The Royal Society of Chemistry (RSC) welcomes the opportunity to respond to the House of Commons Science and Technology Committee's inquiry into *Water Quality.*

1. The RSC is the largest organisation in Europe for advancing the chemical sciences. Supported by a network of 47,000 members worldwide and an internationally acclaimed publishing business, its activities span education and training, conferences and science policy, and the promotion of the chemical sciences to the public. This document represents the views of the RSC. The RSC has a duty under its Royal Charter "*to serve the public interest*" by acting in an independent advisory capacity, and it is in this spirit that this submission is made.

2. The RSC believes that chemicals for control in water discharges must be identified through a thorough environmental risk assessment process. The development of legislation to control such chemicals must be produced with appropriate scientific advice to ensure that it is based upon sound scientific evidence. Where necessary a cost-benefit analysis of options for control should be applied. In advance of taking measures to control specific substances, it is important to consider the following questions:

- What is the extent of the problem? If more substances are identified for control, then understanding how widespread these substances are will be important in determining a solution.
- If further treatment is required, does the cost-benefit analysis suggest that this is the best option?
- What is the fate of chemicals that are removed by treatment? Are they broken down into harmless 'daughter' products or do the daughter products represent a separate hazard?
- In the case of pharmaceuticals, what would be the impact of the withdrawal of the medicines in which the specific substances are used?

Much more research is need into the list of proposed substances before adopting a treatment based solution.

What chemicals should be controlled in water discharges, what should the acceptable thresholds be and how are these chemicals currently controlled?

3. *Chemicals to be Controlled*
Chemicals to be controlled in water discharges cannot be listed in an arbitrary fashion. They need to be identified by a thorough environmental risk assessment process that takes account of the toxicity to the aquatic environment, human toxicity and persistence. This needs to be achieved within a risk framework that takes account of any potential synergistic or antagonistic effects of hazardous substances.[1] Both spatial and temporal consequences must be considered. Effects from long-term, low dose, exposure must be examined, as well as short-term exposure to higher doses. The fate and transportation of such substances must also be investigated. If the substances in question can be broken down into other products, these 'daughter' products must also be taken into consideration. Such assessments are currently applied to understand the risk that various substances or processes pose throughout the environment, in air, water and on land.

4. The process of environmental risk assessment must consider both the hazard and risk of the substance.[2] The differentiation between these two terms is important. Hazard is the inherent potential for something to cause harm, whilst risk is the likelihood that harm will actually be done by the realisation of the hazard. Chemicals should not be selected for control on the basis of hazard alone. In other words, it

[1] - Environment, Health and Safety Committee Note on: Pragmatic Approaches to Assessing the Toxicity of Chemical Mixtures, Environment, Health and Safety Committee of the RSC, May 2012

[2] - Environment, Health and Safety Committee Note on: Environmental Risk Assessment, Environment, Health and Safety Committee of the RSC, April 2008

should be emphasised that it is the *overall* risk from substances that is the key parameter in deciding what chemicals should be controlled in water discharges. The overall risk takes into account not just the intrinsic hazard of substances but also, crucially, the likelihood of a significant exposure to these substances in water.

5. *Acceptable Thresholds and Current Controls*
Acceptable thresholds for chemicals that need to be controlled are currently derived from the Environmental Quality Standard (EQS) for that substance, alongside consideration of the environmental sensitivity of the receiving water (e.g. are there any protected species present?) and the downstream use of the source (e.g. public supply, irrigation of crops). Limits should be set with specific parameters, based on the best available scientific data and an understanding of current detection techniques.

What are the roles of the public, industry, regulators and Government in ensuring chemicals that pose a risk are effectively controlled?

6. The government must produce appropriate legislation to ensure that substances which pose a risk to the environment and/or human health are identified and controlled. This legislation must be developed with appropriate scientific advice to ensure that it is based upon sound evidence. This can include advice from the network of Chief Scientific Advisers, as well as specialist committees. Committees such as the UK Chemical Stakeholder Forum and the Hazardous Substances Advisory Committee are important mechanisms in providing scientific advice in relation to the management of chemicals in the environment.

7. In general, the role of regulatory agencies includes identifying issues in the discharge of controlled chemicals, proposing limits, providing advice, ensuring monitoring is undertaken and enforcing regulations. As part of their role in constructing and enforcing regulation, they have a role in providing input on the efficacy of such regulations.

8. Industry can take a lead in eliminating the use of particularly hazardous chemicals by identifying ways to reduce, replace or substitute these. A 2010 workshop on *Pharmaceuticals in the Environment* by the European Environment Agency identified 'green pharmacy' as one way of reducing the environmental impact of pharmaceuticals. Green pharmacy is defined as *the design of pharmaceutical products and processes that eliminate or reduce the use and generation of hazardous substances.* The report suggests that incentivising green pharmacy (e.g. extending patents for such products) could help to reduce the environmental impact of pharmaceuticals. Industry is also required to comply with national regulations and European directives.

9. The general public have a limited role in the control of chemical risks, but they can be encouraged to minimise the use and discharge of hazardous chemicals (see paragraph 11).

Should pharmaceuticals in water discharges be better controlled and if so, how could this be achieved?

10. A better understanding of the scale and effects of pharmaceuticals in water discharges is needed before determining control measures. The term "pharmaceuticals" covers a multitude of widely differing chemicals. Each pose a different level of potential risk to the environment, and consequently need to be individually assessed. The discharge of pharmaceuticals occurs *via* three main routes; manufacture of pharmaceuticals, human health use and veterinary health use, which need to be considered separately.

11. A wide range of pharmaceutical products, particularly antimicrobials, is administered to livestock and then can pass directly into the aquatic environment *via* run-off from

fields, bypassing wastewater treatment plants. Before investing money in upgrading wastewater treatment processes to remove pharmaceuticals, it may be prudent to examine the relative contribution from domestic and industrial wastewater of human origin and that coming directly from livestock. Encouraging the correct disposal of unused pharmaceuticals by the public is important. One option would be to include a prominent warning on pharmaceutical packaging that unused items must be returned to the pharmacy for safe disposal.

12. There is a particular concern over the discharge of antimicrobial agents that has less to do with the ecotoxicity of these substances and more to do with the propensity of bacteria exposed to such agents to develop and then exchange antibiotic resistance genes. Assessing the levels of antimicrobial agents already in the aquatic environment and their effect on antibiotic resistance is an area of research that needs to be given some priority. Moreover, it has been shown that the over-prescription of antibiotics is a significant factor in decreasing the effective treatment of bacterial infections in humans and also detrimental effects in the aqueous environment with respect to antibiotic resistance of wild-type bacteria.

13. Industrial discharges in relation to the manufacture of pharmaceuticals are another area where control can be exercised and there are already mechanisms by which to achieve this. The EU directive on Integrated Pollution Prevention and Control is included as part of UK environmental permitting regulations for all industrial activities, including the manufacture of pharmaceuticals. The inclusion of ecotoxicity and biota impact limits for industrial discharges can also assist with controlling discharges relating to pharmaceutical manufacture.

14. Clearer monitoring standards within EU directives could lead to more consistent controls for the discharge of hazardous substances. The 2008 EU directive 2008/105/EC on environmental quality standards in the field of water policy allows member states a choice of matrix when monitoring some substances, taking into account that different measurement techniques are available in different member states. These are the biota standard (measurement in organisms) and the water environmental quality standard (measurement in the body of water). However, this can lead to the same environmental situation giving rise to different assessments. For example, if a substance is liable to bioaccumulation, then using a biota standard may result in a bad environmental assessment, whilst applying the water environmental quality standard will result in a good environmental assessment. There is a need to strike a balance between considering best available techniques and setting clear and transparent standards. It may be appropriate to set the matrix for selected substances where such discrepancies occur.

To what extent is innovation in water treatment supported in the UK? How successfully is innovation shared across the UK and the EU?

15. Currently, there is significant activity within the UK water industry to encourage innovation. Most companies have a research and development budget and a good level of cooperation with academia. National organisations such as UK Water Industry Research aim for a strategy that is innovation-led. However, the lack of a national testing facility for new water treatment technologies is a critical barrier, as even when innovative technology is developed, it cannot be demonstrated. An additional hurdle in the early adoption of innovative technology from small and medium enterprises (SMEs) is the financial regulatory framework. This currently requires companies to define significant capital expenditure five years in advance, which can hinder the uptake of new technology.

16. There are a number of other potential obstacles to the adoption of new technology, including the variability in water (e.g. upland, surface, river or groundwater), wastewater types (e.g. domestic, industrial or mixed waste), the regulatory framework and variability in upstream treatment processes. Due to the lack of a national testing

facility, once a new technology has passed proving and pilot stages, it must be assessed in real scenarios. This requires incorporation into working water treatment systems, which can carry regulatory, operational and public health risks, which must be managed.

17. Non-technological innovations can help achieve sustainability objectives and protect water quality. For example, land management practices to reduce diffuse pollution and flooding have been adopted successfully across some parts of the UK (e.g. in Wales and Scotland). These catchment based approaches often have synergistic environmental, economic, societal and landscape benefits.

18. The European Commission is addressing the link between water research and innovation by setting up a European Innovation Partnership (EIP) on water. The aim is to bring together stakeholders from research, industry, policy, finance, governance and other areas to generate innovative technologies and approaches that support future EU policy in water and create jobs and growth. The Royal Society of Chemistry, *via* the European Technology Platform for Sustainable Chemistry (SusChem) is involved in providing advice and scientific input to this EIP.

Has European Commission taken an evidence-based approach to the designation of chemicals that present a significant risk to/via the aquatic environment under the Water Framework Directive?

19. To an extent, the approach used by the EC has been evidence-based. The method used for assessing the risk of hazardous chemicals is defined in Article 16 of the WFD, which also lists the agencies consulted as part of the process. The shortlist of substances has been selected on the basis of scientific evidence that they may pose a significant risk to health.

20. However, concerns have been raised regarding the data used to set the Environmental Quality Standards (EQS) for some of the substances that have been selected for control. For example, in a letter to Richard Benyon (the Parliamentary Under Secretary of State for Natural Environment and Fisheries), the chair of the Hazardous Substances Advisory Committee, Professor Stephen Holgate, raised concerns over the data sets used in the assessment of diclofenac. In setting the EQS for any substance, the full consideration of relevant scientific evidence is of paramount importance.

21. There are other concerns around the EQS for many of the substances identified. Firstly, each substance appears to have been assessed individually, yet there may be synergistic effects that enhance or diminish the environmental impact and/or toxicity of a particular substance. Secondly, substance limits often take little account of the technology available for compliance monitoring. An example is the directive recommendation of a standard of 4.9×10^{-8} micrograms per litre for brominated diphenyl ethers, but there is no analytical technique available that can detect a concentration at this level. Specifying an EQS at a level that currently cannot be measured, regardless of the perceived risk, is unhelpful. That said, setting such levels can provide the driver for technological innovation.

22. Similarly, setting a low EQS where member states may be unable to influence the environmental distribution of substances seems impractical. Referring again to brominated diphenyl ethers, these are largely banned from use throughout the EU, but they are widespread and environmentally stable so concentrations well above the EQS are likely to persist in many surface waters despite the source of input being eliminated.

23. Moreover, in reference to the three pharmaceutical substances that are listed, no assessment has been made of the impact on the availability of medicines in which they are a key constituent. Diclofenac is used to treat osteoarthritis; an illness that affects 2.5 million people in the UK. 17 alpha-ethinylestradiol is used in many brands

of the contraceptive pill. No analysis has been carried out to understand the likely impacts if these medicines were no longer widely available. A cost-benefit analysis should be carried out for each substance. This will need to consider the economic impact of installing new treatment technology, as well as the impact on patients from the withdrawal of medicines.

What likely impacts could the Commission's proposals have in the UK? How could any adverse effects be mitigated?

24. EC standards should not be adopted without examination by UK experts, who should also consider if such standards are appropriate to UK conditions. The main likely impact would be a need to minimise and/or remove the proposed substances from water discharges. To do this, more technologically advanced wastewater treatment capacity will be required. Such technology has a large financial implication as the introduction to the inquiry acknowledges. The EC's own impact assessment estimates that the monitoring of the three pharmaceutical substances on the shortlist could cost somewhere between €15 – 36 million per year across the whole EU. As well as the significant financial impact of widespread installation of advanced treatment technologies, there will be a consequent negative impact to the carbon footprint of EU member states, because such technology is energy intensive.

25. In advance of the adoption of the proposals, it would be prudent to consider the following questions:

- What is the extent of the problem? This question has been answered in part for the current list of priority and priority hazardous substances as a result of the extensive UK wide Chemical Investigation Program carried out in 2011/12. If more hazardous chemicals are identified, then further work will need to be carried out to understand the scale of the issue.
- What proportion of each hazardous chemical enters the environment *via* the sewer network and can therefore be treated?
- What proportion of each hazardous chemical can be removed by the best available wastewater treatment technology?
- If further treatment is required, does the cost-benefit analysis suggest that this is best option?
- In the case of pharmaceuticals, what would be the impact of the withdrawal of related medicines from use?
- What is the fate of chemicals that are removed by treatment? Are they broken down into harmless 'daughter' products or do the daughter products represent a separate hazard?
- Are the chemicals only physically removed into the sewage sludge? Will they potentially find their way into the environment *via* other routes, e.g. agricultural spreading?

26. Answering the above questions will contribute to assessing the likely impacts of the legislation and help to forecast the extent of adverse effects. Again, the issue of risk assessment for chemicals is the most important aspect in targeting potential problem chemicals. Referring only to the hazard information of a substance does not consider the actual exposure and hence the risk of harm of the substance to biological systems in the environment and humans. Much more research is needed before adopting a treatment based solution.