Report to Ad Hoc Group of Ministers on Health and Public Water Supply

Initial situation report on public health issues with respect to water supply across Scotland

August 2002

Prepared by the Drinking Water Quality Regulator for Scotland

Contents

1. Summary and Key Messages

(i) Great improvements have been made in the safety and security of public water supplies in Scotland since 1990.

(ii) Further improvements in the quality of drinking water will depend upon Scottish Water making progress with its investment programme and in modernising operational procedures.

(iii) The Water Supply (Water Quality) (Scotland) Regulations 1990 require that wholesome water should not contain any element, organism or substance at a concentration that would be detrimental to public health. The *Cryptosporidium* (Scottish Water) Directions 2002 places additional obligations on Scottish Water. Any detection of *Cryptosporidium* in the public water supply is notified to the local NHS Board and the Drinking Water Quality Unit at the Scottish Executive.

(iv) The *Cryptosporidium* Directions make mandatory the recommendations of the UK Expert Group on *Cryptosporidium* in Water Supplies. The Directions also require Scottish Water to carry out a risk assessment on all its water supplies and to take action to minimise the risk at all high and moderate risk works by the end of 2005 at the latest. Where improvements cannot be implemented immediately Scottish Water must monitor these sites to warn of any risk to public health.

(v) The standard for trihalomethanes (THMs) in Scotland is currently tighter than that required by the EC Directive. There are breaches of the Scottish standard but the investment programme planned by Scottish Water should ensure compliance with the EC standard, as required, by 2003. The EC standard tightens to match the Scottish standard in 2008 but compliance with this tighter standard should be achieved in Scotland by 2006, if Scottish Water's investment programme is delivered on time.

(vi) Lead in tap water stems from the use of lead in pipes used to distribute water within buildings and to connect the buildings to water mains in the street. There are no lead water mains in Scotland. Many supplies have been treated for some time to prevent the uptake of lead from pipes. Scottish Water has plans to extend the use of this treatment and to remove any lengths of connecting pipework made of lead that still remains in their ownership.

(vii) A number of recent cases of *E.coli* contamination of private water supplies serving camping and caravan sites have highlighted the need for improved regulation of private water supplies. In November 2001 the Scottish Executive issued a consultation document on proposals to strengthen the regulation of private water supplies.

(viii) The Scottish Executive also published a consultation in March 2002 on proposals to regulate the quality of water supplied in public buildings such as schools and hospitals.

(ix) Extreme rainfall events should not affect the quality of the water in the public supply. Any such event will put pressure on the treatment process but it should be designed to cope with such pressures. In the past this has not always been the case

but the increased use of automation and investment in treatment processes should avoid such problems in the future.

2. Introduction

This report was produced following a request made to the Drinking Water Quality Regulator for Scotland (DWQRfS) at the first meeting of the *ad hoc* Group of Ministers on Health and Public Water Supply held on 9 August 2002. The DWQRfS was asked to provide an initial situation report on public health issues affecting water supplies in Scotland.

A further report considering the detailed implementation of the various regulations and Directions relating to drinking water quality and the water incidents that occurred in Glasgow and Edinburgh during August 2002 was also asked for. This detailed report will be submitted to Ministers in due course.

3. Background

Throughout most of the 20th century drinking water in the UK was always thought to be of a very high standard. Serious pathogenic illnesses such as typhoid that gave rise to large water born outbreaks in the 19th century were almost entirely eliminated. This significant improvement in public health came about as disinfection of drinking water supplies in the larger towns and cities became the norm. However, this was not the case for many rural supplies. For example, although by the 1970's there were about 30 water treatment works in the Western Isles and the public water supply extended to most communities, only the water supply to Stornoway was disinfected. This situation was reflected across most of the highlands and islands.

4. The Regulatory Framework

The introduction of The Water Supply (Water Quality) (Scotland) Regulations in 1990 imposed, for the first time, an obligation to disinfect all public water supplies derived from surface waters such as rivers, lochs and reservoirs. It also imposed a uniform sampling regime for checking drinking water quality and introduced standards for 57 different parameters. Twelve of the 57 standards were national standards going beyond the minimum requirements of the 1980 European Drinking Water Directive.

The first full year of results under these regulations, for the calendar year 1991, revealed a shocking situation (Table A). Seven percent of samples failed to meet the coliform standard, which indicates a breach of the integrity of the water supply system. Of greater concern was the fact that 3% of samples contained faecal coliforms (*E.coli*) indicating that faecal contamination had occurred.

The scale of the task that needed to be undertaken was influential in the policy decision that was taken to separate the responsibility for the provision of water services in Scotland into single purpose undertakings enacted through the Local Government Act of 1994.

Table A: Key drinking water quality parameters for Scotland 1991 - 2000

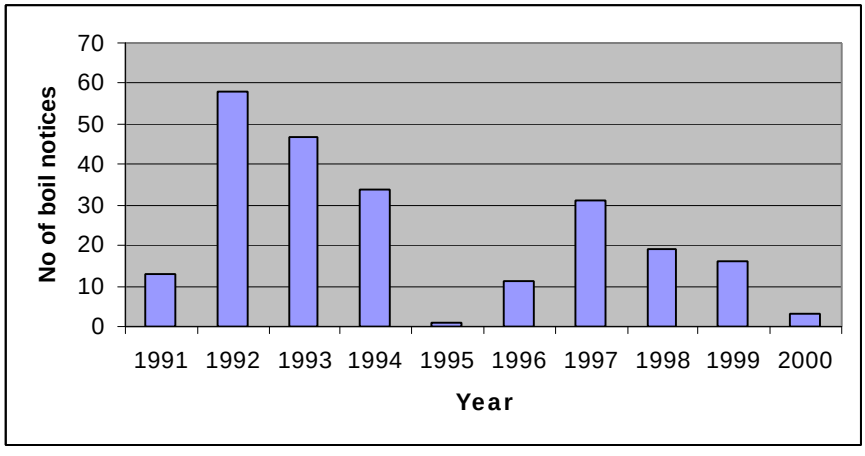
Percentage of Determinations exceeding PCV or relaxed PCV [1]											
Year	Total coliforms	Faceal coliforms	Colour	Turbidity	pH	Aluminium	Iron	Manganese	Lead	Total THMs	All Parameters
1991	7.0	3.0	1.3	1.2		6.0	3.9	1.5	1.6	14.7	2.0
1992	4.6	2.1	1.8	0.4	0.8	4.6	3.7	1.8	1.7	25.3	1.6
1993	2.7	1.3	1.9	0.5	0.8	3.8	3.8	0.9	1.6	20.0	1.4
1994	2.3	0.9	2.3	0.5	0.6	2.6	3.6	1.0	1.7	19.3	1.3
1995	2.6	1.0	2.2	0.5	0.3	1.8	3.6	1.1	1.1	18.1	1.3
1996	2.3	0.7	2.3	0.4	0.6	2.0	3.6	1.0	1.6	23.4	1.4
1997	2.3	0.8	2.7	0.5	0.6	2.0	4.6	1.4	1.4	30.6	1.9
1998	2.4	0.6	1.2	0.3	0.4	1.4	3.6	0.5	1.0	35.3	1.7
1999	1.5	0.3	0.8	0.4	0.3	1.6	3.1	0.8	0.7	23.8	1.5
2000	1.1	0.2	0.7	0.1	0.3	1.1	2.6	0.6	1.1	16.5	1.0

[1] PCV – Prescribed Concentration or Value – the numerical value assigned to water quality standards defining the maximal or minimal concentration or value of a parameter.

Source: Published Annual Report, Drinking Water in Scotland 1991 – 2000, Water Services Unit, Scottish Executive

The routine reporting of water quality failures required by the 1990 Regulations resulted in a rapid rise in awareness by Consultants in Public Health Medicine (CPHMs) of the need to consider drinking water quality as a risk factor when considering public health. In 1992, the worst year for boil notices, a total of 58 such notices were issued, mostly for small rural communities. Figure A provides details of boil water notices issued in Scotland since 1991. The data shows the situation to be highly variable but overall the trend has been downwards as water treatment systems improve.

Figure A: Boil water notices issued in Scotland from 1991 - 2000



Source: Published Annual Report, Drinking Water in Scotland 1991 – 2000, Water Services Unit, Scottish Executive

The effect of the 1990 Regulations has been to bring about major changes. It was impossible to modernise all the water treatment works in Scotland overnight due to the scale of the task. However, improvements have been taking place since the early 1990's and the Quality and Standards process determined Scottish Water's investment priorities for the period 2002 to 2006. This process is outlined in "Water Quality and Standards: Investment Priorities for Scotland's Water Authorities 2002 – 2006" which was published in August 2001.

The1990 Regulations have been updated with the introduction of The Water Supply (Water Quality)(Scotland) Regulations 2001. The 2001 Regulations relate to the provisions of the European Council Directive 98/83/EC on the quality of drinking water intended for human consumption and come into force fully on 25 December 2003.

5. Improvements

Given economic pressures and the long time scale needed to replace or upgrade water treatment works it was crucially important to make the existing assets work better in the short term. This has been done by better training of operatives and by the introduction of instrumentation and control equipment. An important aspect of instrumentation has been the installation of alarm systems, monitored from central control rooms, to warn when things go wrong. Risk management concepts have played an important part in the design of these systems.

Water production is a 24-hour a day / 7-day a week business, so there has been a need for the water industry to move on from the type of employment contract inherited from local government to a more flexible system that allows timeous intervention as and when required. However, there is still some way to go in this area.

6. *Cryptosporidium*

In the last ten years in Scotland between 600 and 1000 cases of human infection from *Cryptosporidium* have been confirmed each year. The majority of these cases are mild, self-limiting infections. Most of the cases are not part of an outbreak and no source of infection is identified. The main sources of infections, in addition to water, are contact with animals and with other affected humans. There are presently no routinely available typing schemes to help understand the epidemiology of *Cryptosporidium*, although this is being actively pursued in the UK. The Scottish Executive has funded research work in this area.

During the late 1980's and early 1990's there were a number of unexplained outbreaks of cryptosporidiosis throughout the UK. Circumstantial evidence implicated drinking water as the likely route of transmission but there was no understanding of the true cause. This resulted in the setting up of a UK Group of Experts on *Cryptosporidium* in Water Supplies under the chairmanship of Sir John Badenoch and latterly Professor Ian Bouchier.

Following extensive research, the Expert Group has now published three comprehensive reports and made wide-ranging recommendations. The recommendations relating to the protection of public water supplies were incorporated into "The *Cryptosporidium* Direction 2000" issued to the Scottish water authorities in March 2000. As part of the legislative framework required to support the formation of Scottish Water in April 2002, the Direction was modified and issued as "The *Cryptosporidium* (Scottish Water) Directions 2002" at the

end of March 2002. The provisions of the 2002 Directions are the same as those of the 2000 Direction in all operational respects, the only changes being minor drafting changes to take account of the new legislative framework.

The Direction makes mandatory the recommendations of the Expert Group. The Direction also introduces a risk management protocol that assigns risk scores to a wide range of attributes of a water supply. These cover:

- Water catchment (agricultural practices, sewage discharges etc.);
- Water treatment (type of treatment, monitoring, performance and operation); and
- Historical data (water analysis results).

The aggregate scores under these headings are adjusted to reflect the population served by the supply. This serves to ensure that if two works are assessed to present a similar risk, the works serving the larger population takes priority for improvement.

At present there are seven water supplies in the high-risk category, 59 supplies in the moderate risk category and the rest are in the low risk category. Details of the high-risk supplies are given in Table B.

Table B: High risk water treatment works for *Cryptosporidium* in Scotland

Water Treatment Works	Area Served	Population Served
Banff	Banff, Macduff	6,600
Buckie	Buckie and surrounding rural areas	5,500
Invercannie	Aberdeen, Banchory	135,000
Inverness Regional	Inverness and surrounding area	40,000
Onich	Onich	570
Turriff	Turriff, parts of Aberdeen, large areas of rural Aberdeenshire	90,600
Milngavie	North Glasgow and surrounding areas	695,690
Badentinan[1]	Buckie, Elgin	16,500
Forehill[1]	Peterhead, Fraserburgh, Ellon and surrounding area	42,300
Glenconvinth[1]	Beauly	5,250
Perth[1]	Perth and surrounding rural areas	49,000
TOTAL		**1,087,010** **(973,960)**[2]

Notes [1] These works do not score as high risk but are regarded as such on a precautionary principle.
[2] This figure excludes the works covered in Note 1.

Source: Drinking Water Quality Unit, Scottish Executive

The risk assessment process is a tool for guidance only. It is reviewed annually as part of a routine audit. When changes are made, such as the installation of monitoring equipment or alterations in agricultural practices on the catchment, the scores are adjusted to reflect the changes.

The Direction requires Scottish Water to carry out improvements at all high and moderate risk works to make them low risk by the end of 2005. Where improvements cannot be implemented immediately Scottish Water must install continuous monitoring for *Cryptosporidium* to warn of any risk to public health. Such monitoring will continue until improvements are made. Table C gives the breakdown of the number of water treatment works and the populations served by the high and moderate risk categories with respect to *Cryptosporidium*. The number of sites subject to continuous monitoring is under review.

Table C: Breakdown of the number of water treatment works according to The *Cryptosporidium* Direction risk assessment[1]

Risk Assessment Category	Number of Works	Population Affected
High	7	973,960
Moderate	59	551,300

[1] All other works are low risk

Source: Drinking Water Quality Unit, Scottish Executive

Continuous monitoring at high risk works since April 2000 has given 872 positive results out of 10,322 tests carried out (~8%). The presence of one or more oocysts in any sample is considered to be a positive result. The highest level recorded has been 0.35 oocysts per 10 litres of water in the former West of Scotland Water Authority area (with the highest level from the former North of Scotland Water area being 0.26 oocysts/10 litres and the highest level from the former East of Scotland Water area being 0.11 oocysts/10 litres).

No *Cryptosporidium* monitoring result in Scotland, from a treated water supply, has approached the standard set in the English water quality regulations of 1 oocyst per 10 litres. Nevertheless, we have had two outbreaks of cryptosporidiosis since April 2000. The first outbreak was in Glasgow in May 2000 and the second in Aberdeen in February 2002. During the recent alert in Glasgow, levels were recorded that were much higher than those recorded in May 2000 although again, they were well below the standard set in the English water quality regulations. To date, the elevated levels recently reported in Glasgow have not resulted in any increase in reported cases of cryptosporidiosis.

The standard for *Cryptosporidium* in the English water quality regulations is considered to be a standard that treated water must not exceed. Since there have been outbreaks of cryptosporidiosis in Scotland associated with levels below the regulatory standard in England it was not considered beneficial to set a similar standard in Scotland. A health-based standard for *Cryptosporidium* in water has not been set anywhere in the UK. Indeed the UK Expert Group on *Cryptosporidium* in Water Supplies, chaired by Professor Bouchier, stated in 1998 that "it is not possible to recommend a health-related standard for *Cryptosporidium* in drinking water". However, the Water Supply (Water Quality) (Scotland) Regulations 1990 require that, in addition to the 57 standards mentioned earlier, wholesome water should not contain any element, organism or substance at a concentration, which would be detrimental to public health.

The regulatory standard set in England has had the effect of making the private water companies operating in England adopt good practice. Such measures have been made mandatory in the *Cryptosporidium* Direction issued in Scotland.

7. Disinfection

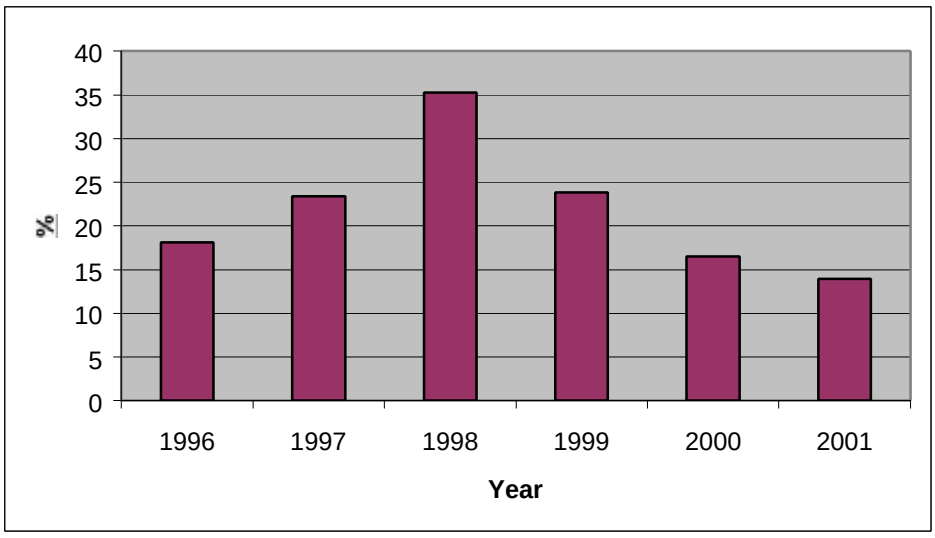
In the World Health Organisation's "Guidelines for drinking-water quality" the section dealing with disinfectants and disinfection by-products starts with the statement "Disinfection is unquestionably the most important step in the treatment of water for public supply. The destruction of microbiological pathogens is essential and almost invariably involves the use of reactive chemical agents such as chlorine".

The normal disinfection process adopted for public drinking water supplies in the UK is based on the use of chlorine, which has the advantage of remaining in the water as it passes through the distribution system. Scottish Water has an obligation under the Regulations to disinfect all its water supplies derived from surface waters such as rivers, lochs and reservoirs and has an objective to maintain a measurable chlorine residual in water to the far end of its distribution systems.

Chlorine is highly effective at killing most of the more common human pathogens. However, if a disinfection failure occurs there is the possibility of human pathogens being present in the supply. Reporting requirements require the immediate notification of any disinfection failure to the relevant health authority and the Drinking Water Quality Unit at the Scottish Executive. Chlorination, while effective against most common human pathogens, will not kill oocysts of *Cryptosporidium* and a barrier such as filtration is required to physically remove the oocysts rather than inactivate or kill them by chemical means.

Concerns have been expressed over the health implications of the presence of chemicals known as trihalomethanes (THMs) in public drinking water. Trihalomethanes occur in drinking water principally as products of the reaction between chlorine or bromine and naturally occurring organic materials, which may also be present in the water. Figure B shows the recent trend of reducing failures of the THM standard. This falling trend will continue as the old water treatment plants are replaced. After 2006 full compliance with the THM standard will be expected.

Figure B: Percentage of determinations for THMs exceeding PCV or relaxed PCV



Source: Published Annual Report, Drinking Water in Scotland 1991 – 2000, Water Services Unit, Scottish Executive

The International Agency for Research on Cancer (IARC) classifies THMs as "possible human carcinogens" for which there is "limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals". The particular issue of the safety of THMs in drinking water was considered in 1999 by the Department of Health's Committee on Carcinogenicity who concluded that: "Overall, the further epidemiological studies fail to provide persuasive evidence of a consistent relationship between chlorinated drinking water and cancer".

The World Health Organisation (WHO) comment that with respect to drinking water contamination only four members of the broad group of chemicals known as trihalomethanes (THMs) are important: bromoform, dibromochloromethane (DBCM), bromodichloromethane (BDCM) and chloroform. This group of chemicals may act as an indicator for the presence of other chlorination by-products (also known as disinfection by-products (DBPs) in North America). Control of these four trihalomethanes should help to reduce levels of other uncharacterised chlorination by-products.

The water quality regulations in operation in Scotland (and the rest of the UK) require that the sum of these four THMs does not exceed 100 micrograms per litre. This standard is stricter than the 150 micrograms per litre standard set in the new European Drinking Water Directive that has to be met by by December 2003. Given the recent focus on chloroform, the most commonly occurring THM, it is worth noting that the World Health Organisation (WHO) Guideline Value for chloroform alone is 200 micrograms per litre (200 millionths of a gram per litre of water). This value is set by WHO as being the level at which there is a risk of producing one additional cancer per 100,000 of the population ingesting drinking water containing the substance at the guideline value for 70 years (that is a risk value of 10^{-5}).

The WHO comment that where local circumstances require that a choice must be made between meeting either microbiological guidelines or guidelines for disinfectants or disinfectant by-products, the microbiological quality must always take precedence – "efficient disinfection must never be compromised"

8. Lead

There is no naturally occurring lead in any Scottish drinking water supply. The detection of lead in tap water stems from the use of lead pipes to distribute water in buildings and to connect the building to the water main in the road. In more recent times the use of lead solder to joint copper pipes has also added to the risk of excess lead in tap water. All lead pipes and lead solders are now banned from use but there is a significant legacy of lead pipes still in use in older buildings. Recent instances where lead solder has continued to be used illegally resulted in a toughening of the offence provisions in The Water Industry (Scotland) Act 2002.

Lead is now recognised as a neurotoxin, even at low levels. The naturally soft acidic water in Scotland means that lead is easily dissolved into water. In order to meet the standards set in Regulations the water authorities have, for many years, treated the water to reduce its acidity and to coat the inside of lead pipes with an insoluble material. A new, much tougher, standard for lead will come into force after 2003 which means that Scottish Water is now improving its water treatment and is making progress on removing any remaining lead pipes in its ownership. Scottish Water also will have a duty to notify owners and occupiers whenever they find lead pipes in the course of their work.

Apart from the presence of lead in public buildings (see section 10) there is no legal requirement for lead to be removed from domestic dwellings. The Drinking Water Quality Unit estimates that there are at least 400,000 houses in Scotland with lead plumbing and possibly more, including all those where the underground section of pipes between the house and the road needs to be replaced.

9. Private Water Supplies

In Scotland, a private water supply is a drinking water supply not controlled by Scottish Water and where the responsibility for the maintenance of the supply lies with the owner or user. In Scotland, just over 1.5% (80,000 people) of the population have private water supplies to provide their domestic drinking water with a further 68,700 having drinking water provided in association with a commercial activity e.g. hotels or campsites. This number does not include the transient population who may use such facilities and thereby be exposed to waterborne hazards associated with private water supplies. The responsibility for regulating private water supplies lies with Scotland's local authorities.

In general, the quality of water from private water supplies in Scotland is well below that found in the public supply. Any treatment that may be present is typically low-tech and is often subject to poor maintenance. There have been a number of cases of *E.coli* O157 associated with private water supplies such as those at the camping and caravan sites at Applecross in 2000; Bettyburn Girl Guide camp in 2001 and Rothiemurchus in August 2002.

In November 2001 the Scottish Executive issued a consultation document on proposals for revised and strengthened Private Water Supply regulations. The proposed new Regulations will place a duty on local authorities to ensure that all private water supplies serving more than 50 people or those serving a commercial function (e.g. B&B) comply with the standards of drinking water quality that are comparable to those found in the public drinking water supply. All other private water supplies will be regulated using a risk-based approach that has been developed by the Executive in collaboration with The Macaulay Land Use Research Institute, The Robert Gordon University and The Royal Environmental Health Institute of Scotland (REHIS). This risk-based system is currently undergoing evaluation trials as part of a research project being undertaken by MLURI and Aberdeen University. The project management board for this work includes representatives from Scottish Executive Public Health Policy Unit; Scottish Executive Drinking Water Quality Unit; Scottish Centre for Infection and Environmental Health and The Royal Environmental Health Institute of Scotland.

The Executive has made £850,000 available in the current financial year to produce a comprehensive education and support package to professionals (e.g. environmental health officers and plumbers) and users (both permanent and casual such as visitors to Bed and Breakfast establishments or campsites) to inform them of the potential risks posed by private water supplies and the appropriate measures to be undertaken to protect themselves from such risks. The initial meeting of the project steering group has been held and this work is progressing.

10. Public Buildings

In March 2002 the Scottish Executive published a consultation paper on proposed regulations governing the quality of drinking water that the public should be able to expect to be provided in public buildings such as schools, hospitals and restaurants. The report on this consultation report is in preparation and will be published in due course.

One of the principle aims of the proposed regulations is to control the presence of lead in the drinking water supplied from public buildings.

Although public mains water supplies in Scotland do not contain significant levels of lead, lead in water can still be a problem in some premises because of lead from pipes, or solder joints or storage tanks dissolving into the water. In order to assess the risks to public health posed by drinking water from public buildings such as schools, hospitals and restaurants, the Scottish Executive commissioned a survey in April 2000 into the compliance of public buildings with the new Drinking Water Directive. The survey looked at a range of public buildings and a range of drinking water quality parameters, including lead.

The results of the survey indicated that there was a high level of compliance with the Directive but that the main problem will be in achieving compliance with the new lead standard which moves from the present regulatory limit (under the 1990 Regulations) of 50 micrograms per litre through an intermediate standard of 25 micrograms per litre from 25 December 2003 until 24 December 2013 when the final regulatory standard of 10 micrograms per litre will come into force.

11. Climate Change

There is interest in the question of whether Scottish Water will be adversely affected if recent rainfall events become more common.

Any extreme rainfall event will put increased pressure on water treatment processes. The great majority of water treatment works have coped with the recent rainfall events but there have been a small number of reports of treatment problems. However, these were from plants that are generally due for replacement.

Scottish Water has been asked to provide a report on the implications of more frequent occurrences of extreme rainfall to their treatment facilities. Where modern water treatment is already in place there should be no material change to the effectiveness of that treatment. However, at times of extreme loading it may be necessary to adjust the treatment process.

In the past, and to some extent up to the present, problems have arisen because of poor process control. In many older plants treatment processes are under manual or pre-set control. These plants require staff to be on-call continuously to attend when problems occur. Inevitably this can cause some delay in making crucial adjustments. The use of automation in modern plants allows most of this work to be done timeously and without the necessity of staff attendance.

As part of Scottish Water's efficiency drive, much of this work is being undertaken in order to achieve better use from a skilled workforce. These efficiency measures will also improve the reliability of water treatment systems at times of extreme loading.

12. Conclusions

The principal issues for further improvements to public water supplies were outlined in the Water Quality and Standards: Investment Priorities for Scotland's Water Authorities 2002 – 2006 (published in August 2001). This document sets clear objectives for Scottish Water including:

- to meet the requirements of The *Cryptosporidium* Directions by 2005;
- to improve drinking water treatment to eliminate trihalomethanes (THMs) by 2006;
- to carry out all its duties to limit the uptake of lead from domestic dwellings by 2003;
- to replace any lead pipes in its ownership that are encountered during mains renewal operations.

Other Government initiatives are to:

- improve the understanding of the relationship between drinking water quality and the risk to public health;
- introduce new Private Water Supply Regulations;
- introduce new Drinking Water Supplies in Public Building Regulations;
- consider what further measures can be introduced to eliminate lead from private dwellings.

TIM HOOTON
Drinking Water Quality Regulator for Scotland