogens, mutagens or reproductive toxicants; or substances deemed to be persistent, bioaccumulative and toxic in the environment) are to be registered in 2011, regardless of tonnage manufacture/import.

Once a substance has been registered, its dossier is evaluated for completeness. Member States may also elect to evaluate a substance and complete an additional, thorough, hazard and risk assessment of the substance (e.g. if they deem it to be particularly hazardous).

Member States may recommend that substances be placed onto Annex XIV. This is a list of substances that will potentially be subject to Authorisation. Authorisation requires a manufacturer or importer of a substance to make an application to use the substance on a case-by-case basis. They can use the substance if approval is granted. Previously, substances of high concern were restricted, and these restrictions are still applicable. Restrictions are generic conditions of use and apply to all users.

The Classification, Labelling and Packaging (CLP) Regulation is directly-acting in all EU Member States, requiring no national transposition. Its provisions will be phased in over a period of years until 1 June 2015 when the Regulation will be fully in force. This is intended to help suppliers and users of chemicals change from the current EU classification and labelling system to the new Globally Harmonised System (GHS)-based system.

The Regulation provides a transition period to allow a gradual migration from the existing system to the new regime. This transition period is up to 7½ years (the Regulation will apply to the classification of substances from 1 December 2010, and to the classification of mixtures from 1 June 2015). The transitional period will end on 1 June 2015 when the CLP Regulation enters fully into force.

A number of approval schemes have been developed separately for specific groups of products, some of which are used in the home or garden.

Medicines are regulated by The Medicines and Healthcare Products Regulatory Agency, (Ref. 8) which produces an Approved List of Active Ingredients for

Medicines. The prime concern of the Agency is the efficacy of medicines and their safety with respect to human health. However, the Community code relating to medicinal products for human use (Ref. 9) requires that manufacturers should indicate risks to the environment that arise from use, storage and disposal of the medicine. Consequently, since 1995, marketing authorisation applications for medicines were required to have an environmental risk assessment (ERA) when presented to the MHRA or other agencies recognised by the European Medicines Evaluation Agency. Prior to 1995, it is unlikely that any medicinal product will have been subject to an ERA. A similar set of regulations exists for veterinary medicines.

The Chemicals Regulation Directorate (CRD) of HSE (Ref. 10) administers the Biocidal Products and Pesticide Regulations (Ref. 11). Pesticides can be defined as any substance, preparation or organism prepared or used for controlling any pest. A Plant Protection Product (PPP) is a type of pesticide that is used for agricultural purposes. PPPs protect plants or plant products against all harmful organisms or prevents the action of such organisms (for example agricultural/horticultural fungicides and insecticides). They can also influence the life processes of plants, other than as a nutrient (for example as a growth regulator). Others preserve plant products, and some destroy undesired plants or destroys parts of plants or checks or prevents the undesired growth of plants (for example herbicides) (Ref. 10).

Recently, the regulation of pesticides in the EU changed, with the introduction of an EU Thematic Strategy for Pesticides. This comprises:

- Regulation (EC) No 1107/2009 (PPPR), replacing the Plant Protection Products Directive 91/414/EEC. This applies from June 2011;

- the on-going review programme under Directive 91/414/EEC;

- the Sustainable Use of Pesticides Directive (2009/128/EC), which sets specific measures to protect the aquatic environment and drinking water from the harmful effects of pesticides;

- the Statistics Regulation (1185/2009/EC), that prescribes the collection of data on the sale of pesticides (starting in 2011) and five yearly usage data; and,

- an amendment to the Machinery Regulation (2009/127/EC), allowing new spraying equipment to be certified.

In addition to banned substances, large numbers of substances have been withdrawn following reviews. This may be for reasons of safety or because companies took commercial decisions not to support substances through the review process. National reviews have been conducted in the UK in the past, followed by reviews at European Commission level under Council Directive 91/414/EEC. This has now been replaced by Regulation (EC) No 1107/2009.

Biocidal products are defined as chemicals or micro-organisms, or mixtures of either or both, intended to control unwanted organisms, such as animals, insects, bacteria, viruses and fungi. The products covered by these Regulations are widely used in the home (and industry). They include: wood preservatives, public hygiene insecticides, rodenticides, surface biocides and antifouling paints. Typical household biocides include disinfectants and fly sprays. However, some categories of product are excluded from the Regulations, notably medicines (see MHRA above) and products used to kill weeds or protect plants from pests (see below).

The Biocidal Products Regulations implement the Biocidal Products Directive of the European Union (Ref. 12). This Directive will progressively replace the current UK national approval scheme for non-agricultural pesticides under the Control of Pesticides Regulations 1986 (as amended). It establishes a single European market in biocides by introducing a harmonised authorisation system based on assessment of risks to people and the environment, together with consideration of efficacy. Ultimately only those biocidal products that contain an active substance included in Annex I of the Directive will be authorised for use. When the Directive has been fully implemented in all Member States, existing and new active substances will have to be evaluated to ascertain whether or not they will be included in Annex I. Once an active substance has been included in Annex I, national Competent Authorities can authorise products containing it in individual Member States (providing that any necessary data have been supplied and any conditions put on Annex I inclusion are met). The review of existing active substances is expected to last 10 years and will be controlled by a series of Commission Regulations.

Biocides and pesticides are both designed to be toxic to target organisms in the environment; it follows that they have greater potential than many other household chemicals to pollute and damage the environment. Therefore, it is important to understand that the schemes operated by the HSE provide reassurance about the safety of the approved pesticides and biocides if, and only if, they are used in accordance with the instructions given on the label.

5 Personal Care Products (also known as body care products)

Personal Care Products (PCPs) are applied to the external body for cleaning, protecting and keeping it in good condition and consist of a diverse range of products (from baby products to hair colourants), which include fragrances, lotions and cosmetics.

As an example of how many different substances may be found in household products, consider a bottle of ordinary shampoo bought in a supermarket. The ingredients shown in Box 1 are listed on the label.

Methylchloroisothiazolinone and methylisothiazolinone are biocides and may not be fully biodegradable in a sewage works. In reality the concentration of such substances will be so low in the total wastewater entering the sewage treatment works that they will be unlikely to pose a problem at the works nor in the discharged treated sewage.

Relatively small polar molecules may not be effectively removed via waste water treatment (e.g. removal efficiencies for synthetic musks were demonstrated to be 72-98% removed, but metabolites of galaxolide (another PCP perfume) increased during treatment) or drinking water treatment (N,N-diethyl-meta-toluamide (DEET) found in insect repellant, and tonalide (another musk) were substances most frequently detected in finished water) (Ref. 14).

Box 1

Sodium laureth sulphate	Benzoic acid
Sodium chloride	Lamium album
Cocamidopropyl betaine	Hedera helix
Ammonium lauryl sulphate	Lavandula angustifolia
PEG-7	Methylparaben
Glyceryl cocoate	Sorbitol
Cocamide DEA	Methylchloroisothiazolinone
Propylene glycol	Citric acid
Glycerine	Methylisothiazolinone

The ingredients for a heavy-duty hand-cleaner are listed in Box 2. Polyethylene is not biodegradable although chemically it is relatively inert. Again, its concentration will be low and unlikely to pose a problem at a sewage treatment plant, and it would almost certainly be removed with the sludge. Since it is inert it is unlikely to

have any impact if the sludge is applied to farmland, and would be of no significance if the sludge were incinerated.

Box 2

Aqua	Trideceth-10
Dimethyl Gluturate	Benzyl Alcohol
Polyethylene	Methylchloroisothiazolinone
Dimethyl Adipate	Methylisothiazolinone Dimethyl
Succinate	Perfume
Xanthan Gum	CI 42090
Propylene Glycol	

As the two lists show, a wide range of chemicals and mixtures of chemicals are used in body-care products. Many are of natural plant or animal origin, but also many are now manufactured synthetically. More than 5,000 different chemicals are used in the manufacture of perfumes (Ref. 16), and in a survey conducted in 2010, the International Fragrance Association (IFA) identified 3,194 fragrance compounds currently in use in consumer goods worldwide (Ref. 29).

Some of the fragrance chemicals used in soaps, shampoos and other household products are not readily biodegradable, although the concentration in which they reach waste aqueous discharges is generally too low to pose a risk to the operation of wastewater treatment plants. However, many can also bio- accumulate in aquatic wildlife e.g. shellfish (Ref. 17), especially in commercial shellfisheries downstream of wastewater treatment plants whose discharges may carry these chemicals in trace quantities.

Zinc oxide and zinc stearate are used in the manufacture of face powders. As noted previously, domestic households are a major source of zinc in sewage and the sludge that has to be disposed of from sewage treatment works, and these body-care products are the major cause (Ref. 15). This creates a problem for the water industry since the zinc concentrations in the sewage sludge may limit its recycling on agricultural land (Ref. 18).

6 Cleaning agents

Domestic cleaning products include washing powders and liquids, fabric conditioners, bar soaps, hand and machine dish wash products, household disinfectants, hair care and polishes and specialist cleaners for use in kitchens and bathrooms. Substances used include surfactants, lipophilic care components and emulsifiers, fruit acids and solvent alcohols, polymers, preservatives, fragrance

enhancers, dyestuffs, ultraviolet filters, perfume oils and propellants. In 2004, the European Commission Regulation (EC) No 648/2004 on detergents came into force, which aims to ensure that safe products are placed on the market.

The most common cleaning agents are the detergents used for dishwashers and the household laundry (Ref. 30). A review (Ref. 19) lists 45 different chemicals or groups of chemicals (e.g. perfumes), which are used in the manufacture of laundry detergent products. Many of the chemicals listed are not fully removed in a wastewater treatment plant. Household detergents include alkyl benzene sulfonates, the alkyl phenoxy polyethoxylates (e.g. nonyl phenoxy ethoxylates), diethanolamine and triethanolamine, all of which exhibit varying levels of degradation. Alkyl glucosides, which are quickly biodegraded, are also used.

These cleaning agents usually contain phosphate, which can be removed by biological wastewater treatment processes, but there is always a residual quantity in the discharge. Phosphates can cause eutrophication of natural waters in which excessive growths of algae occur leading to a reduction in biodiversity and water quality (Ref. 20). In 2010, the European Commission issued a Draft Decision banning phosphates in laundry detergents (Ref. 21). It is hoped that limiting phosphates and others phosphorous compounds in household laundry detergents will reduce the contribution of phosphates from detergents to eutrophication in EU waters and will reduce the cost of phosphorous removal in waste water treatment plants.

Another important group of cleaning agents (which are also used in home maintenance) are solvents such as acetone, turpentine, white spirit and methylated spirit. Small quantities of these non-chlorinated solvents are generally biodegradable and would not pose a treatment problem if put into the sewer, although the accumulation of flammable (and potentially explosive) vapours could create a hazard.

7 Pesticides, Biocides and Garden Chemicals

The terms 'pesticides' and 'biocides' have been described in the section dealing with regulation of chemicals. They cover a wide range of functional products and include herbicides, fungicides, insecticides, rodenticides, soil-sterilants, wood preservatives, surface biocides and disinfectants among others. The range of applications include the following:

- home garden (amateur gardening);
- animal husbandry;
- food storage practice;

- vertebrate control (including rodenticides and repellents);
- domestic use;
- wood preservation;
- as a surface biocide;
- public hygiene or prevention of public nuisance;
- other industrial biocides;
- as an anti-fouling product;
- 'other' (as may be defined by Government Ministers).

The common garden slug Arion hortensis feeding on a green leaf
© Adam Hart-Davis / Science Photo Library

Only products that have been formally approved under the appropriate legislation (see section 4) and registered by the HSE (Ref. 10) can be used in the UK. The approval specifies the particular applications for each pesticide or biocide, and only applies if the product is used as specified on the label.

New approvals are being made all the time and are published monthly in The Pesticides Register (Ref. 22). The total number of products approved for amateur use was, at the time of writing, 672 (Dec. 2012) out of a total of 3456 products on the approved pesticides database. Different products may contain the same active ingredients (for example, a sample survey revealed five different brands of weedkiller, which were all preparations of glyphosate [2]).

[2] Chemical name: N-(phosphonomethyl)glycine; developed by Monsanto, no longer covered by patents, and therefore available for use by any manufacturer of weedkillers

.

There are around 300 active ingredients approved for all uses that can be used in pesticide products, so there will be far less approved for garden and household use.

The most commonly used domestic weed killers are glyphosate and sodium chlorate. Glyphosate is strongly adsorbed to soil where it slowly biodegrades (Ref. 23) and so represents little threat to the water environment in domestic use unless it is disposed of down the drain. In water it is toxic to fish and other aquatic life.

The range of chemicals in fertilisers includes potassium nitrate, magnesium sulphate (Epsom salts), ammonium sulphate and also some metals such as copper combined with the chelating agent ethylene diamine tetra-acetic acid (EDTA). Garden fertilisers represent little or no hazard for wastewater treatment plants; indeed they may provide nutrients for the bacteria in the plant. Furthermore, as noted above, sewage is a very dilute form of wastewater so any concentrations arising from disposal via the drain are likely to be low.

Pesticide and garden chemicals should carry a MAPP (Ministerially Approved Pesticide Products) number on the label. Information on the product, including the chemicals it contains, can be found by undertaking a search on the HSE website using this number. Most labels carry risk information and there should also be an appropriate hazard symbol.

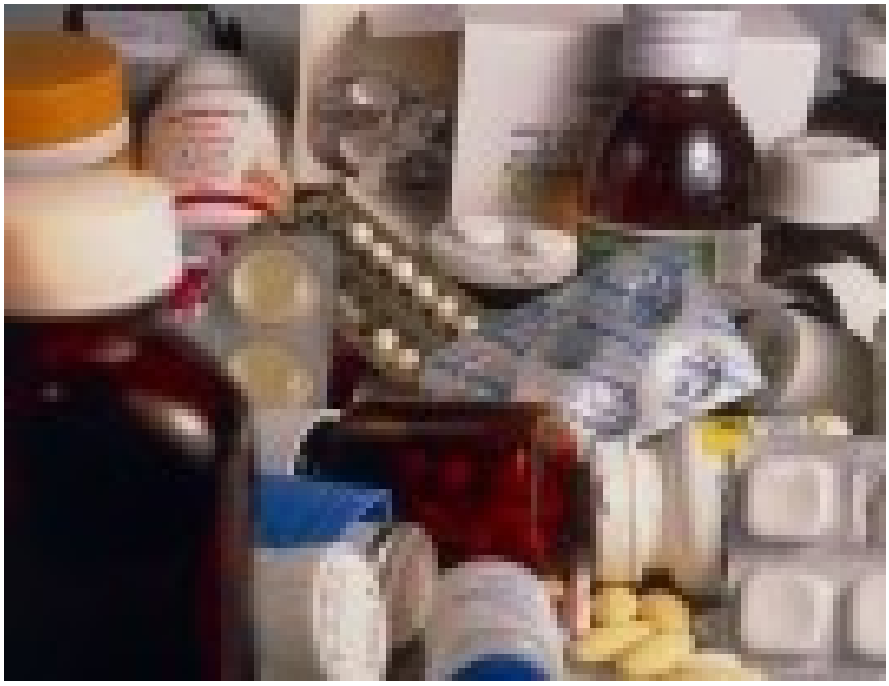
Surplus pesticides from householders' homes or gardens are classified as hazardous household waste. Section 51 of the Environmental Protection Act 1990 places a duty on waste disposal authorities to provide places (usually known as Civic Amenity sites) where people resident in that area may bring items of household waste for disposal. Waste disposal authorities must make special arrangements for safe disposal of hazardous household waste including providing some places to which this waste can be brought free of charge. These places must be properly licensed by the Environment Agency so that they can dispose of the material safely.

The Crop Protection Association has produced a number of publications regarding pesticide use, available from their website (Ref. 24). The Pesticide Action Network UK (PAN) is another organisation that provides information on pesticides; their website (Ref. 25) provides a list of local council facilities for disposal of pesticide waste.

8 Prescription and Non-Prescription Medicines

The active ingredients used in drugs and medicines in the UK are approved for use by the Medicines and Healthcare Products Regulatory Agency (MHRA) who keep a list of the approved chemicals (see section on regulation of chemicals).

This indicates that there are over 5,000 different chemicals that may get into the sewer, the great majority of which are biologically active.



Expired Medicines. Assortment of old medicines and pills that have passed their sell-by date
© Cordelia Molloy / Science Photo Library

Many chemicals, such as ascorbic acid (vitamin C) pass through the body unchanged, even though they have a biological effect whilst they are present in the body, so virtually all the ascorbic acid taken orally will get into the sewer. Fortunately ascorbic acid is non-toxic and poses no environmental risks. However, some active chemicals such as oestrogens can also pass through the body unchanged and also through wastewater treatment plants relatively unchanged. If the effluent is discharged to a water body used as a source of drinking water there is natural concern that this could affect human health. The Drinking Water Inspectorate (DWI) for England & Wales has issued Consumer Advice leaflets on endocrine disrupters and pharmaceuticals (Ref. 26). These state that there is no evidence whatsoever that EDCs pose a risk to human health through drinking

water. They also state that studies have confirmed the presence of residues from a wide range of common pharmaceuticals in sewage effluents and that residues have also been detected in rivers downstream of sewage effluent discharges, but almost always at concentrations of less than 1µg/l (a very low level). The Consumer Advice leaflets provide reassurance that processes applied to the treatment of raw water sources containing sewage effluents is effective at the removal of oestrogens and other pharmaceutical residues.

There is also concern that the release of antibiotics into the environment via the drain and wastewater treatment plants could induce the development of resistant strains of bacteria and other unforeseen long-term effects. In a Defra project for the Drinking Water Inspectorate in 2007, a desk-based estimate was carried out to estimate the potential concentrations of pharmacueticals in drinking water in comparison with therapeutic doses used in medicine. The results showed a high margin of safety for commonly used pharmaceuticals (Ref. 27).

The Health Services recognise the dangers of disposing of unwanted chemicals by throwing in the refuse bin or by flushing down the toilet. For this reason, and because of the potential dangers of medicines stored in the home, most local pharmacies will accept medicines for safe disposal (usually by incineration at over 1000 °C to ensure no active medicine remains).

9 Future developments

Currently, there is much interest in the presence of pharmaceuticals, PCPs and other household chemicals in environmental and drinking water. Large scale monitoring exercises currently taking place world-wide should enable an accurate assessment of potential damage to human health and the environment.

10 Concluding remarks

As can be seen from Table 1, there are many other products and chemicals in addition to those specifically discussed above. Some of these pose problems for the water industry, for example the dumping of used engine oil down the drain by amateur car maintenance enthusiasts, or the pouring of used white spirit or turpentine down the lavatory by householders after DIY painting. Sometimes this can pose a real risk to the environment as in the case of significant quantities of unwanted pesticides or biocides.

It is clear that the average household will contain many chemicals that are hazardous and pose potential risks to health or the environment or to the

organisations treating our domestic aqueous discharges. Legislation, much of it being driven by the European Union, is addressing many of the products, such as detergents, that are necessarily added to water and enter our domestic wastewaters. Unfortunately, the lavatory or drain is frequently used as a convenient way to dispose of other unwanted household chemical products. However, waste disposal authorities have a duty to provide places (usually known as Civic Amenity sites) where people resident in that area may bring items of household waste for disposal. We all have a responsibility to use such facilities and heed the advice concerning safe disposal of hazardous chemicals and *"Never dispose down lavatories, drains or near ponds, watercourses, ditches or near wildlife habitats"* (Ref. 24).

The paucity of information on the toxicity, fate and behaviour in the environment of many of the 1000s of chemicals which are used in everyday life is now being increasingly accepted by both scientists and regulators. This includes the need to have knowledge of the entire life cycle of chemicals from the synthesis and production procedures through to the disposal and fate and behaviour in the environment. The European Union has led the way in beginning to address this with its REACH regulation as a first step in collecting basic information on chemicals used and produced in Europe.

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APPENDIX

HAZARD DEFINITIONS

From Schedule 1 of The Chemicals (Hazard Information and Packaging forSupply) Regulations 2002 SI 2002 No. 1689 (the "CHIP" Regulations). These will gradually be replaced with CLP definitions.

PHYSICO-CHEMICAL PROPERTIES

Explosive
Solid, liquid, pasty or gelatinous substances and preparations which may react exothermically without atmospheric oxygen thereby quickly evolving gases, and which under defined test conditions detonate, quickly deflagrate or upon heating explode when partially confined.

Oxidising
Substances and preparations which give rise to a highly exothermic reaction in contact with other substances, particularly inflammable substances.

Extremely Flammable
Liquid substances and preparations having an extremely low flash point and allow boiling point and gaseous substances and preparations which are flammable in contact with air at ambient temperature and pressure.

Highly Flammable
The following substances and preparations, namely

(a) substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy,
(b) solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition,
(c) liquid substances and preparations having a very low flash point, or substances and preparations which, in contact with water or damp air, evolve extremely flammable gases in dangerous quantities.

Flammable
Liquid substances and preparations having a low flash point.

HEALTH EFFECTS

Very toxic
Substances and preparations which in very low quantities cause death or chronic damage to health when inhaled, swallowed or absorbed via the skin.

Toxic
Substances and preparations which in low quantities cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin.
Harmful
Substances and preparations which may cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin.
Corrosive
Substances and preparations which may, on contact with living tissues, destroy them.
Irritant
Non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, may cause inflammation.

ENVIRONMENTAL EFFECTS

Dangerous for the environment
Substances and preparations, which, were they to enter into the environment, would present or might present an immediate or delayed danger for one or more components of the environment.

N.B. Preparations
CHIP requires that preparations (mixtures of substances, e.g. paints andadhesives) be classified for environmental effects.

N.B. Substances
CHIP requires environmental classification of substances (single chemicals). This is done by obtaining relevant data on a substance and then comparing it to criteria set out in the Approved Classification and Labelling Guide. There is no requirement to carry out tests.

The ACLG divides environmental effects into two categories:

- damage to the aquatic environment (which in turn divides into 2 subcategories)
    - acute damage
    - long term damage
- damage to the ozone layer

(A third category - damage to the terrestrial environment - exists, but criteria for its application are still being agreed.)