**PE1646/H**
**Scottish Water submission of 24 November 2017**

Thank you for the opportunity for Scottish Water to provide further information to the Public Petitions Committee in consideration of Petition PE 1646 (Drinking water supplies in Scotland). We are happy to provide more information about the measures taken to monitor the quality and safety of the water in Badenoch and Strathspey subsequent to the move from chlorination to chloramination.

Both chlorination and chloramination are methods of disinfecting drinking water as part of a more comprehensive treatment process that is in place at Aviemore water treatment works. The use of disinfection also ensures that drinking water remains free of harmful bacteria as it travels through the network to customer homes.

**Regulatory and Enhanced Sampling and Analysis**

Scottish Water, like other UK water companies, operates in a highly regulated industry where public health is the prime concern and we take this responsibility very seriously. We undertake rigorous monitoring to confirm that the water supplied complies with health based standards as set out in the Public Water Supplies (Scotland) Regulations 2014. The Drinking Water Quality Regulator (DWQR) is responsible for ensuring that Scottish Water complies with these legal water quality duties. Although SEPA do not monitor drinking water in the supply networks, they are responsible for monitoring some source water quality in Drinking Water Protected Areas and any outputs from water treatment works which discharge direct to the environment.

During the introduction of the chloramination disinfection process at Aviemore water treatment works, we carried out normal regulatory sampling and analysis and, in addition, established an enhanced sampling and analysis programme to ensure the water supplied since the introduction of chloramination in April 2017 has been of the right quality and safety.

The Aviemore water treatment works has been continuously monitored on-site and over 13,400 analytical tests have been completed from over 4,500 samples collected from the water supply in the Badenoch and Strathspey area from April to October 2017.

Our analysis of water quality and safety included:

- ***On-line telemetry analysis:*** monitoring and evaluating automatic sensors and bench tests via a telemetry system in place at the treatment works, with results monitored in real time, to ensure the chloramination process is operating correctly. This includes continual monitoring of phosphate, turbidity, pH, flow, total ammonia and chlorine (free and total). Automatic alarms are raised if any of the parameters being monitored approach set target levels, requiring an on-site operator to attend. In addition, this system has automated safety measures in place which stop water entering the clear water tanks and into supply if certain levels are breached.
- ***Regulatory programme of sampling and analysis:*** the requirements for this are set out in the Public Water Supplies (Scotland) Regulations 2014, including the processes and procedures that must be met, the collecting and analysing samples and the performance, frequency and characteristics necessary for sampling or testing drinking water.

- ***Enhanced sampling and analysis:*** this was specific to Badenoch and Strathspey and focused on the water quality and safety in supply at customer homes as well as the source water, the treated water at the Aviemore works and the water in supply at service reservoirs. This additional sampling and analysis has been completed according to the same standards as the regulatory programme and was put in place to ensure that additional analysis was completed for our customers, examining taste and odour and the chloramination disinfection process, including the levels of monochloramine and disinfection by-products (specifically N-Nitrosodimethylamine (NDMA)) to ensure the safety of the water in relation to the chloramination disinfection process. Further regulatory disinfection by-products analysis was also completed for Trihalomethanes (THMs).

Table 1 in Appendix 1 details the types of samples collected and number of tests completed for the Badenoch and Strathspey water supply over the period 1st April to 31st October 2017, covering the switch to chloramination on 4th April. Further information on Scottish Water's scientific services practices and accreditation are available in our previous submission to the petitions committee.

**Summary of Results of Scottish Water monitoring**

Overall, the quality of water supplied to customers in the Badenoch and Strathspey area continues to consistently comply with health based regulatory standards. This is the case both in relation to the current change from chlorination to chloramination disinfection in April 2017 and in the earlier change from the Loch Einich source water supply to the Aviemore boreholes. This was outlined in the DWQR response to the Petitions Committee in June this year and summarised in Appendix 1, Table 2.

Over the period detailed in this response, no regulatory water quality and safety parameters relating to the chloramination process, or treatment processes in general, failed in relation to regulatory health based standards or World Health Organisations (WHO) guideline values. There was one failure for iron levels during this time. However, this was related to network flushing activity and did not pose a risk to health. Appendix 2 outlines our regulatory programme compliance.

In terms of our on-line telemetry analysis, there was no activation of any automated safety measures and no areas of concern highlighted within the telemetry data which continually monitors the the chloramination disinfection process. Appendix 3 shows data collected from on-line sensors at the treatment works for parameters related to the chloramination process.

The test results for both the regulatory and enhanced monitoring programmes which are particularly relevant in relation to safety and quality have been summarised in the graphs contained in Appendix 4. Analysis of the disinfectant by-product associated with chloramination (NDMA) was carried out by an independent laboratory with over 70 samples analysed. The highest concentration of NDMA recorded in these samples was 0.8 ng/L and the vast majority of samples were below the limit of detection (0.5 ng/L). No samples approached World Health Organisation (WHO) guideline values (100 ng/L).

Overall disinfection by-product levels, as measured as total trihalomethanes (THMs) were all below 3.2 μg/L. The PCV limit is 100 μg/L. Similarly all monochloramine concentrations were recorded at or below 0.7 mg/L which is significantly lower than the WHO guideline of 3 mg/L.

A full regulatory programme data set has been reported to our regulator, the DWQR.

Going forward and given the results of our current monitoring, Scottish Water intends to phase out the enhanced monitoring programme and return to normal regulatory sampling and analysis.

We hope that the information provided has enabled you to make a full assessment of the water quality and safety at Aviemore water treatment works, particularly during the period when we changed disinfection processes from chlorination to chloramination. We also hope that this information has provided reassurance that we are supplying customers in Badenoch and Strathspey with high quality drinking water and that we take our responsibilities and obligations in relation to drinking water quality very seriously.

We would certainly be happy to answer any further questions or provide any further information which the committee would find helpful.

**Appendix 1**

**Number and type of tests – regulatory and enhanced monitoring**

The number of tests completed for the regulatory and enhanced monitoring programmes over the period 1st April to 31st October 2017 covering the switch to chloramination on 4th April 2017 are summarised in Table 1 below. In total, 4,591 samples have been collected with 13,485 analytical tests completed.

**Table 1** Type of sample collected and number of tests completed at Aviemore over the period 1st April – 31st October 2017 covering the switch to chloramination on 4th April 2017 for the regulatory and enhanced monitoring programmes

| Sample Type | Regulatory Programme Test numbers | Enhanced Monitoring Programme Test numbers |
|---|---|---|
| Source water from the individual boreholes | | 9 |
| Combined source water from all boreholes | | 355 |
| Treated water leaving the works | 777 | 959 |
| Treated water in supply at the service reservoirs | 1440 | 1462 |
| Treated water in supply at customer homes | 421 | 8062 |

The overall analysis which is completed on these samples incorporates the parameters routinely tested to demonstrate compliance with the Public Water Supplies (Scotland) Regulations 2014 and the additional test completed for the enhanced monitoring programme. The full scope of analytical tests and sampling activity can be found within the Accreditation Schedule held on the UKAS website: www.ukasscheduleofaccreditation.co.uk.

Test protocols are generally based on methods documented by The Standing Committee of Analysts (SCA) who exists to provide authoritative guidance on methods of sampling and analysis. In some cases methods can also be based on other equivalent international standards. The SCA methods are published by the Environment Agency.

**Summary of Badenoch and Strathspey water quality data – 2007 to 2016**

Overall, the quality of water supplied to customers in the Badenoch and Strathspey area continues to consistently comply with health based regulatory standards. This is the case both in relation to the current change from chlorination to chloramination disinfection in April 2017 and in the earlier change from the Loch Einich source water supply to the Aviemore boreholes in February 2012. This was outlined in the DWQR response to the Petitions Committee in June this year which is summarised in Table 2 below and available at: http://www.parliament.scot/S5_PublicPetitionsCommittee/Submissions%202017/PE1646D_Drinking_Water_Quality_Regulator_for_Scotland.pdf

**Table 2** Summary of the Badenoch and Strathspey water supply compliance at customer taps from 2007 to 2016 as reported by the DWQR in their June 2017 response to the Petitions Committee

Water Quality Data

This is a summary of the water quality data from Regulatory samples for the treatment works and samples taken from consumers' taps.

| Blackpark WTW | | | | Aviemore WTW | | |
|---|---|---|---|---|---|---|
| Year | No. of samples | No. of failures | | Year | No. of samples | No. of failures |
| 2007 | 497 | 9 | | 2012 | 510 | 0 |
| 2008 | 509 | 12 | | 2013 | 697 | 0 |
| 2009 | 492 | 14 | | 2014 | 970 | 0 |
| 2010 | 479 | 23 | | 2015 | 552 | 0 |
| 2011 | 460 | 6 | | 2016 | 987 | 0 |

Aviemore Regulatory Water supply zone – samples taken from consumers' taps

| Year | No. of samples | No. of failures |
|---|---|---|
| 2008 | 715 | 1 |
| 2009 | 712 | 1 |
| 2010 | 713 | 0 |
| 2011 | 711 | 0 |
| 2012 | 729 | 0 |
| 2013 | 608 | 0 |
| 2014 | 747 | 0 |
| 2015 | 731 | 0 |
| 2016 | 736 | 0 |

**Appendix 2**

The regulatory compliance achieved to date in 2017 for the Badenoch and Strathspey supply is summarised in Table 3 below. Only one parameter breached the PCV limits. This was iron and was a result of network flushing activities and did not pose a risk to health.

No regulatory water quality and safety parameters relating to the chloramination process or treatment process in general failed for samples collected as part of the regulatory or enhanced monitoring programmes.

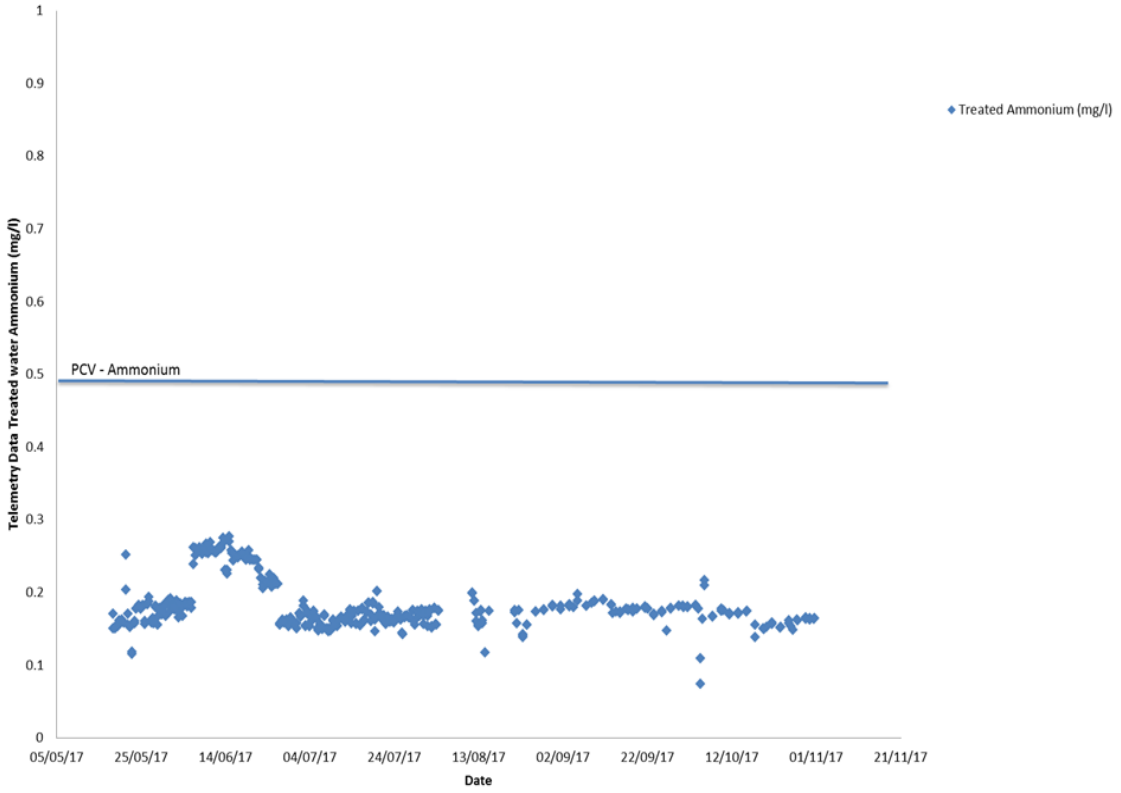
**Table 3** Regulatory programme compliance with health based regulatory standards for samples taken between 1st April and 31st October 2017 inclusive in Badenoch and Strathspey customer properties

| Determinand | No. of Results | PCV | Units of Measure | Results Failing PCV (%) | Min | Mean | Max |
|---|---|---|---|---|---|---|---|
| 1,2 Dichloroethane | 3 | 3 | µg/l | 0 | < 0.1 | <0.1 | <0.1 |
| Aluminium | 14 | 200 | µgAl/l | 0 | < 9 | 10.5 | 19 |
| Ammonium | 14 | 0.5 | mgNH4/l | 0 | 0.05 | 0.16 | 0.22 |
| Antimony | 4 | 5 | µgSb/l | 0 | < 0.02 | <0.02 | <0.02 |
| Arsenic | 4 | 10 | µgAs/l | 0 | < 0.2 | <0.2 | <0.2 |
| Atrazine | 6 | 0.1 | µg/l | 0 | 0.01 | 0.012 | 0.013 |
| Benzene | 3 | 1 | µg/l | 0 | < 0.03 | <0.03 | <0.03 |
| Benzo (a) pyrene | 4 | 0.01 | µg/l | 0 | < 0 | <0 | <0 |
| Boron | 5 | 1 | mgB/l | 0 | < 0.02 | <0.02 | <0.02 |
| Bromate | 5 | 10 | µgBrO3/l | 0 | < 0.3 | <1.1 | <1.3 |
| Cadmium | 4 | 5 | µgCd/l | 0 | 0.02 | 0.028 | 0.05 |
| Chloride | 5 | 250 | mgCl/l | 0 | 17 | 17.2 | 18 |
| Chromium | 4 | 50 | µgCr/l | 0 | 0.3 | 0.4 | 0.5 |
| Clostridium perfringens (incl. spores) | 14 | 0 | CFU in 100ml | 0 | 0 | 0 | 0 |
| Coliform bacteria | 21 | 0 | CFU in 100ml | 0 | 0 | 0 | 0 |
| Colony count at 22°C | 14 | | cfu/ml | 0 | 0 | 31.857 | 260 |
| Colony count at 37°C | 14 | | cfu/ml | 0 | 0 | 13.571 | 179 |
| Colour | 14 | 20 | mg/l Pt/Co | 0 | < 2 | 2.5 | 9 |
| Conductivity | 14 | 2500 | µS/cm at 20°C | 0 | 146 | 150.429 | 156 |
| Copper | 4 | 2 | mgCu/l | 0 | 0.001 | 0.025 | 0.06 |
| Cyanide | 6 | 50 | µg/l | 0 | < 0.8 | 0.95 | 1.4 |
| E. coli | 21 | 0 | CFU in 100ml | 0 | 0 | 0 | 0 |
| Enterococci | 5 | 0 | CFU in 100ml | 0 | 0 | 0 | 0 |
| Fluoride | 5 | 1.5 | mgF/l | 0 | 0.168 | 0.192 | 0.222 |
| Free chlorine | 21 | | mg/l | 0 | 0.03 | 0.048 | 0.09 |
| Gross alpha | 4 | | Bq/l | 0 | < 0.04 | <0.04 | <0.04 |
| Gross beta | 4 | | Bq/l | 0 | 0.02 | 0.032 | 0.04 |
| Heptachlor | 1 | 0.03 | µg/l | 0 | < 0.003 | <0.003 | <0.003 |
| Heptachlor epoxide | 1 | 0.03 | µg/l | 0 | < 0.005 | <0.005 | <0.005 |
| Hydrogen ion | 14 | min 6.50 max 9.50 | pH value | 0 | 7.9 | 8.136 | 8.4 |
| Iron | 14 | 200 | µgFe/l | 7.143 | < 7 | 30.429 | 316 |
| Lead | 4 | 10 | µgPb/l | 0 | < 0.2 | 0.2 | 0.2 |
| Lindane (g- HCH) | 1 | 0.1 | µg/l | 0 | < 0.003 | <0.003 | <0.003 |
| Manganese | 14 | 50 | µgMn/l | 0 | 1 | 2.643 | 7 |
| Mercury | 5 | 1 | µgHg/l | 0 | < 0.02 | <0.02 | <0.02 |
| Nickel | 4 | 20 | µgNi/l | 0 | < 0.2 | <0.2 | <0.2 |
| Nitrate | 5 | 50 | mgNO3/l | 0 | 2.79 | 3.262 | 3.88 |
| Nitrite | 5 | 0.5 | mgNO2/l | 0 | < 0.01 | 0.011 | 0.015 |
| PAH - total | 4 | 0.1 | µg/l | 0 | < 0.005 | <0.005 | <0.006 |
| Pesticides: Total | 6 | 0.5 | µg/l | 0 | 0.01 | 0.012 | 0.013 |
| Propetamphos | 5 | 0.1 | µg/l | 0 | < 0.002 | <0.002 | <0.002 |
| Quantitative odour | 14 | 0 | Dilution number | 0 | 0 | 0 | 0 |
| Quantitative taste | 14 | 0 | Dilution number | 0 | 0 | 0 | 0 |
| Selenium | 4 | 10 | µgSe/l | 0 | < 0.3 | <0.3 | <0.3 |
| Simazine | 6 | 0.1 | µg/l | 0 | < 0.002 | <0.002 | <0.002 |
| Sodium | 5 | 200 | mgNa/l | 0 | 11.7 | 12.3 | 13 |
| Sulphate | 5 | 250 | mgSO4/l | 0 | 6.6 | 6.74 | 6.9 |
| THM: Total | 3 | 100 | µg/l | 0 | < 3.2 | <3.2 | <3.2 |
| TON ratio | 5 | | | 0 | 0.06 | 0.068 | 0.08 |
| Tetra & Trichloroethene | 3 | 10 | µg/l | 0 | < 0.4 | <0.4 | <0.4 |
| Tetrachloromethane | 3 | 3 | µg/l | 0 | < 0.1 | 0.1 | 0.1 |
| Total chlorine | 21 | | mg/l | 0 | 0.31 | 0.566 | 0.65 |
| Total organic carbon | 5 | | mgC/l | 0 | < 0.2 | 0.28 | 0.4 |
| Turbidity | 14 | 4 | NTU | 0 | < 0.2 | 0.329 | 2 |

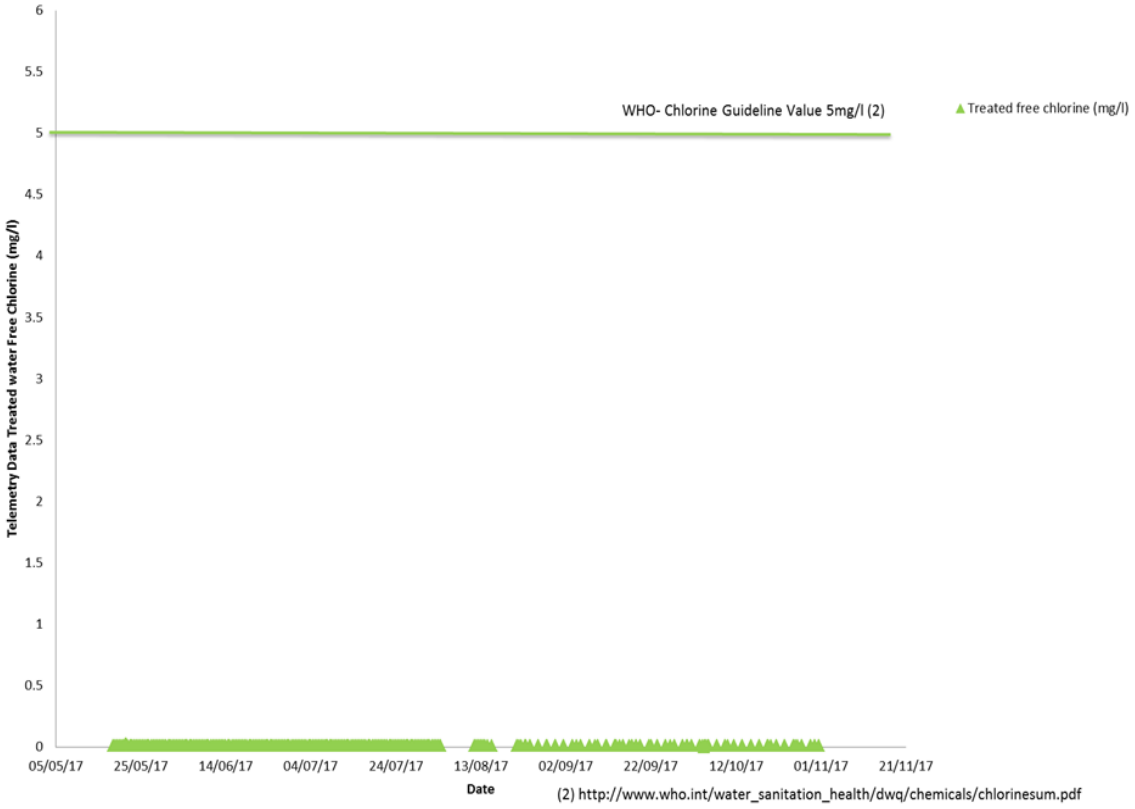
**Appendix 3**

**Telemetry data**

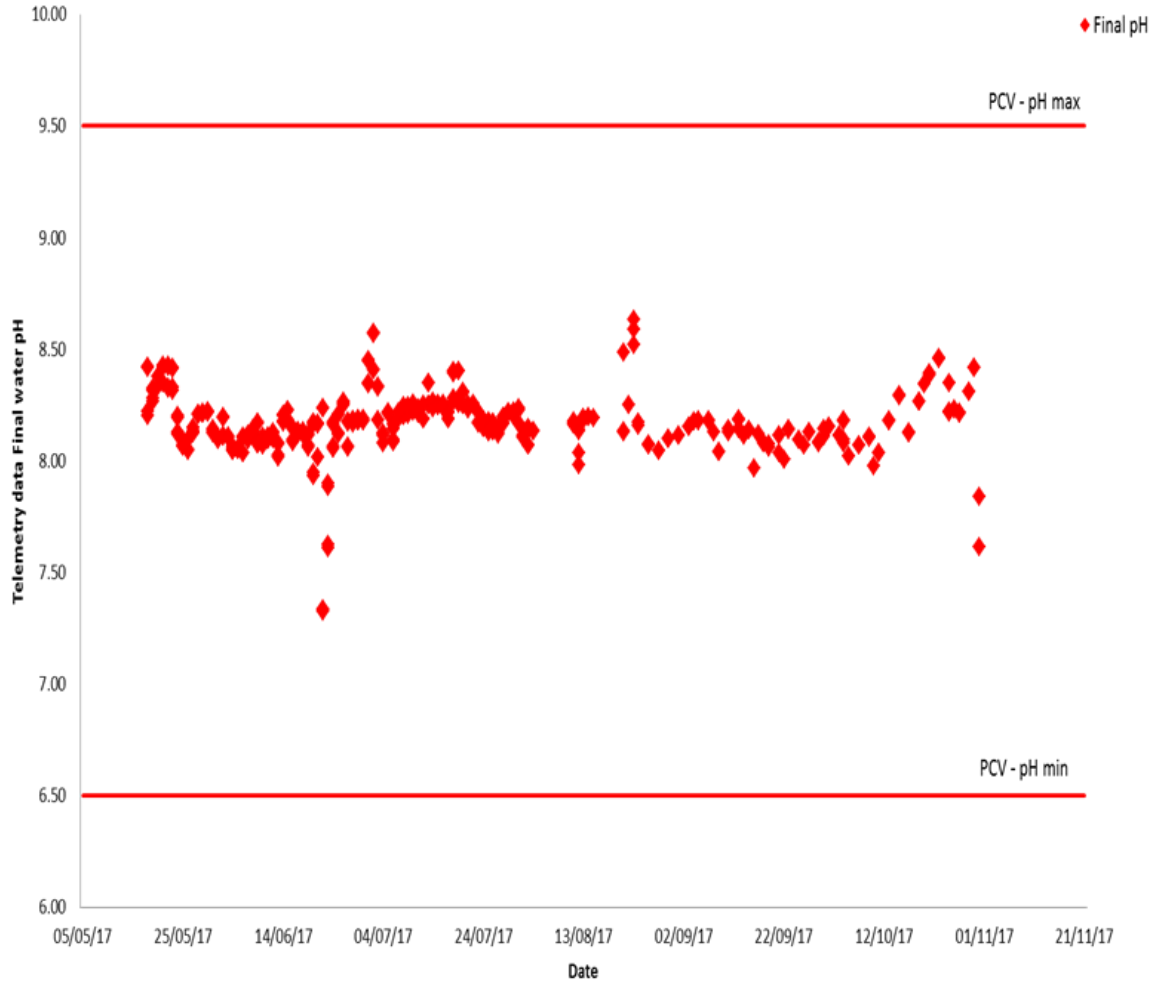
At the treatment works, the telemetry data are used to ensure that the treatment processes are working correctly. Automatic alarms are raised if any of the monitored parameters are approaching fixed operational target levels and an on-site operator is required to attend to the works to adjust the treatment process back into specification within 1 hour. If the actions levels are breached, automatic alarms are raised and the works is immediately shut down, with the water stopped entering the clean water tank and thus into supply. Rectification of these works issues is required to start immediately. An example of the works operation in 2017 is outlined in the 3 graphs below and the relevant regulatory Prescribed Concentration and Value (PCV) limits or WHO guideline values are also provided where applicable.




1(A) Ammonium




1(B) Free chlorine



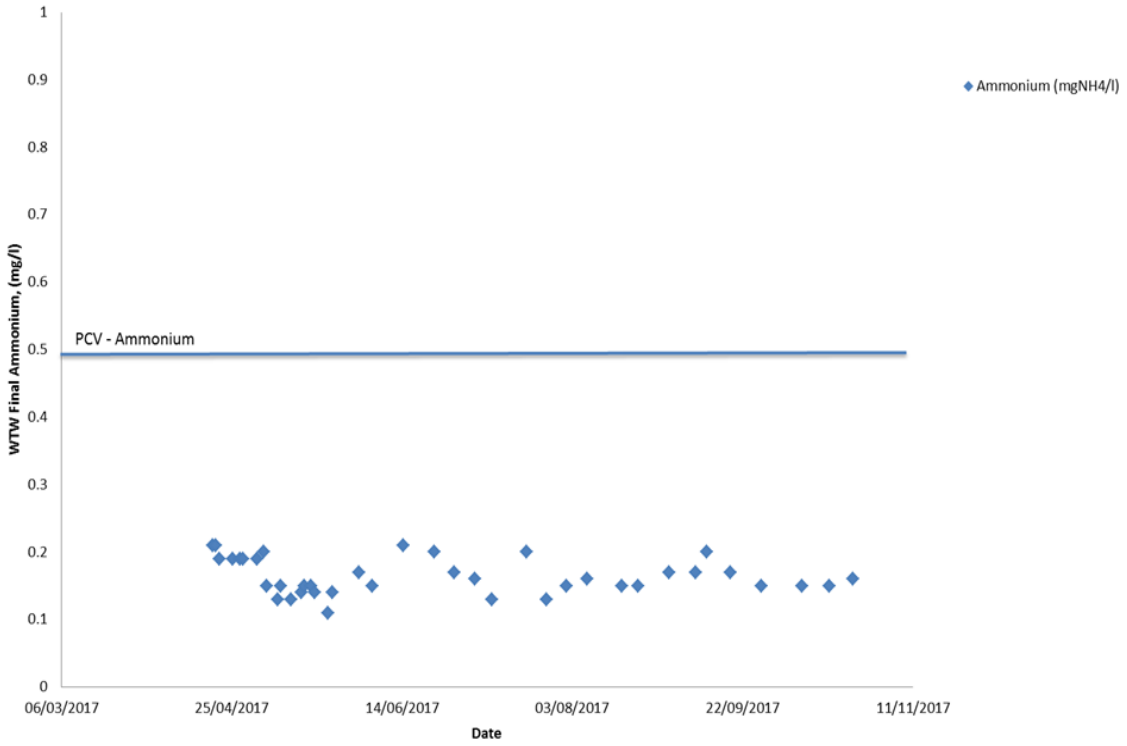

1(C) Hydrogen Ion (pH)

**Figures 1(A) – 1(C)** Concentrations of ammonium (A), free chlorine (B) and hydrogen ion (pH) (C) in the treated water at the Aviemore water treatment works up till 31st October 2017

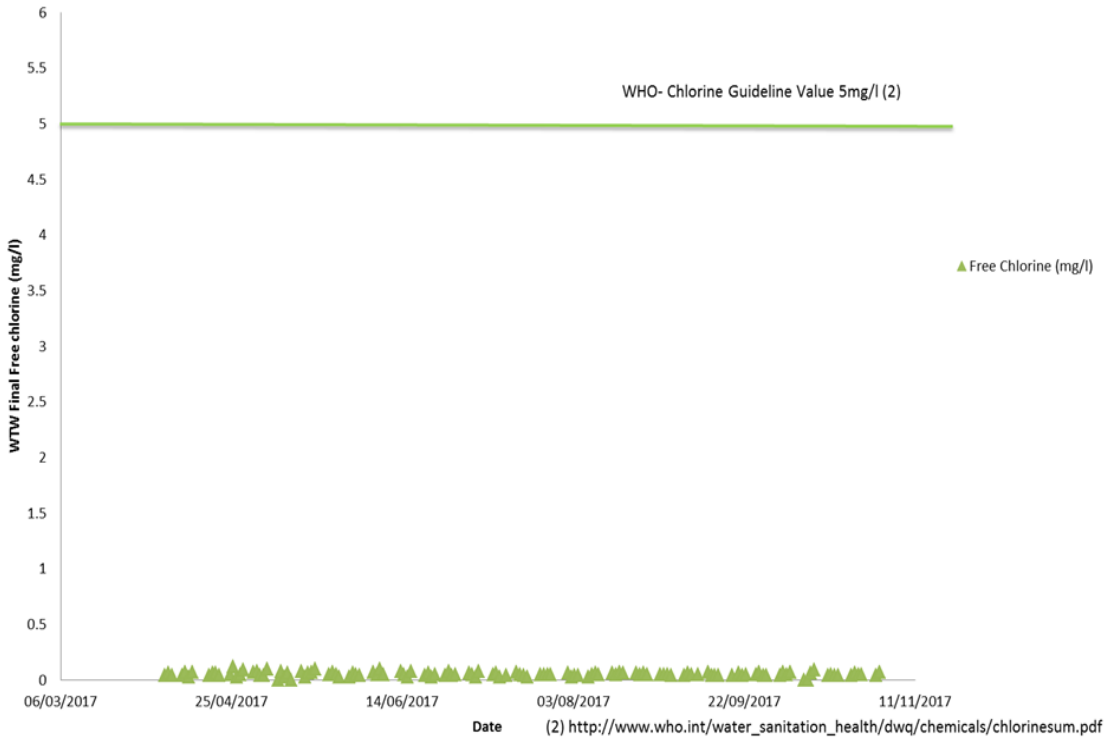
## Appendix 4

### Regulatory and enhanced monitoring programmes

The test results for both the regulatory and enhanced monitoring programmes which are particularly relevant in relation to safety and quality have been summarised in the graphs below (Figures 2 and 3) for samples collected at the treatment works and in supply in customers homes. The relevant regulatory PCV limits are also provided where applicable. Please not there is no PCV for monochloramine nor for NDMA, however there are guideline values from the World Health Organisation and these have been highlighted where appropriate on the below graphs.

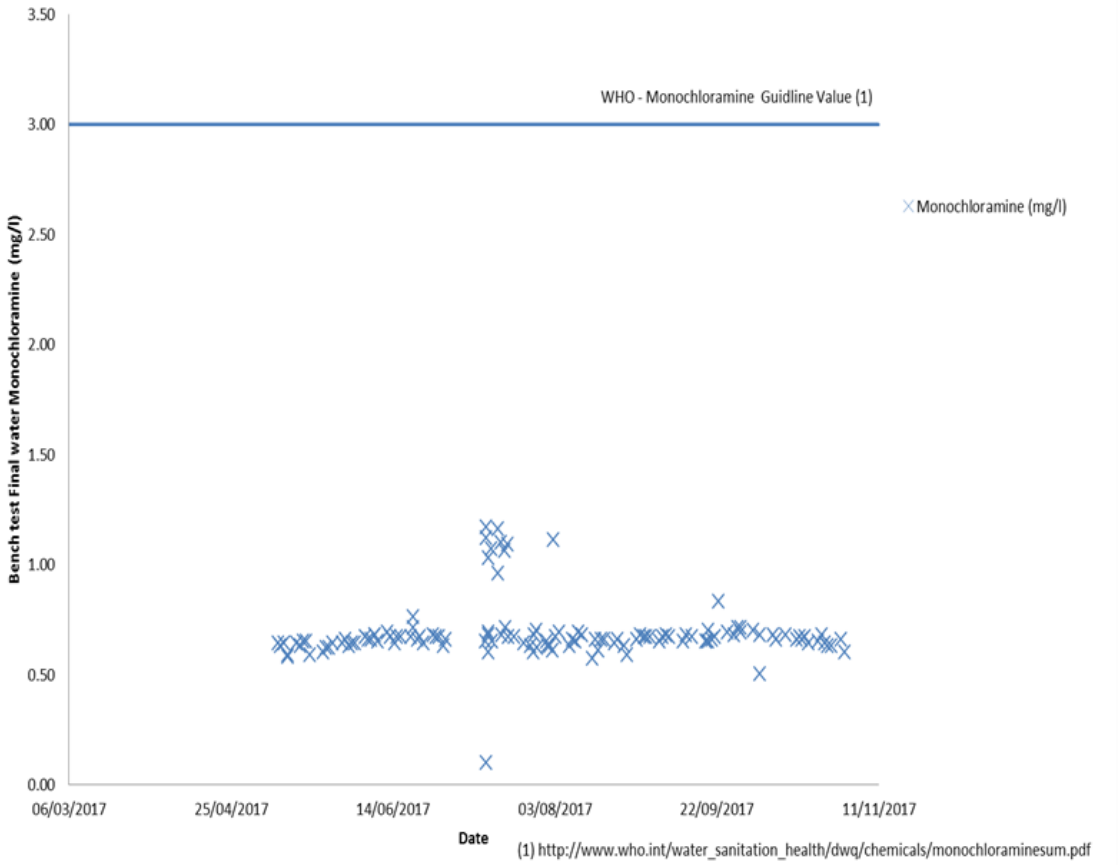



2(A) Ammonium

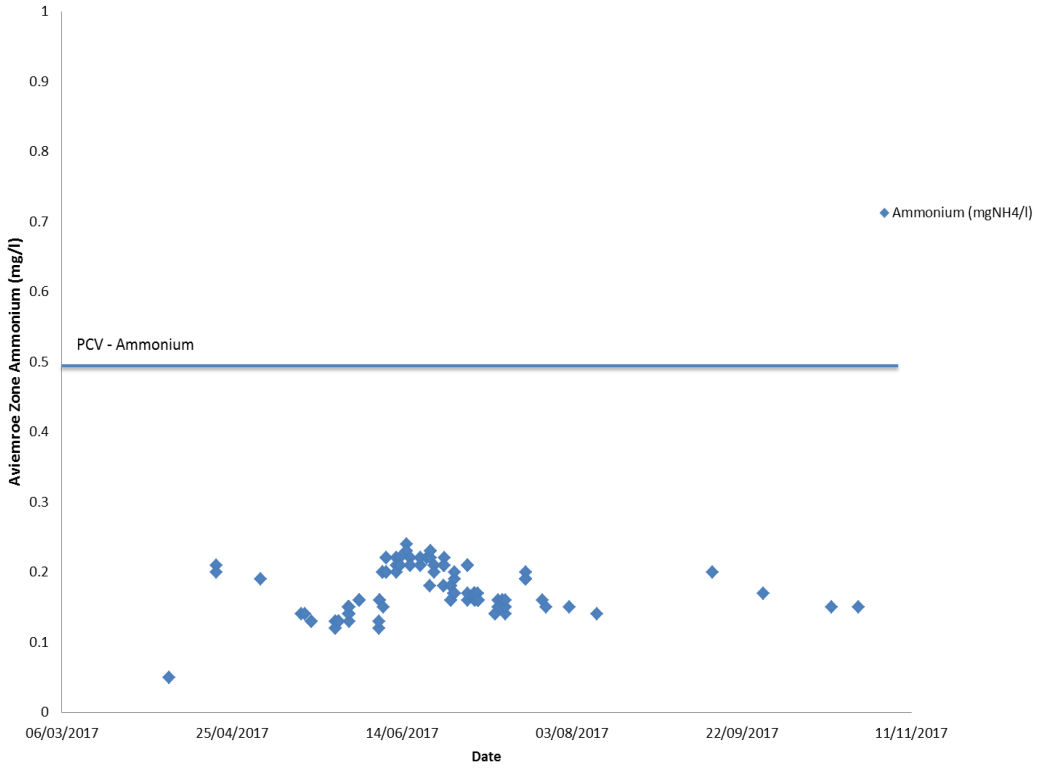



2(B) Free chlorine

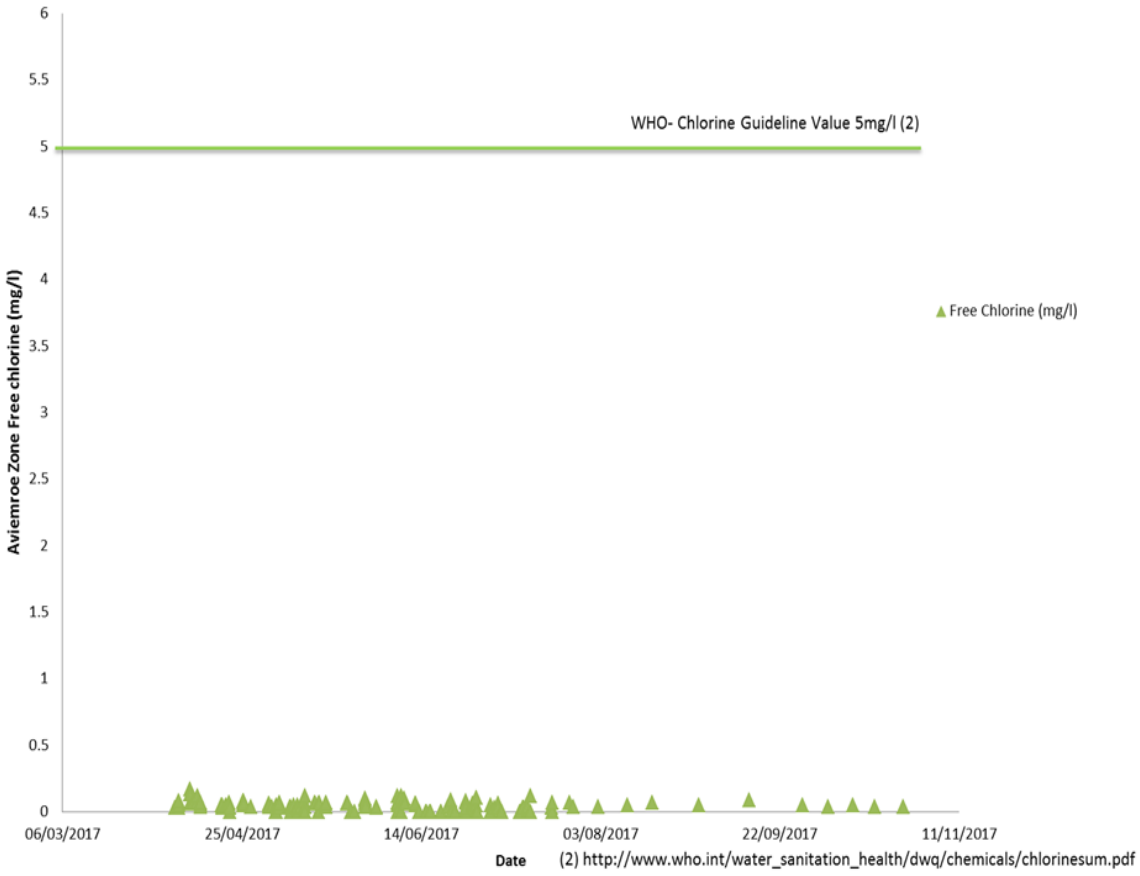
2(C) Monochloramines



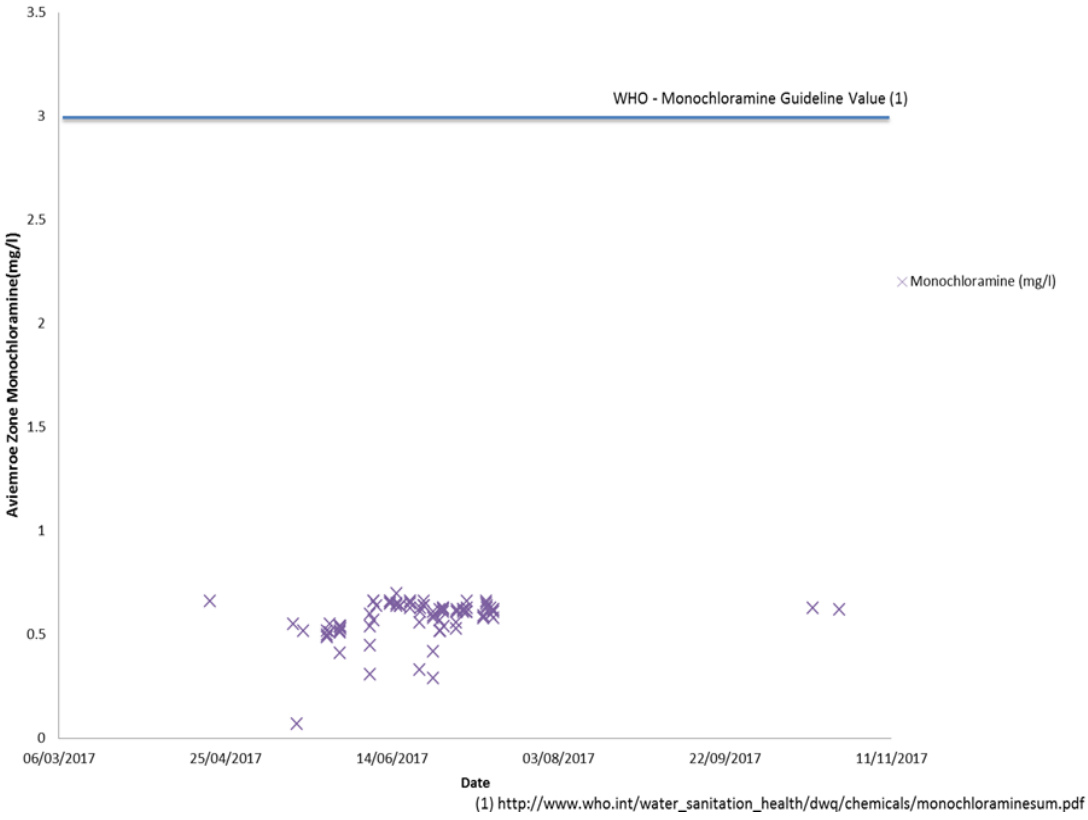

**Figures 2(A)-2(C)** Concentrations of ammonium (A), free chlorine (B) and monochloramine (C) in the final treated water ***at the Aviemore water treatment works*** from 1st April – 31st October 2017 ***measured as part of the regulatory and enhanced monitoring programmes.***


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Aviemroe Zone Ammonium (mg/l)
PCV - Ammonium
Ammonium (mgNH4/l)
06/03/2017
25/04/2017
14/06/2017
03/08/2017
22/09/2017
11/11/2017
Date

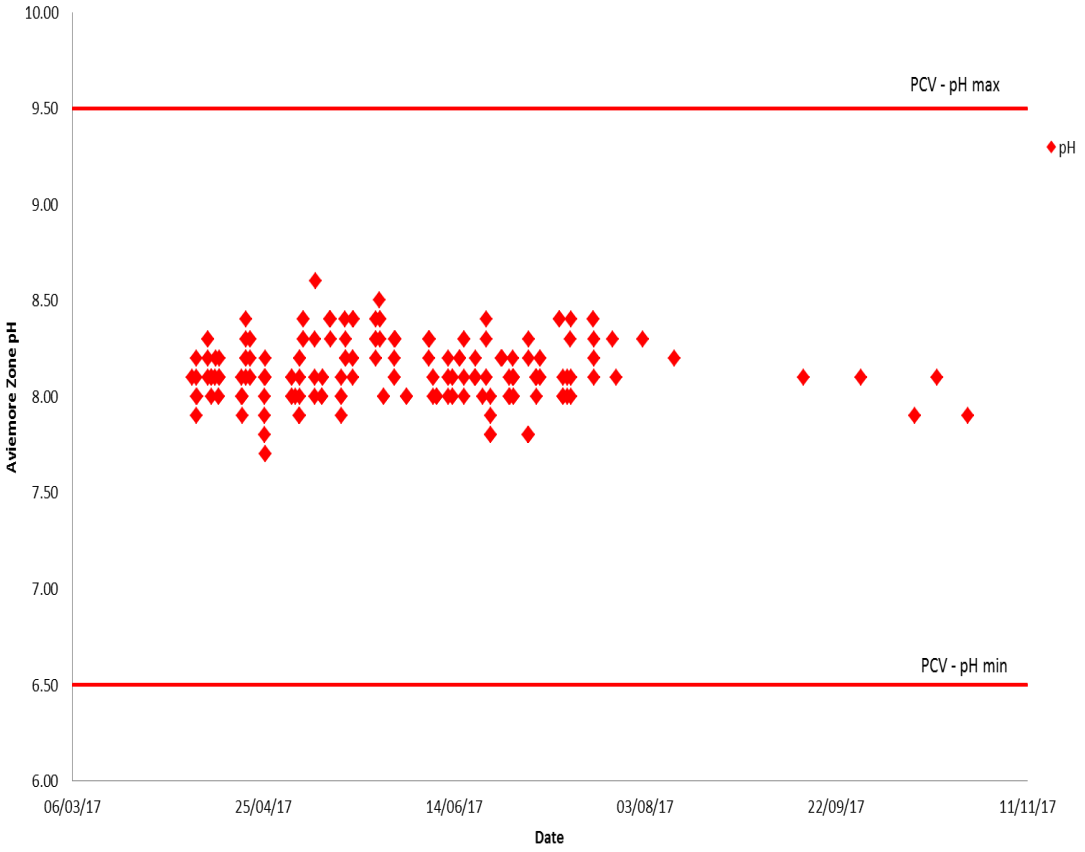
3(A) Ammonium




3(B) Free chlorine




3(C) Monochloramine




3(D) Hydrogen Ion (pH)

**Figures 3(A)-3(D)** Concentrations of ammonium (A), free chlorine (B), monochloramine (C) and hydrogen ion (pH)(D) in the final treated water ***at customer homes*** from 1st April – 31st October 2017, ***measured as part of the regulatory and enhanced monitoring programmes***

The data presented in Figures 2 and 3 are form the accredited sampling and analysis completed by Scientific Services. A full regulatory programme data set has been reported to the DWQR.

The disinfectant by-product associated with chloramination includes NDMA. The NDMA analysis was completed by an independent laboratory (ALS Environmental) and the limit of detection for their method was 0.5 ng/L – 20 ng/L. Over 70 samples from April 2017 were analysed from water collected at customer properties. The highest concentration was 0.8 ng/L which was recorded in one sample. There was one further sample at 0.6 ng/L and two samples at 0.5 ng/L. The vast majority of samples were below the limit of detection. Therefore, no samples approached the WHO guideline concentrations of 100 ng/L.

Similarly all monochloramine concentrations (Figures 2 and 3) were recorded at or below 0.7 mg/L which is significantly lower than the WHO guideline of 3 mg/L.

Overall disinfection by-products as measured as total trihalomethanes (THMs) were all below 3.2 µg/L. The PCV limit is 100 µg/L.

## Water Quality and Safety Parameters

### Outline of parameters and test protocol reference for drinking water determinants

| Parameter | Test Protocol | Method Basis |
|---|---|---|
| Coliforms | MD08 : Determination & Enumeration of Coliform Bacteria & E.Coli in Potable, Raw and Swimming Pool Waters using a single membrane filtration technique | The Microbiology of Drinking Water (2016) – Part 4 – Methods for the isolation and enumeration of coliform bacteria and *Escherichia coli* (including *E. coli* O157:H7) |
| E.coli | See above | See above |
| Total Viable Counts | The Determination of Colony Count in Potable, Raw and Swimming Pool Waters by Pour Plate Method | The Microbiology of Drinking Water (2012) - Part 7 – Methods for the enumeration of heterotrophic bacteria |
| Faecel Streptococci | MD04 The Determination of Enterococci in Potable and Raw Waters by Membrane Filtration | The Microbiology of Drinking Water (2012) - Part 5 – Methods for the Isolation and enumeration of enterococci |
| Clostridia | MD05 Clostridium Perfringens In Potable and Raw Waters by Membrane Filtration | The Microbiology of Drinking Water (2015) – Part 6 – Methods for the isolation and enumeration of sulphite-reducing clostridia and *Clostridium perfringens* by membrane filtration |
| Qualitative Odour | D58 Determination of Qualitative and Quantitative Taste and Odour in Raw and Potable Waters | The determination of taste and odour in drinking waters (2014) |
| Qualitative Taste | See above | See above |
| Quantitative Odour | See above | See above |
| Quantitative Taste | See above | See above |
| Cryptosporidium | MP18 Isolation and Identification of Cryptosporidium Oocysts in Raw and Potable Waters using Compressed Foam Filters | The Microbiology of Drinking Water (2010) - Part 14 - Methods for the isolation, identification and enumeration of *Cryptosporidium* oocysts and *Giardia* cysts |
| Free Chlorine | The Measurement of Free and Total Chlorine Residual in Potable Water Using HACH Colorimeter (Method Code S01) | Hach Pocket Colorimeter Chlorine Manual 1997. Hach Pocket Colorimeter II Chlorine Instruction Manual 2004 |
| Total Chlorine | See above | See above |
| Alkalinity | IC078 - Alkalinity in Sewage Effluents, Industrial Effluents, Leachates, Sewage Sludge Supernatants, Raw and Potable Waters and pH in Crude,Final and Trade Effluents and Leachates | Environment Agency, The Determination of Alkalinity and Acidity on Water 1981; Methods for the Examination of Waters and Associated Materials; |

| | | |
|---|---|---|
| Appearance | **ICO26 Determination of Appearance in Raw and Potable Waters | In house screening procedure |
| Aluminium, Iron, Manganese, Antimony, Arsenic, Cadmium, Copper, Chromium, Lead, Nickel & Selenium | ICPOES1 - Fe, Mn and Al in Potable and Raw Waters using a Perkin Elmer Optima 8300 ICP Spectrometer.<br>GIC001 – Analysis of defined elements by Perkin Elmer Nexion 300X ICPMS Spectrometer*<br>(also covers Al, Fe, Mn) | Standard Methods for the Examination of Water and Wastewater, 1989, 17th edition, published by APHA, AWWA, WPCF.<br>USEPA Method 200.8 |
| pH, Colour, Conductivity and Turbidity | GIC003 Conductivity, pH, Turbidity and Colour in Raw Water and Potable Waters by Peerless Autoanalyser System<br><br>IN33 Turbidity in Potable and Raw waters.<br><br>IN37 pH in Raw and Potable waters by pH meter.<br><br>IN38 Conductivity in raw and potable waters by conductivity meter @20$^{o}$C<br><br>IC002 Measurement of Colour in Raw and Potable waters by Uv-Vis Spectrometry | The Measurement of Electrical Conductivity and the Laboratory determination of the pH value of Natural, Treated and Waste Waters, 1978, Methods for the Examination of Waters and Associated Materials. HMSO ISBN 0 11 751 428 4.<br>The Determination of pH in Low Ionic Strength Waters, 1988, Methods for the Examination of Waters and Associated Materials. HMSO ISBN 0 11 752 084 5.<br>Department of the Environment, Methods for the Examination of Water and Associated Materials, Colour and Turbidity of Waters, 1981, Methods for the Examination of Waters and Associated Materials. HMSO ISBN 0 11 751 955 3. |
| Cyanide | IC008 Cyanide in Defined Matrices by Continuous Flow Analyser | Cyanide in Waters etc 1988. Methods for the Examination of Waters and Associated Materials. HMSO ISBN 0 11 752219 8.<br>SKALAR method for Total Cyanide, Catnr. I295-0047w/r Issue 102808/MH/99253508 |
| TOC | D45.1 The Determination of Total Organic Carbon (TOC) in defined matrices | Skalar Formacs HT combustion TOC/TN Analyser, user manual.<br>The instrumental determination of Total Organic Carbon, Total Oxygen and Related Determinands 1979 HMSO ISBN 0-11-751458-6 |
| Ammonium, Chloride, Nitrate, Nitrite, | IC009 - The Determination Of Chloride, Nitrite, Nitrate, Ton, Ammonium and Phosphate (SR) In Defined Matrices By Discrete Auto Analyser | Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992, Pb. American Public Health Association. HMSO ISBN 0-87553-207-1. |

| | | |
|---|---|---|
| | | Department of the Environment, Method for the Examination of Water and Associated Material, Chloride in Waters, Sewage and Effluents, 1981.<br>Department of the Environment, Method for the Examination of Water and Associated Material, Oxidised Nitrogen in Waters 1981.<br>Department of the Environment Standing Committee of Analysts method "Method for the Spectrophotometric Determination of Ammonia in Water" published in the method book, "Ammonia in Water 1981 |
| Boron, Sodium, Sulphate | ICPOES2 - Ca, Na, Mg, K, Ba, B, P, Li, Sulphate and Total Hardness (by Calculation) in Potable, Raw and Phosphate Dosed Waters using a Perkin Elmer Optima | Standard Methods for the Examination of Water and Wastewater, 1989, 17th edition, published by APHA, AWWA, WPCF.<br>Sulphate in Waters, Effluents and Solids (2nd Edition). 1988. HMSO,<br>Methods for the Boron in Waters, Effluents, Sewage and some Solids, 1980. HMSO, (Methods for the Examination of Waters and Associated Materials) |
| Mercury | ICPMS1 - Mercury In Potable And Raw Waters Using A Perkin Elmer ICPMS Spectrometer | Determination of mercury in potable water by ICP-MS using gold as a stabilising agent. James Allibone, Ebby Fatemian and Peter Walker (Thames Water). Journal of Analytical Atomic Spectrometry, 1998. |
| GC MS Scan* | **OC066 Semi Quantitative Screening for Semi-Volatile Organic Compounds using Gas Chromatography Mass Spectrometry | Standard Methods, For The Examination Of Waste And Wastewater, 18th Edition, American Public Health Association, Pages 6-76 - 6-89. |
| Phenols* | O021 The Determination of Phenolic Compounds by GC/MS | Environment Agency The Determination of Microgram and Submicrogram Amounts of Individual Phenols in River and Potable Waters 1988; Methods for the Examination of Waters and Associated Materials. |
| Low level Phenols*, ** | O021 The Determination of Phenolic Compounds by GC/MS | Environment Agency The Determination of Microgram and Submicrogram Amounts of Individual Phenols in River and Potable Waters 1988; Methods for the Examination of Waters and Associated Materials. |
| Benzene, 1,2-dichloroethane, Tetrachloroethene and Trichloroethene, | O013 The Determination of THM's & Volatiles in Potable and Untreated Waters by | |

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| Tetrachloromethane, THM: Total | Headspace Injection Gas Chromatography by GC/MS | In house developed method with ISO17025 accreditation. |
| Benzo(a)pyrene, PAH Total | OC 012 Determination of Polycyclic Aromatic Hydrocarbons in Raw and Potable Waters By Solvent Extraction and High Performance Liquid Chromatography with Programmable Fluorescence Detection | Environment Agency, The Determination of 6 Specific Polynuclear Aromatic Hydrocarbons in Waters (with notes on the determination of other PAH) 1985: Methods for the Examination of Waters and Associated Materials. **Environment Agency,** The Determination of 6 Specific Aromatic Hydrocarbons in Water (additional methods) 1997: Methods for the Examination of Waters and Associated Materials. |
| Fluoride, Bromate | O019 - Determination of Anions in Raw and Potable waters by Ion chromatography. | Determination of Disinfection By-Product Anions and Bromide in Drinking Water Using a Reagent-Free™ Ion Chromatography System Followed by Postcolumn Addition of an Acidified On-Line Generated Reagent for Trace Bromate Analysis, Dionex Application Note 171. |
| Aldrin, Dieldrin, Heptachlor, Heptachlor epoxide, Lindane | O020 The Determination of Pesticides and Herbicides in Raw and Potable Waters by GC/MS | Environment Agency, Organochlorine Insecticides and Polychlorinated Biphenyls in Waters 1978. Environment Agency, Organo-Phosphorous Pesticides in River and Drinking Water 1980 Tentative Method. |
| MCPP, MCPA, MCPB, 2,4-D, 2,4-DB, Dicamba | O024 The Determination of Acidic Herbicides by Triple Quad LC/MS/MS | In house developed method with ISO17025 accreditation. |
| Simazine, Atrazine, Linuron, Diuron, Propetamphos, Diazinon, Metazachlor, Metaldehyde, Isoproturon, Chlortoluron | O043 Determination of Mixed Pesticides, Herbicides and Fungicides by Direct Injection Triple Quad LC/MS/MS Analysis | In house developed method with ISO17025 accreditation. |
| Metsulfuron-methyl, Thifensulfuron-methyl, Tribenuron-methyl** | O018 Sulfonyl Urea Herbicides by Direct Injection LC/MS/MS | In house developed method with ISO17025 accreditation. |
| Cypermethrin, Flumethrin**, Permethrin | O009 The Determination of Pyrethroids and Flumethrin in Raw and Potable Waters by GCMS and GC-ECD | Environment Agency, Methods for the Determination of Synthetic Pyrethroid Insecticides in Waters by Gas Liquid |

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| | | Chromatography 1992, Methods for the Examination of Waters and Associated Materials.. Environment Agency, Pyrethrins and Permethrin in Potable Waters by Electron-Capture Gas Chromatography 1981, Methods for the Examination of Waters and Associated Materials. |
| Asulam | O022 Asulam by Direct Injection LC/MS/MS | In house developed method with ISO17025 accreditation. |
| Indicative dose –Gross alpha, Gross beta | RAD-1 Measurement of Alpha/Beta Activity in Potable and Raw Waters | Environment Agency, Measurement of Alpha and Beta Activity of Water and sludge samples. The determination of Radon - 222 and Radium - 226. The Determination of Uranium (including General X- Ray Flourescent Spectometric Analysis) 1985 - 1986. |
| Radon | RAD-3 Measurement of Radon in potable and raw waters | Water quality - Radon-222 - Part 4: Test method using two-phase liquid scintillation counting - 2013 |
| *** NDMA (N-Nitrosodimethylamine) | ALS Method Statement (outlined in Appendix 2) | Solid phase extraction followed by GCMSMS analysis |
| **** Monochloramine | The Measurement of monochloramine in Potable Water Using HACH Colorimeter (Method Code 10270) | Indophenol Method using Hach Pocket Colorimeter Chlorine Manual SL1000 |

*Additional screening tests analysed on request

** Outwith scope of accreditation

Total Pesticides: the sum of the concentrations of each pesticide analysed. The pesticides analysed are based on risk assessment.

*** NDMA analysis was completed by an independent laboratory (ALS Environmental). The method is not accredited

**** the monochloramine method is not accredited. It was completed by Scientific Services accredited DWTS samplers