Assessment of the Effects of Jug Water Filters on the Quality of Public Water Supplies

Final Report to the Drinking Water Inspectorate

DWI 6049/2
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ASSESSMENT OF THE EFFECTS OF JUG WATER FILTERS ON THE QUALITY OF PUBLIC WATER SUPPLIES

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EXECUTIVE SUMMARY

Jug water filters are popular, and undoubtedly can improve certain aspects of water quality. However, there is also the possibility that under certain circumstances they could lead to deterioration in quality. For example:

- Growth of bacteria in the filter cartridge could lead to elevated levels of Heterotrophic Plate Count (HPC) bacteria in the filtrate. Excessive growth could lead to an impairment of flavour and odour.

- Filters that incorporate silver to control the growth of bacteria could leach excessive concentrations into the filtered water.

- Partial softening of the water could lead to elevated leaching of metals from kitchen appliances and utensils such as kettles and saucepans.

Misuse or abuse by the consumer could exacerbate any problems due to bacterial growth. For example failure to change the filter cartridge at the recommended intervals could lead to a build up of bacteria. If the filter cartridge was contaminated with pathogenic bacteria, as a result of poor personal hygiene or contamination in the kitchen, the filter could become colonised leading to the presence of pathogens in the filtered water.

This laboratory study was undertaken to examine possible adverse effects of jug filters on water quality. The tests examined the effects of the devices both when operated according to the instructions for use and when operated so as to simulate misuse.

The tests were run with two test waters: “Water X”, a low-nutrient groundwater, and “Water Y”, a high nutrient surface water. A soft water (“Water Z”) was used in tests on metals leaching. Tests were undertaken using three popular brands of jug filter over an eight-week period (twice the manufacturers’ recommended lifetime). Five litres of water were filtered on each test day (Monday to Friday) and samples were taken when the following cumulative volumes had been filtered: 5, 10, 15, 25, 50, 75, 100, 150 and 200 litres. In addition, each Monday following stagnation over the weekend, the first litre filtered was sampled followed by a further sample after a total of two litres of filtrate had been discarded, as per the manufacturers’ instructions. Tests were also run on another filter system over its claimed lifetime of 20 weeks, following a similar protocol. Additional tests were undertaken to examine the effects of bacterial contamination of filters, storage of filtered water, prolonged non-use of filters and metals leaching from kitchenware.

As expected HPC levels were greater in Water Y than in Water X. The HPC levels in the feed waters were variable over the period of testing, as is expected with waters taken from supply. It should be noted that increases in HPC levels are not of themselves indicative of potential adverse health effects.

Both 22 °C and 37 °C HPC levels tended to be higher in the filtrates than in the feed water. The 22 °C HPC levels with Water Y tended to increase over the period of testing

for "regular" samples whereas in the Monday morning samples the levels peaked around the middle of the testing period. These results, obtained over a prolonged period of testing are reassuring in that there was no evidence of an "explosion" in HPC levels. In general the results are in line with expectations, with growth of HPC bacteria being greater with the high nutrient Water Y.

With the Monday morning samples, the HPC levels in the third litre filtered were generally (but not always) lower than in the first litre. Thus the manufacturers' recommendations to discard filtered water in order to flush the cartridge are partially effective. However, even after discarding two litres of filtrate the 22 °C HPC levels in the high nutrient water tended to be higher than those for "normal" samples at an equivalent stage of filter life.

Silver leached from three of the filters tested. There is a lack of toxicological data on long-term human exposure to silver in drinking water to determine whether the concentrations found are of concern to health. The concentration of silver leached fell over the period of testing.

There was no evidence that the filters caused deterioration in odour or flavour; some panellists detected odour and flavour in some filtered water samples but there was no clear pattern or consistency when all of the panellists' results were considered. There was no deterioration in odour or flavour even for samples taken well past the recommended lifetime for the filter cartridges. These results indicate that the odour or flavour of the filtered water would not indicate to consumers that the cartridge life had been exceeded.

Tests were run in which the filters were deliberately challenged with *E. coli* and *Salmonella* to simulate contamination of the filter. It was found that these organisms were only present – if at all – in the first filtrate following inoculation. Thereafter these bacteria were not detected in any filtrate, or in the filter media at the end of the experiment. These results are reassuring in that they indicate that pathogenic bacteria will not survive in the filtered water or in the filter media.

Storage of filtered water had little effect on HPC levels in the low-nutrient Water X. With the high nutrient Water Y, HPC levels tended to increase with storage of the filtered water; storage of the unfiltered water also resulted in a smaller increase in HPC.

Allowing filters to stagnate for seven days (prolonged non-use) with Water X had little effect on HPC levels in the filtrates. With Water Y the 22 °C HPC levels in the filtrates increased when the filters were stored, and the effects were greater with storage at 20 °C than at 4 °C. This demonstrates that it is advisable to store filter cartridges in a refrigerator during periods of prolonged non-use.

Overall there was no evidence that jug water filter systems have adverse effects on microbial water quality, even when tested under conditions simulating abuse and contamination.

Metals leaching tests were run in which jug-filtered water was boiled in kettles and saucepans. These tests showed substantial leaching of nickel into filtered hard Water X and soft Water Z when boiled in kettles with exposed nickel-plated elements. There was little leaching of the other metals that were tested for (chromium and iron) when filtered water was boiled in kettles with flat bed stainless steel elements and stainless steel and saucepans. High nickel concentrations were also found when unfiltered water samples were boiled in kettles with exposed nickel-plated elements.

Additional tests were undertaken using hard Water X with eight models of kettle with exposed heating elements; six of these had nickel-plated elements and the other two had non-plated stainless steel elements. The kettles with nickel-plated elements leached substantial quantities of nickel. These tests were run over a four-week period, over which time the nickel levels gradually fell. At the start of the test, with new filter cartridges, leaching of nickel was higher with jug-filtered water than untreated Water X. As the jug filters became exhausted the nickel concentrations fell to levels at or below those of untreated Water X. The increased leaching observed with new filter cartridges was associated with the reduced pH and alkalinity of the water. Nickel did not leach from kettles with stainless steel elements. A small-scale survey of households also showed nickel leaching from certain kettles, higher nickel levels being associated with boiling water filtered through new filter cartridges.

1. INTRODUCTION

1.1 Background

A variety of plumbed-in water treatment devices are available for domestic use. These include plumbed-in systems such as ion-exchange softeners, activated carbon filters and reverse osmosis systems. In addition, there has been a growth in recent years in sales of free-standing “jug” filters. These employ a replaceable filter cartridge that typically contains a mixture of weak base ion-exchange resin and granular activated carbon. The resin effects partial softening (thus reducing scum on tea etc.) and provides some removal of metals such as lead and copper. The activated carbon removes chlorine and may also give some removal of coloured humic substances and some other organic chemicals.

Whilst jug filters are popular, and undoubtedly can improve certain aspects of water quality, there is also the possibility that under certain circumstances they could lead to deterioration in quality. For example:

- Growth of bacteria in the filter cartridge could lead to elevated levels of Heterotrophic Plate Count (HPC) bacteria in the filtrate. Excessive growth could lead to an impairment of flavour and odour.

- Filters that incorporate silver to control the growth of bacteria could leach excessive concentrations into the filtered water.

- Partial softening of the water could lead to elevated leaching of metals from kitchen appliances and utensils such as kettles and saucepans.

Misuse or abuse by the consumer could exacerbate any problems due to bacterial growth. For example failure to change the filter cartridge at the recommended intervals could lead to a build up of bacteria. If the filter cartridge was contaminated with pathogenic bacteria, as a result of poor personal hygiene or contamination in the kitchen, the filter could become colonised leading to the presence of pathogens in the filtered water.

As a result of concerns such as those outlined above, the Drinking Water Inspectorate (DWI) awarded a contract to WRc-NSF to undertake a study of the possible adverse effects of jug filters on water quality. This study involved a laboratory simulation of the effects of the devices both when operated according to the instructions for use and when operated so as to simulate misuse (i.e. ignoring the instructions).

1.2 Objectives

The objectives of this study, as stated in the contract specification provided by the DWI are:

1. To propose for study in-house treatment systems that might, in particular water quality and/or environmental settings cause significant deterioration in the quality water supplied to a property.

2. To identify water supply zones where water quality exhibits appropriate characteristics and to identify in-house water treatment systems that are offered for sale within the relevant supply zones.

3. To propose and justify studies to compare water quality before and after treatment (including, as a minimum, aesthetic and microbiological parameters). To investigate possible sources of deterioration in water quality, under conditions that are representative of actual use conditions, including realistic simulations of possible abuse, or failure to follow the supplier's instructions.

4. To purchase in-house water treatment systems from retail outlets and to consult with suppliers to ensure that the proposed test conditions are consistent with suppliers' operating instructions for the treatment systems.

5. To conduct a programme of testing that has been agreed with the Contract Manager and to report on the quality of the water before and after in-house treatment, identifying and discussing the implications of adverse effects on water quality.

6. To produce guidance to assist consumers to identify possible disbenefits arising from the use of in-house treatment systems and to avoid use of systems that are unsuitable, or unnecessary, in their own water supply.

1.3 Structure of the report

The basic test conditions are described in Section 2. The test procedures are detailed in Section 3 and the results are presented in Section 4 as shown in Table 1.1.

Table 1.1 Key to test procedures and results

Topic		Procedure	Results
	Growth of HPC bacteria		4.1.2
Basic tests	Silver leaching	3.1	4.1.3
	Odour and flavour		4.1.4
	Challenge tests		4.2.1
Additional microbial	Storage of filtered water	3.2	4.2.2
	Non-use of filter		4.2.3
Metals leaching		3.3	4.3

The results are discussed in Section 5 and Section 6 presents the main conclusions.

Whilst the results of this report can be understood without the description of the experimental methods given in Sections 2 and 3, the methodology should be taken into account for a full appreciation of the conclusions.

2. TEST CONDITIONS

2.1 General

Three sets of tests were run:

1. Tests on four models of jug filter systems, with two types of water, to examine effects on HPC bacteria, flavour and odour and silver leaching.

2. Additional microbiological tests with three models of filter to examine the effects of contamination, storage of filtered water and prolonged non-use of the filter.

3. Tests with three models of filter to assess the effects of partial water softening as a result of jug filtration on metals release from stainless steel and exposed plated heating elements and stainless steel cookware. An initial test using two models of kettle was followed by extended testing with eight models of kettle.

2.2 Filters

There are at least five brands of jug filter on sale in the UK. Most of these offer a choice of several models. A list was compiled of the makes and models available from which DWI selected four models from four different brands for testing. In this report these are identified as "A", "B", "C" and "D". Filters A, B and C were conventional gravity-fed systems with a claimed cartridge capacity of approximately 100 litres, equivalent to a lifetime of about one month. Filter D was a more elaborate filter incorporating an electric pump; the claimed cartridge capacity was 750 litres, with a maximum 20-week lifetime.

Test filters A to C were purchased from retail outlets by WRc-NSF staff. Test filters D were obtained by mail order from the supplier.

The test filters were set-up following the manufacturers' instructions for use.

2.3 Kettles and saucepans

Kettles and saucepans were purchased from retail outlets by WRc-NSF staff.

Nine models of kettles were used in the tests on metals leaching. These are coded as Kettles J to R. They were conditioned before use following the manufacturer's instructions which involved filling the kettle with tap water and boiling; the number of fillings and boilings (up to four) varied with the model of kettle. The composition of the kettle elements was determined following the experiments and the results are summarised in Table 2.1.

Table 2.1 Composition of kettle elements

Kettle code	Tube	Plating
J	Concealed element – not analysed	
K	Copper	Nickel
L	Copper	Nickel
M	Copper	Nickel
N	Copper	Nickel
O	Copper	Nickel
P	Copper	Nickel
Q	Stainless steel	Not plated
R	Stainless steel	Not plated

2.4 Test waters

For these studies, it was important that one water type used for the tests contained sufficient micro-organisms to challenge the filter and that microbial activity was encouraged by the presence of sufficient nutrients and a low disinfectant residual. Medmenham tap water (groundwater) was used as a low-nutrient water (Water X) with low HPC. The "High Nutrient" water (Water Y) was collected from a water treatment plant treating a lowland surface water. The nutrient content of the waters was determined by measuring the concentration of assimilable organic carbon (AOC) at the start of the experiments using the procedure developed by Jago and Stanfield (1992).

An additional, soft, test water (Water Z) was used in metals leaching tests; this was obtained from WRc-NSF Oakdale.

Test waters were collected at least weekly and stored in 50 litre polyethylene containers at room temperature in the laboratory. The period of storage was variable as the required volumes of water varied during the various stages of the experiments.

A full chemical analysis was run on initial samples of the test waters. Thereafter pH was measured daily and alkalinity weekly.

2.5 Methods of water analysis

Colony counts of heterotrophic bacteria were carried out by the pour plate method using yeast extract agar as the culture medium (DoE 1994, SCA 2002). For all samples tests were carried out at both 22 °C (incubation for 72 hours) and at 37 °C (incubation for 48 hours).

Alkalinity was determined by titration against standardised hydrochloric acid with potentiometric detection of the end point (SCA 1981).

Calcium was determined by flame atomic absorption spectroscopy (SCA 1987).

Chromium, iron, nickel and silver were determined by inductively coupled plasma – mass spectrometry (SCA 1996).

Hexavalent chromium [Cr(VI)] was determined using a method involving reaction of Cr(VI) with diphenylcarbazide, solvent extraction and atomic absorption spectrometry (Gardner and Comber 2002).

3. EXPERIMENTAL PROTOCOLS

3.1 Basic tests

3.1.1 Filters A, B and C

The following procedure was used to examine effects on HPC levels, flavour and odour and silver leaching. The test filter cartridges have a claimed capacity of approximately 100 to 150 litres and a lifetime of approximately four weeks. The following procedure tested the filters over an eight week period, simulating use beyond both claimed capacity and lifetime.

The three models of filter were each tested with low-nutrient and high-nutrient water.

For each filter tested, on each working day (Monday to Friday), five 1-litre portions of water were filtered, allowing a gap of at least 30 minutes between portions. Between filtrations, filtered water was left in the jug (i.e. the cartridge was kept wet). The filters were kept at ambient temperature (20 °C) throughout the tests.

On each Monday, following the weekend stagnation, the first litre of water filtered was taken for analysis. The manufacturer's instructions for use – all of which state that the first two litres of filtrate should be discarded after stagnation – were then followed after which a further sample was taken. This procedure was designed to identify (a) water quality deterioration under "worst case" conditions and (b) whether the manufacturer's recommendations were effective.

In addition to the above sampling, samples were taken and analysed on days that corresponded to when the following volumes of water filtered were reached: 5, 10, 15, 25, 50, 75, 100, 150 and 200 litres. These volumes correspond to 5%, 10%, 15%, 25%, 50%, 75%, 100%, 150% and 200% of capacity for a 100-litre capacity cartridge. The schedule for these samples is given in Table 3.1.

3.1.2 Filter D

The same basic test procedure, filtering five litres of water per day, was followed. Samples were taken at times corresponding to the same percentage capacities as for Filters A to C. Because Filter D has a higher capacity, the tests ran over a longer period (20 weeks). In addition, testing of Filter D commenced after testing of Filters A to C. Consequently the results for Filter D are presented separately. The sampling schedule is given in Table 3.2.

Samples were also taken on some Mondays, following the same procedures as for Filters A to C. A number of samples were taken immediately following Bank Holidays, corresponding to extended periods of non-use.

Table 3.1 Sampling schedule – Filters A to C

Litres filtered	% Capacity	Day number	Date
5	5%	1	21-Jan-02
10	10%	2	22-Jan-02
15	15%	3	23-Jan-02
25	25%	5	25-Jan-02
50	50%	12	1-Feb-02
75	75%	19	8-Feb-02
100	100%	26	15-Feb-02
150	150%	40	1-Mar-02
200	200%	54	15-Mar-02

Table 3.2 Sampling schedule – Filter D

Litres filtered	% Capacity	Day number	Date
5	1%	1	18-Feb-02
25	5%	5	22-Feb-02
50	10%	12	1-Mar-02
75	15%	19	8-Mar-02
125	25%	33	22-Mar-02
250	50%	68	26-Apr-02
375	75%	103	31-May-02
500	100%	138	5-Jul-02

3.1.3 Analysis

The five litres of filtrate collected on each sampling day were pooled before analysis. All samples were analysed for Total Viable Count at 22 °C and 37 °C, silver concentration and odour and flavour. For the plate counts, blank controls were run on each day at the start and end of analysis and all the results were satisfactory.

Odour and flavour tests on each sample were undertaken by three panellists; different panellists were used in different odour and flavour assessment sessions. Corresponding samples of influent water (composite for each day) were also analysed.

3.2 Additional microbiological tests

3.2.1 General

Filters A, B and C were used with the same test waters and basic filtration protocol as specified above.

Three stages of filter maturity were examined:

- Immature (after 2 days, ≡ 10% capacity for a 100-litre capacity cartridge)
- Semi-mature (after 14 days, ≡ 50% capacity for a 100-litre capacity cartridge)
- Mature (after 28 days, ≡ 100% capacity for a 100-litre capacity cartridge).

3.2.2 Challenge tests

Separate filters (A, B and C), at different stages of maturity, were challenged separately with *E. coli* and *Salmonella typhimurium* to simulate a contamination incident. An inoculum was prepared as a high number of bacteria (*E. coli* [NCTC 9001] 1.5×10^6, *S. typhimurium* [NCTC 12416] 4.6×10^5) in 1 ml of suspension medium spiked into 1 litre of test water, which was then filtered in the normal way. The suspension of bacteria was washed prior to use to remove nutrients. These two bacteria were also dosed into the test water only (no filter) as a control and to introduce compensation for changes in survival not associated with the filter. The filtrates were examined for the presence of these bacteria up to one week after inoculation. On completion of the test the filter cartridge was examined to assess whether these bacteria were still present on the medium. Techniques were applied to homogenise the filter matrix and bacteria were enumerated using liquid culture techniques using methods described by Pitchers and Jago (1992).

3.2.3 Effects of storage

Filtered water was collected from each filter (A, B and C) at different stages of maturity and stored in covered glass beakers (under conditions representing storage in jugs with lids) under different conditions. The filtered water samples were composites collected following the general filtration protocol. A control was set up to compensate for the changes in numbers of micro-organisms that may have taken place in unfiltered water when it was stored under the same conditions. Separate volumes of filtered water were stored at ambient temperature (20 °C) and in the refrigerator (4 °C). The numbers of heterotrophic bacteria (22 °C and 37 °C) in the stored water were determined immediately and after intervals of 1, 2, 4, and 7 days.

3.2.4 Impact of prolonged non-use

Filters (A, B and C), of different maturity, were left to stagnate for seven days. One set of filter cartridges was sealed and stored cold and another set of filter cartridges was stored in the empty filter jugs under ambient conditions to represent misuse. The first 1-litre flush through each filter was collected, which simulated disregard of instructions stated by the manufacturer, and the numbers of heterotrophic bacteria were measured in the filtrate. A further litre of water was filtered and the filtrate was discarded, after which a third litre was filtered and assayed for heterotrophic bacteria. This reflected the manufacturer's instructions regarding flushing before water is considered fit for use. This was repeated at 7-day intervals up to a total of 28 days.

3.3 Metals leaching tests

3.3.1 Initial tests

Filters A, B and C were each used to filter a hard water (X) and a soft water (Z), using new filters for each water. After following the manufacturer's instructions for use, five 1-litre portions of water were filtered, allowing a gap of at least 30 minutes between portions. The five litres of filtrate were collected and pooled.

Portions of the unfiltered and filtered water were boiled in electric kettles (until the kettle automatically switched off) and pans (15 minutes simmering). One model of kettle with flat bed (concealed) stainless steel element (Kettle J) and one model with exposed nickel-plated elements (Kettle K) were tested. Each water sample was tested in duplicate, using the same kettles and pans. Kettle water samples were allowed to cool for 1-hour; pan samples were taken immediately. The pH of water samples (including unfiltered test water) was determined, together with Ca, Fe, Cr and Ni.

Tests on hard water and soft water were conducted separately, using different samples of the kettles and pans. The same kettles and pans were used for the different jug-filtered samples. The kettle and saucepan manufacturers' instructions for use were followed prior to the boiling tests.

3.3.2 Extended tests

Laboratory tests

Eight models of kettle (Kettles K to R) with exposed heating elements were used, one of which (Kettle K) was included in the initial tests.

Three makes of filter (A to C as tested previously) were each tested with each of the eight models of kettle. Each filter (and associated unfiltered water sample) was used with the same kettle throughout the tests.

Five 1-litre portions of Medmenham tap water (Water X) were filtered each day, five days per week as in previous experiments. The five litres of filtrate from each filter were pooled and the pH was measured. One litre of the pooled filtrate was boiled until the kettle switched off automatically, then allowed to cool in the kettle for one hour before being sampled. This was repeated with a second portion of filtrate (i.e. two 1-litre portions of water per day were boiled in each kettle). Samples of unfiltered water were treated in the same way. Samples of the boiled water and unboiled Medmenham tap water were analysed on days 1, 2, 3, 4, 5, 12, 19 and 26.

On days 1 and 5 each of the two litres of boiled water were analysed separately. On days 2, 3, 4, 12, 19, and 26 the two litres of boiled water were pooled prior to analysis. The samples were analysed for alkalinity, Ca, total Cr, Cr(VI), Fe and Ni. The "Day 1" samples from Kettle K in these tests are directly comparable to the initial tests.

In the case of boiled unfiltered Medmenham tap water, two portions were taken for analysis. One portion was filtered through a 0.45 μm pore size membrane filter prior to analysis (for dissolved metals), the other was unfiltered (for total metals).

In addition, with Kettle K (the same model as previously tested) and unfiltered Medmenham tap water the above procedure was followed but in addition water samples were taken immediately after boiling, then again after the 1-hour cooling period.

At the end of the experiment, repeat boilings of Medmenham tap water were undertaken using Kettles K and L. One litre of tap water was placed in the kettle, boiled and allowed to stand for one hour after which time a 60 ml sample was taken for nickel analysis. This was repeated a further six times without changing the water in the kettle.

Metallurgical analysis of kettle elements

The elements from the Kettles K to R that had been used to boil unfiltered Medmenham tap water were analysed[1] by optical spectroscopy and Scanning Electron Microscopy coupled with Energy Dispersive X-ray analysis (SEM/EDX). The elements were sectioned and three samples of each element were mounted in cross-section through the element tubing using a conductive bakelite resin. The resulting samples were ground and polished to a 1 mm finish for metallurgical examination. The specimens were examined using optical and scanning electron microscopy. For the SEM examination the mounted specimens were attached to an aluminium SEM stub and coated with carbon.

Coating thickness measurements were taken for each kettle element. The chemical analysis of the coating was conducted using the EDX facility of the scanning electron microscope. Individual analyses were conducted at the surface of the element and in the bulk tube material to identify coating layers on the element. The digimap facility for the microscope was used to identify the distribution of the elements to allow thickness and composition of different coating layers to be determined.

[1] The metallurgical analysis was undertaken by Sheffield Testing Laboratories Limited.

Samples from consumers' premises

Five households that have jug filters and kettles with exposed heating elements were identified. The householders were requested to take two sets of samples at "random" times within a one-month period. One set of samples was taken shortly (but not immediately) after replacement of the filter cartridge; the other set was taken once the cartridge was near the end of its life. Samples of tap water, filtered water and boiled water were taken; the boiled samples were taken after allowing five minutes for the water to cool. These samples were analysed for alkalinity, Ca, total Cr, Cr(VI), Fe and Ni. Details of the filter and kettle were recorded (make, model, approximate age).

4. RESULTS

4.1 Basic tests

4.1.1 Feed waters

The chemical analysis of the initial samples is given in Table 4.1 and heterotrophic plate count results for samples of the feed waters are given in Table 4.2. The results of routine pH and alkalinity measurements are given in Appendix A. Assimilable Organic Carbon (AOC) concentrations were measured during the period 29 January to 4 February 2002 and determined to be 0.035 mg/l and 1.99 mg/l for Waters X and Y respectively.

Table 4.1 Chemical analysis of feed waters

Parameter	Unit	Water X 21/01/02	Water Y 21/01/02	Water Z 12/04/02
Al	µg/l	1.5	52.2	11.5
Alkalinity	mg/l $CaCO_3$	216	161	41.7
Ca	mg/l	112	116	19.5
Cl	mg/l	19.7	63.5	10.5
Colour	Hazen	<2	<2	<2
Conductivity	µS/cm	536	715	132
Cu	µg/l	83.2	2.4	9.4
Fe	µg/l	<20	24	<20
K	mg/l	1.81	5.86	0.51
Mg	mg/l	2.38	5.86	1.28
Mn	µg/l	0.18	3.43	3.95
Na	mg/l	11.2	38.4	5.49
NH_3	mg/l N	<0.05	<0.05	0.09
NO_3	mg/l N	6.70	8.87	0.50
Pb	µg/l	4.54	0.19	0.15
pH		7.35	7.58	7.47
Si	mg/l	10.5	6.78	0.97
SO_4	mg/l	16.9	92.2	17.1
TOC	mg/l	0.64	2.53	0.42
Total P	mg/l	<0.05	0.07	0.74
Turbidity	NTU	<0.06	<0.06	<0.06
Zn	µg/l	104	9.4	6.6

Table 4.2 HPC results for feed waters (cfu/ml) – Filters A to C

	Water X		Water Y	
	22 °C	37 °C	22 °C	37 °C
23-Jan-02	3	0	1	0
5-Feb-02	0	0	0	1
19-Feb-02	0	0	0	0
7-Mar-02	0	0	TNTC	2
18-Mar-02	40	11	TNTC	440
22-Mar-02	63	67	11800	720

TNTC = Too Numerous To Count – approximately >10,000

4.1.2 Heterotrophic plate count

Filters A, B and C

The 22 °C HPC results for filters A, B and C are given in Table 4.3 and Table 4.4. The results for Monday morning samples for Water Y are plotted in Figure 4.1 and Figure 4.2. Table 4.5, Table 4.6, Figure 4.3 and Figure 4.4 give the 37 °C HPC results.

Table 4.3 22 °C heterotrophic plate counts (cfu/ml)

			Water X			Water Y		
Day no	%Cap	Date	A	B	C	A	B	C
1	5	21-Jan-02	0	0	0	5	30	35
2	10	22-Jan-02	0	1	1	1	5	1
3	15	23-Jan-02	1	2	0	0	2	6
5	25	28-Jan-02	0	1	0	0	0	0
10	50	1-Feb-02	1	18	0	16	374	256
15	75	8-Feb-02	0	0	0	134	1340	4480
20	100	15-Feb-02	0	0	0	1440	7160	3040
30	150	1-Mar-02	0	0	0	527	972	518
40	200	15-Mar-02	21	600	600	5700	2000	3500

Table 4.4 22 °C heterotrophic plate counts (cfu/ml) – Monday morning samples

Date	Litre No.	Water X A	Water X B	Water X C	Water Y A	Water Y B	Water Y C
28-Jan-02	1	0	31	0	1110	143	52
28-Jan-02	3	0	0	0	149	120	19
4-Feb-02	1	0	8	0	10000	1036	1000
4-Feb-02	3	0	1	0	644	354	728
11-Feb-02	1	0	0	0	4400	27100	60000
11-Feb-02	3	0	0	0	1445	2945	6000
18-Feb-02	1	0	0	0	48000	66400	30800
18-Feb-02	3	0	0	1	22200	23700	15400
25-Feb-02	1	0	0	0	11100	19000	13900
25-Feb-02	3	0	0	0	3100	9900	700
4-Mar-02	1	268	266	23	290	1590	1080
4-Mar-02	3	2	11	5	130	340	1205
11-Mar-02	1	320	0	300	4200	1700	5500
11-Mar-02	3	300	284	480	1060	980	1210

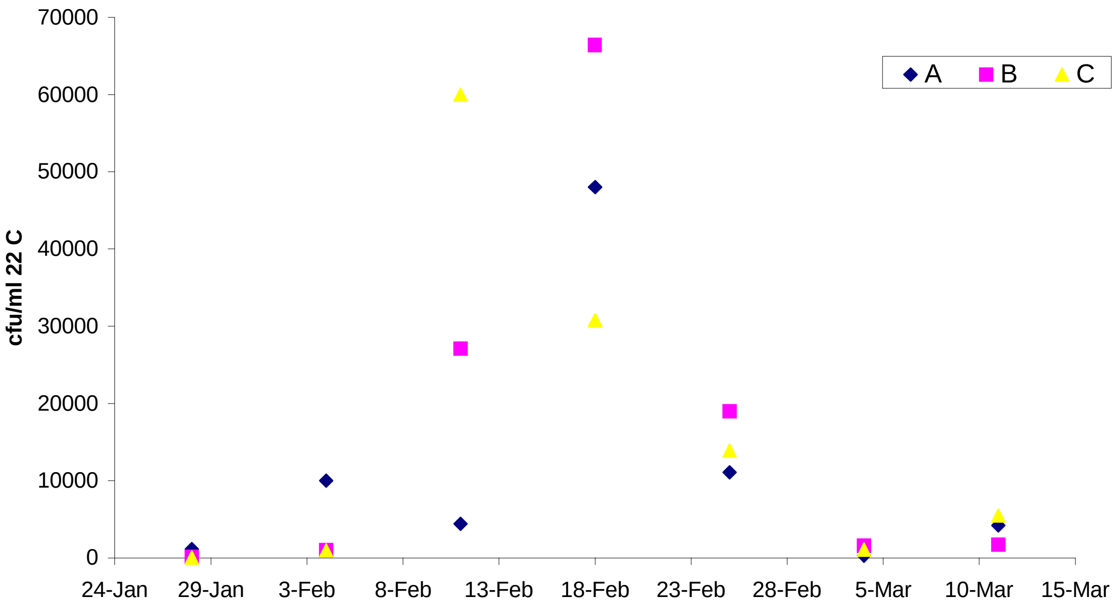

Figure 4.1 22 °C HPC (cfu/ml) – Monday morning samples, Water Y, 1st litre

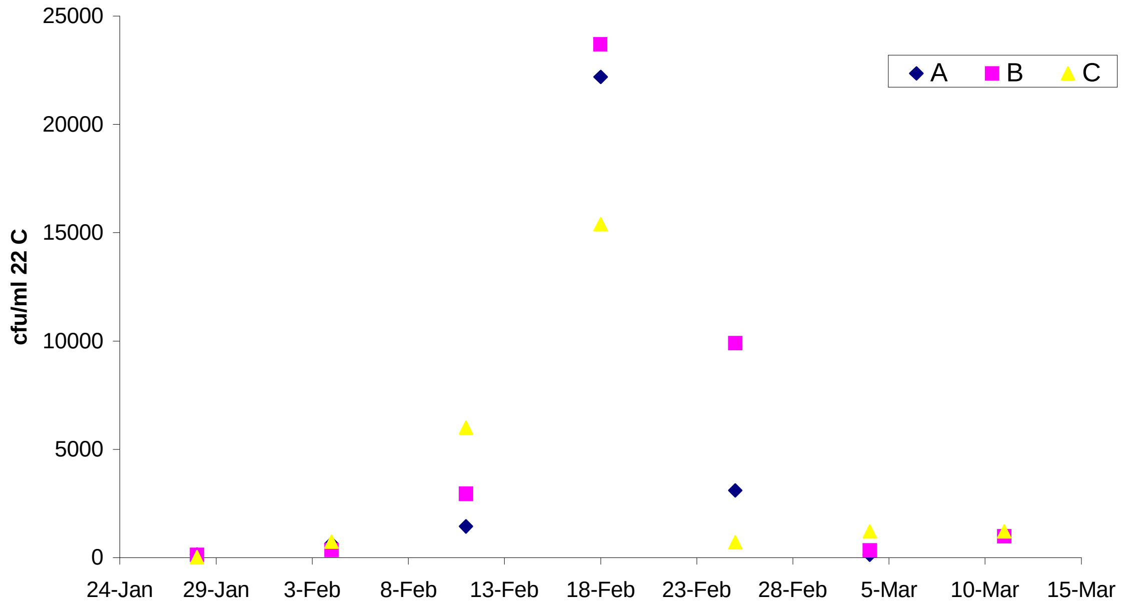

Figure 4.2 **22 °C HPC (cfu/ml) – Monday morning samples, Water Y, 3rd litre**

Table 4.5 **37 °C heterotrophic plate counts (cfu/ml)**

			Water X			Water Y		
Day no	%Cap	Date	A	B	C	A	B	C
1	5	21-Jan-02	0	0	0	5	2	10
2	10	22-Jan-02	0	0	0	0	0	6
3	15	23-Jan-02	0	3	0	0	5	6
5	25	28-Jan-02	0	0	0	0	1	0
10	50	1-Feb-02	0	0	0	0	42	280
15	75	8-Feb-02	0	0	0	25	892	73
20	100	15-Feb-02	0	0	0	28	3	119
30	150	1-Mar-02	0	0	0	7	0	0
40	200	15-Mar-02	9	0	0	81	39	34

Table 4.6 37 °C heterotrophic plate counts (cfu/ml) – Monday morning samples

Date	Litre No.	Water X A	Water X B	Water X C	Water Y A	Water Y B	Water Y C
28-Jan-02	1	0	0	0	2	0	1
28-Jan-02	3	0	0	1	3	0	0
4-Feb-02	1	3	0	0	104	122	13
4-Feb-02	3	0	0	0	20	89	1
11-Feb-02	1	0	0	4	54	600	27
11-Feb-02	3	0	0	0	31	600	21
18-Feb-02	1	0	0	0	142	13	122
18-Feb-02	3	0	0	1	213	16	75
25-Feb-02	1	0	0	0	77	1	16
25-Feb-02	3	0	0	0	78	2	9
4-Mar-02	1	90	0	2	144	43	390
4-Mar-02	3	0	0	0	74	36	111
11-Mar-02	1	16	1	1	8	3	446
11-Mar-02	3	49	0	0	25	12	360

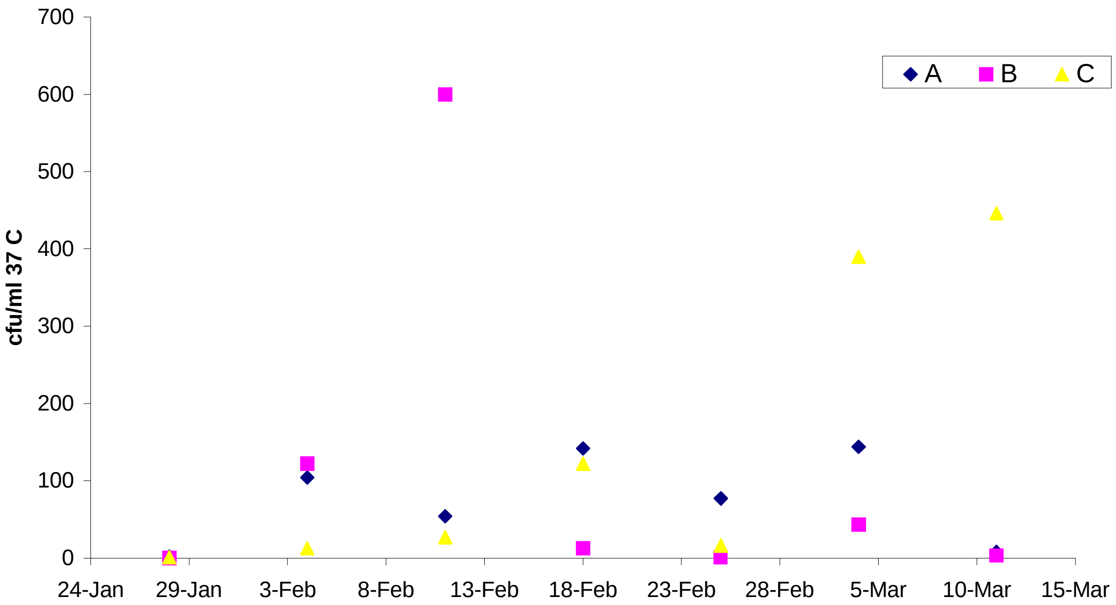

Figure 4.3 37 °C HPC (cfu/ml) – Monday morning samples, Water Y, 1st litre

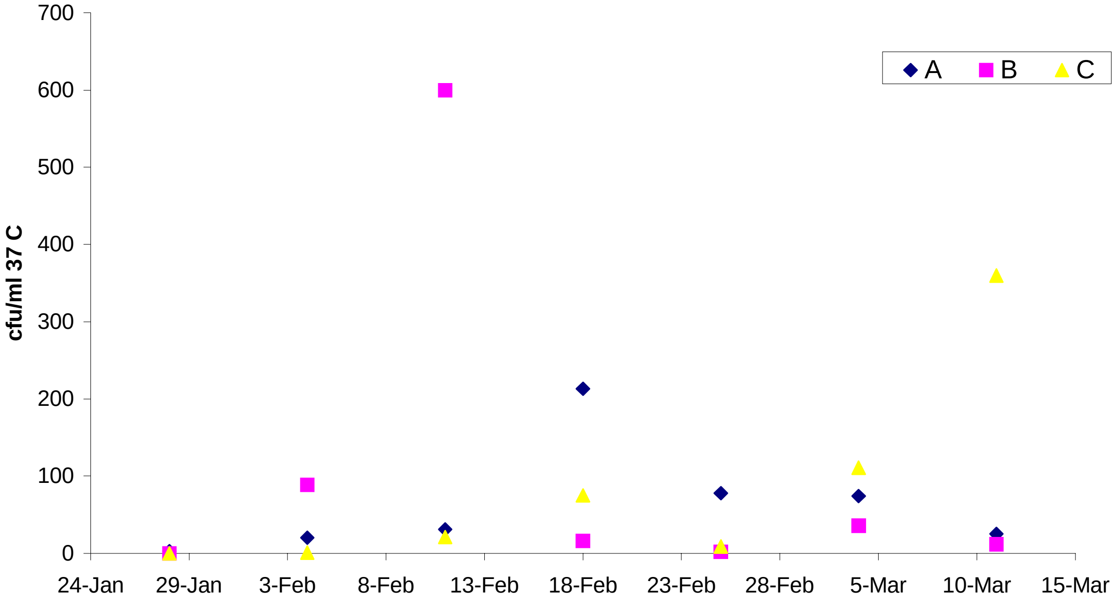

Figure 4.4 37 °C HPC (cfu/ml) – Monday morning samples, Water Y, 3rd litre

Filter D

The HPC results are given in Table 4.7 and in Figure 4.5 to Figure 4.8. The results for Monday morning samples are given in Table 4.8 and Figures 4.9 to 4.12.

Table 4.7 Heterotrophic plate counts (cfu/ml) - Filter D

Date	% Capacity	HPC 22 °C				HPC 37 °C			
		Water X		Water Y		Water X		Water Y	
		Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate
22-Feb-02	5		130		18100		3		2
1-Mar-02	10		300		1000		13		0
8-Mar-02	15		400		46000		57	TNTC	
22-Mar-02	25	63	2900	11800	33000	67	5500	720	17300
26-Apr-02	50	2250	19200	16500	76300	120	45500	500	89000
31-May-02	75	9200	10700	28200	29000	450	53000	2400	17500
5-Jul-02	100	51500	37100	21500	26000	1400	22700	18700	14100

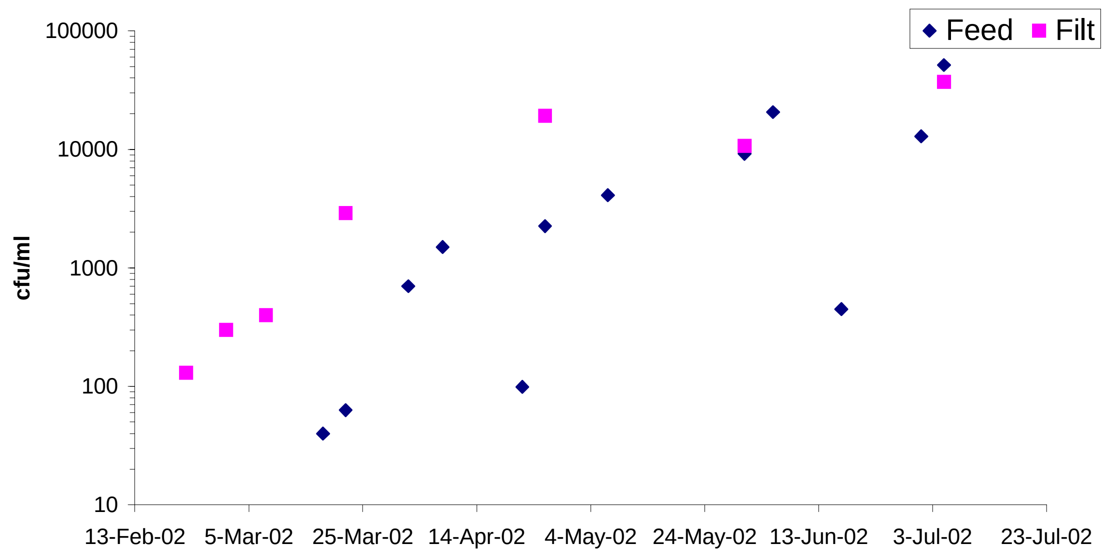

Figure 4.5 22 °C HPC (cfu/ml) - Filter D, Water X

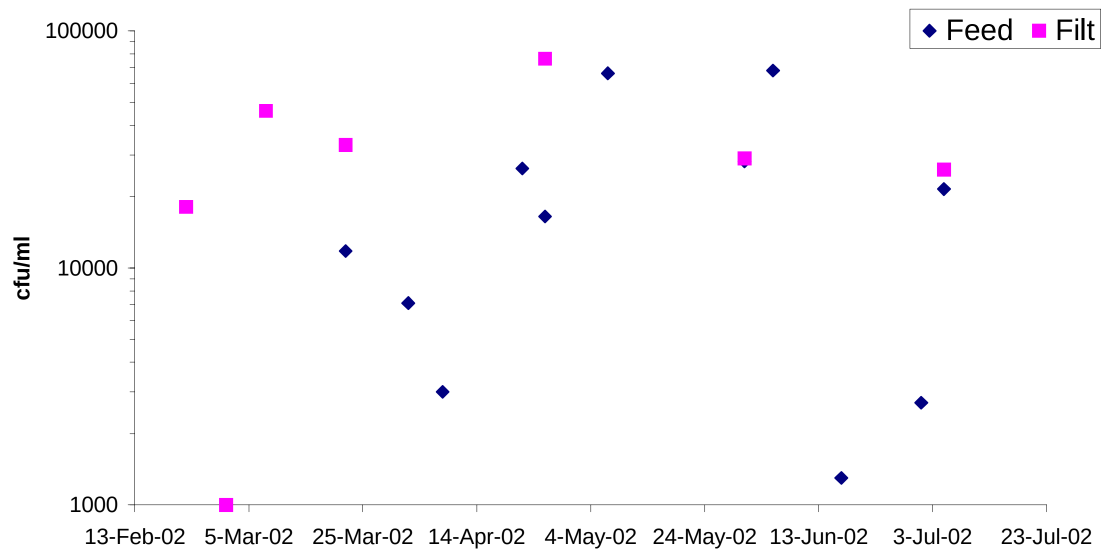

Figure 4.6 22 °C HPC (cfu/ml) - Filter D, Water Y

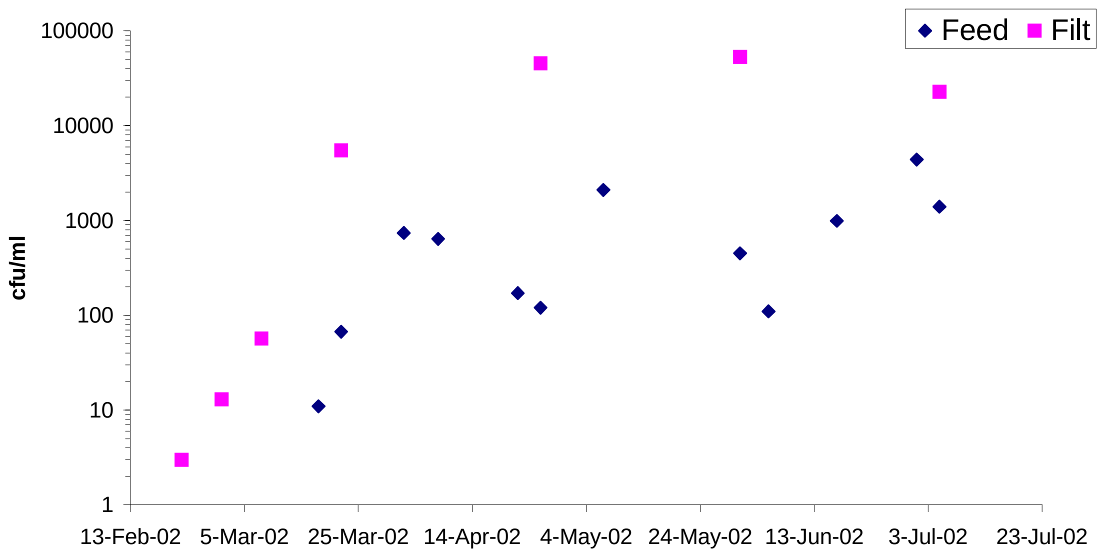

Figure 4.7 37 °C HPC (cfu/ml) - Filter D, Water X

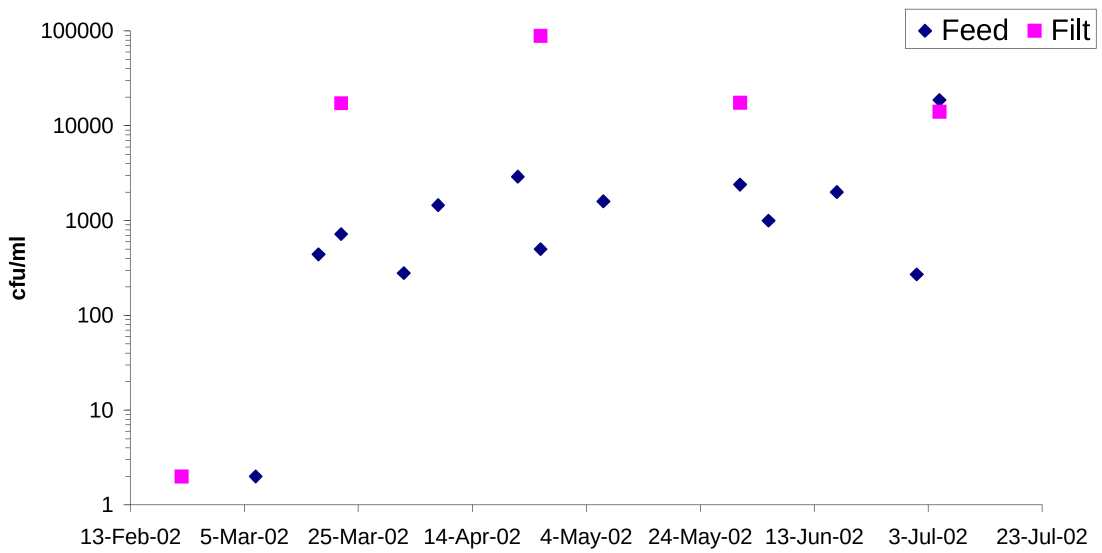

Figure 4.8 37 °C HPC (cfu/ml) - Filter D, Water Y

Table 4.8 Heterotrophic plate counts (cfu/ml) - Filter D – Monday morning samples

Date	Litre No.	HPC 22 °C				HPC 37 °C			
		Water X		Water Y		Water X		Water Y	
		Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate
25-Feb-02	1		2600		418		9		4
25-Feb-02	3		380		220		3		3
04-Mar-02	1		32000		57000		TNTC		TNTC
04-Mar-02	3		800		100		31		5
11-Mar-02	1		333		73000		34		TNTC
11-Mar-02	3		90		21000		22		TNTC
18-Mar-02	1	40	3100	TNTC	120000	11	2000	440	42000
18-Mar-02	3		1200		60900		100		20545
25-Mar-02	1		40000		90900		260		1100
25-Mar-02	3		405		38000		100		330
02-Apr-02[a]	1	700	7657	7100	18000	739	3900	279	1400
02-Apr-02	3		103600		20000		50000		3181
08-Apr-02	1	1500	7650	3000	18200	639	13000	1450	87000
08-Apr-02	3		112700		20000		6600		25000
22-Apr-02	1	99	17000	26300	41000	171	51800	2900	14600
22-Apr-02	3		11000		29000		16300		18000
07-May-02 [a]	1	4100	80000	66300	132000	2100	15000	1600	8200
07-May-02	3		35400		46300		8700		8100
20-May-02	1		37600		62000		3000		8700
20-May-02	3		23000		14500		2000		4300
05-Jun-02 [b]	1	20600	450000	68100	70900	110	9000	1000	4300
05-Jun-02	3		37200		35700		4000		4700
17-Jun-02	1	450	900	1300	6700	990	3500	2000	8000
17-Jun-02	3		1400		720		1800		2400
01-Jul-02	1	12900	13300	2700	27100	4400	85500	270	21600
01-Jul-02	3		3000		18500		14600		9500

a Sampled on Tuesday (after 3 days standing)
b Sampled on Wednesday (after 4 days standing)

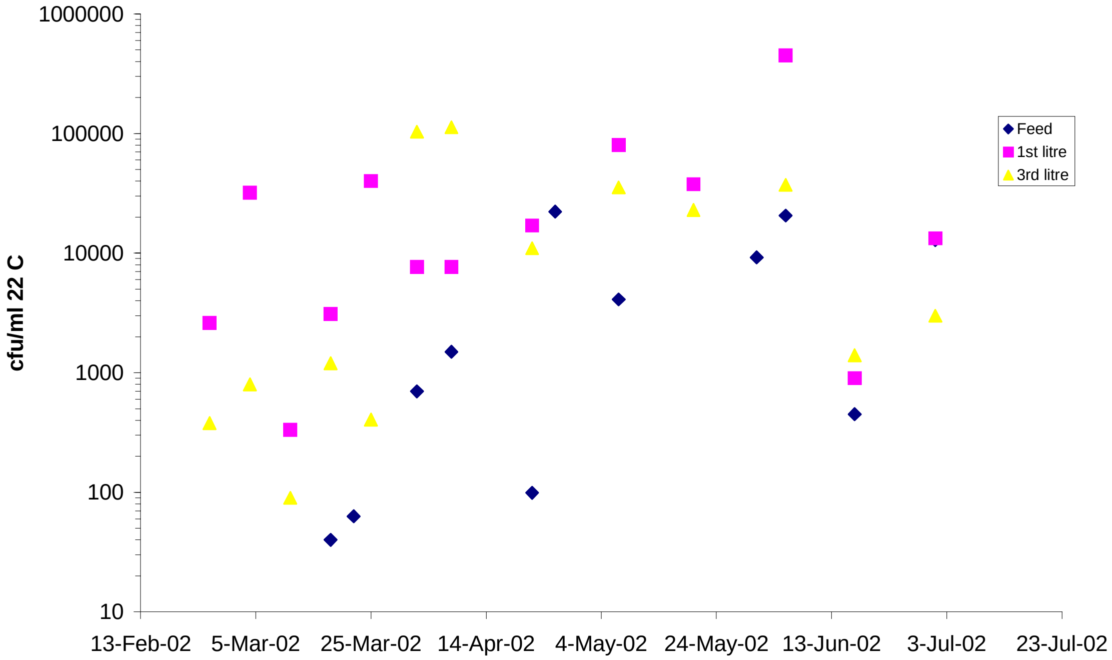

Figure 4.9 22 °C HPC (cfu/ml) – Monday morning samples – Filter D, Water X

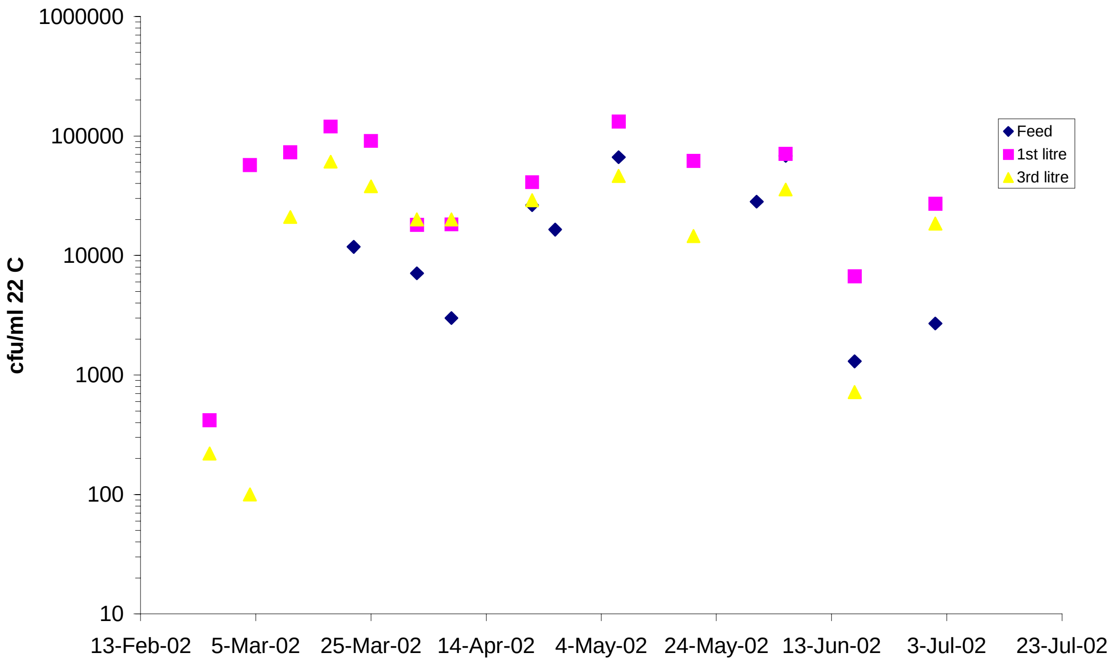

Figure 4.10 22 °C HPC (cfu/ml) – Monday morning samples – Filter D, Water Y

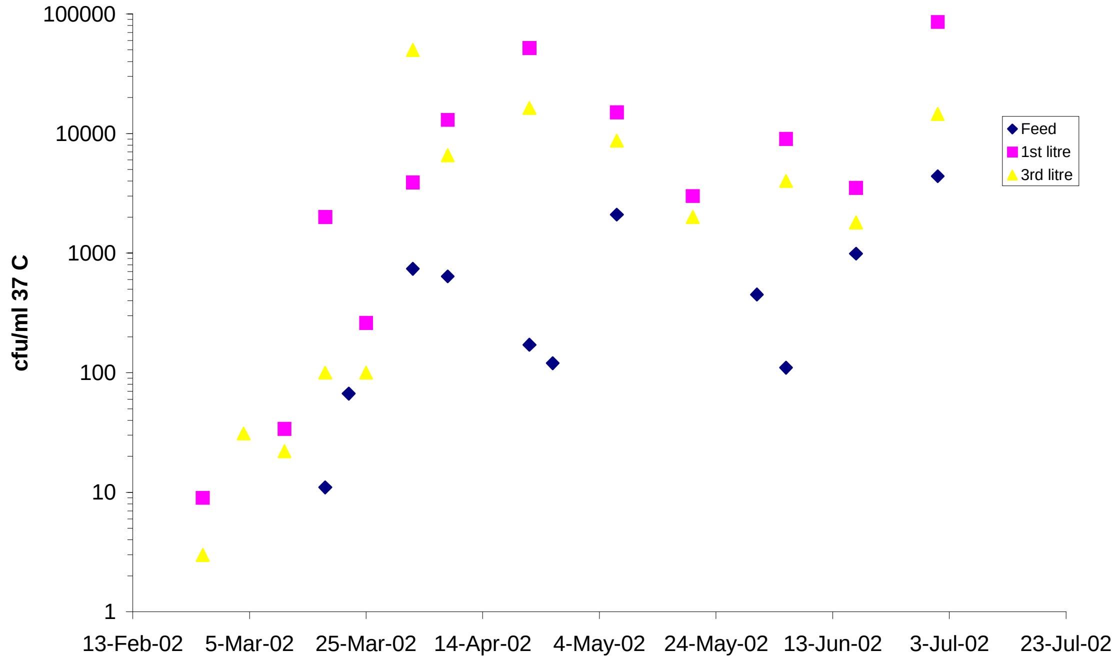

Figure 4.11 37 °C HPC (cfu/ml) – Monday morning samples – Filter D, Water X

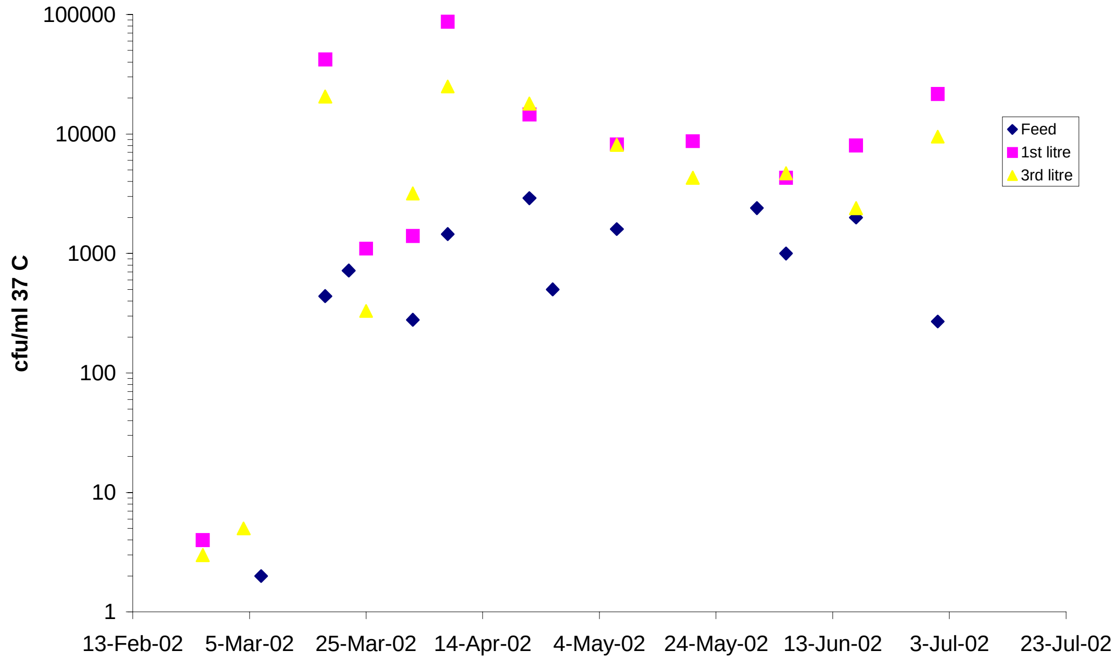

Figure 4.12 37 °C HPC (cfu/ml) – Monday morning samples – Filter D, Water Y

4.1.3 Silver leaching

The results for silver leaching from Filters A, B and C are given in Table 4.9, Figure 4.13 and Figure 4.14. The results for Monday morning samples are presented in Table 4.10 and Figures 4.15 and 4.16.

Table 4.9 Silver concentrations (µg/l)

			Water X				Water Y			
Day no	%Cap	Date	Feed	A	B	C	Feed	A	B	C
1	5	21-Jan-02	<0.1	43.5	25.7	48.7	<0.1	48.0	29.1	25.2
2	10	22-Jan-02	<0.1	38.5	33.0	38.0	<0.1	20.4	18.7	17.7
3	15	23-Jan-02	1.8	36.3	34.0	35.7	2.5	21.2	19.1	15.7
5	25	28-Jan-02	1.8	32.8	31.4	38.3	2.9	14.4	25.9	13.8
10	50	1-Feb-02	<0.1	39.6	41.5	33.7	<0.1	15.3	19.8	13.7
15	75	8-Feb-02	<0.1	32.2	36.0	22.8	<0.1	17.7	22.3	13.3
20	100	15-Feb-02	<0.1	26.3	32.3	16.5	<0.1	17.4	23.5	13.5
30	150	1-Mar-02	<0.1	8.2	32.4	9.5	<0.1	10.9	21.3	11.3
40	200	15-Mar-02	<0.1	3.1	27.5	4.8	<0.1	5.4	18.6	7.8

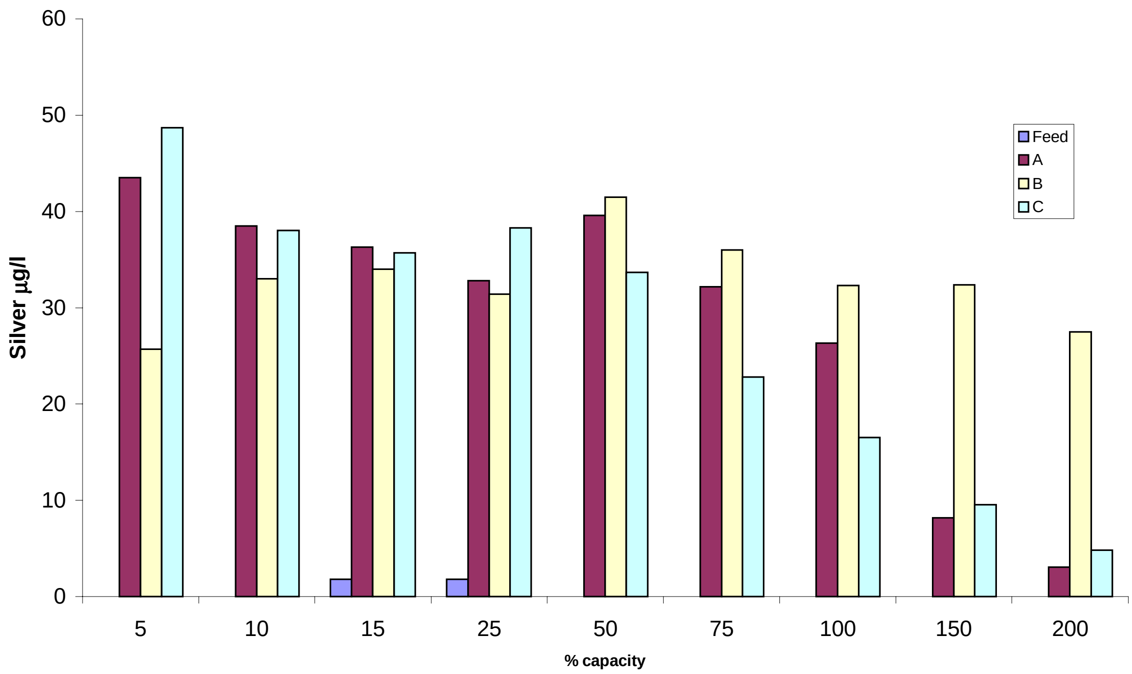

Figure 4.13 Trends in silver leaching – Water X

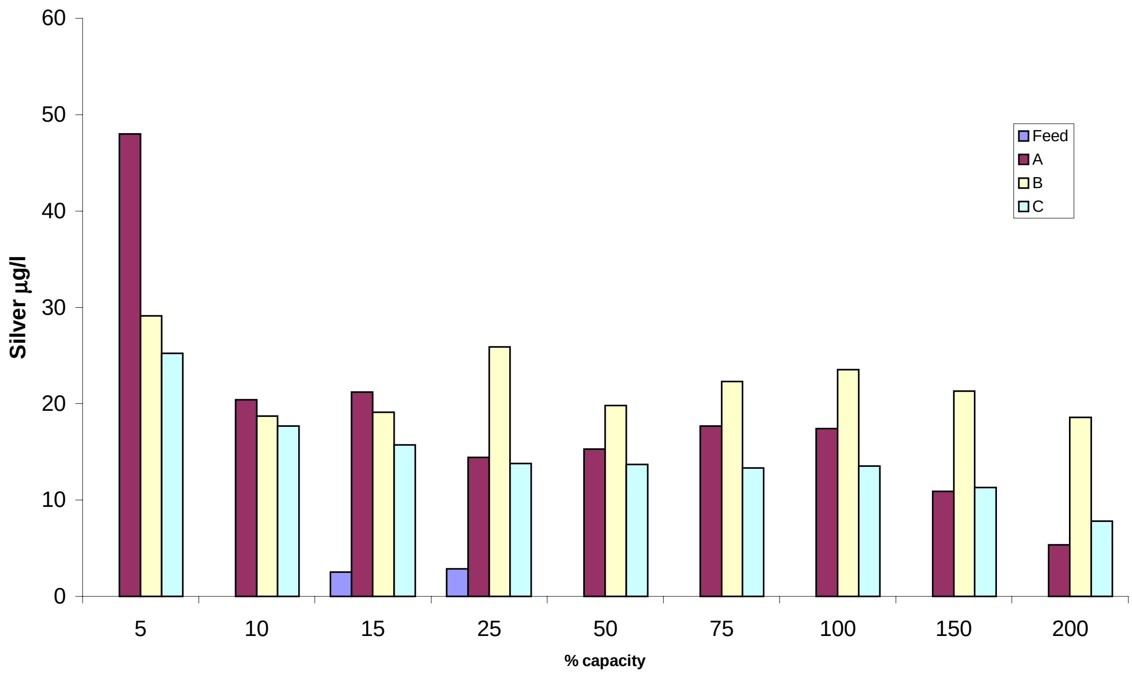

Figure 4.14 Trends in silver leaching – Water Y

Table 4.10 Silver concentrations (µg/l) – Monday morning samples

Date	Litre No.	Water X Feed	Water X A	Water X B	Water X C	Water Y Feed	Water Y A	Water Y B	Water Y C
28-Jan-02	1	1.4	42.4	43.6	45.1	2.3	17.7	20.4	15.5
28-Jan-02	3		27.4	30.5	31.9		15.7	23.3	12.4
4-Feb-02	1	<0.1	45.1	39.5	38.5	<0.1	16.2	23.1	14.6
4-Feb-02	3		31.9	30.2	27.2		13.1	18.4	11.8
11-Feb-02	1	<0.1	40.3	39.9	27.9	<0.1	21.8	25.9	16.9
11-Feb-02	3		29.1	30.9	21.7		18.4	23.0	14.3
18-Feb-02	1	<0.1	27.2	36.9	18.9	<0.1	20.0	23.6	16.2
18-Feb-02	3		22.6	34.5	16.5		15.4	21.1	13.0
25-Feb-02	1	<0.1	15.9	36.0	13.6	<0.1	16.5	23.2	15.4
25-Feb-02	3		11.6	28.5	11.3		13.4	21.2	12.6
4-Mar-02	1	0.3	8.1	33.2	11.5	0.1	10.3	20.7	11.6
4-Mar-02	3		6.6	28.9	8.9		8.4	17.5	9.2
11-Mar-02	1	<0.1	4.2	26.8	6.6	<0.1	9.5	22.2	10.6
11-Mar-02	3		3.6	27.5	6.6		7.5	19.8	9.2

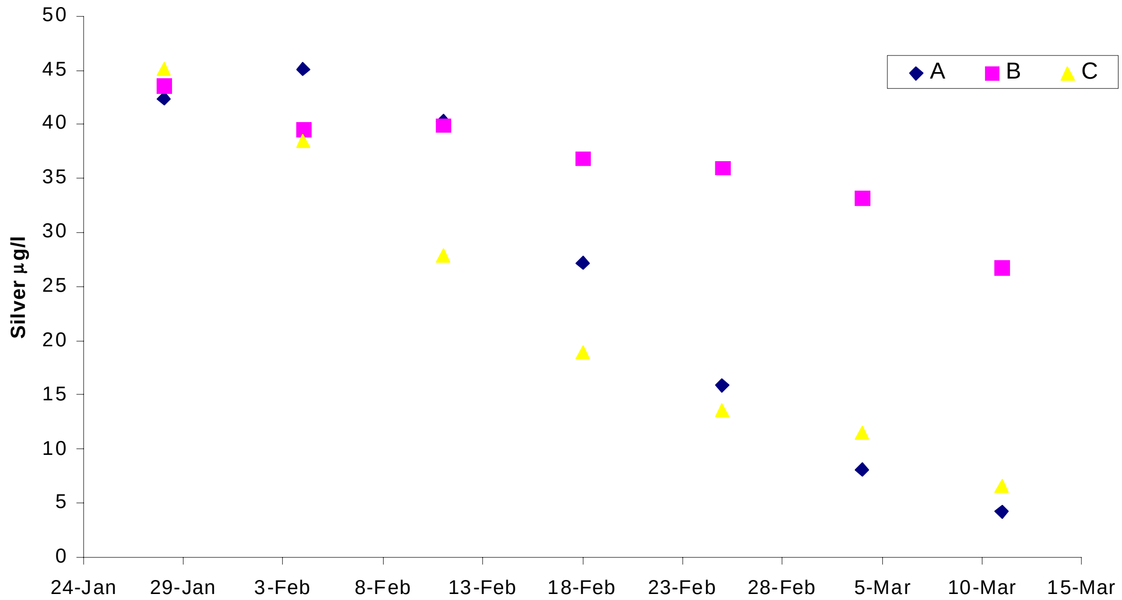

Figure 4.15 Silver leaching – Monday morning samples, Water X, 1st litre

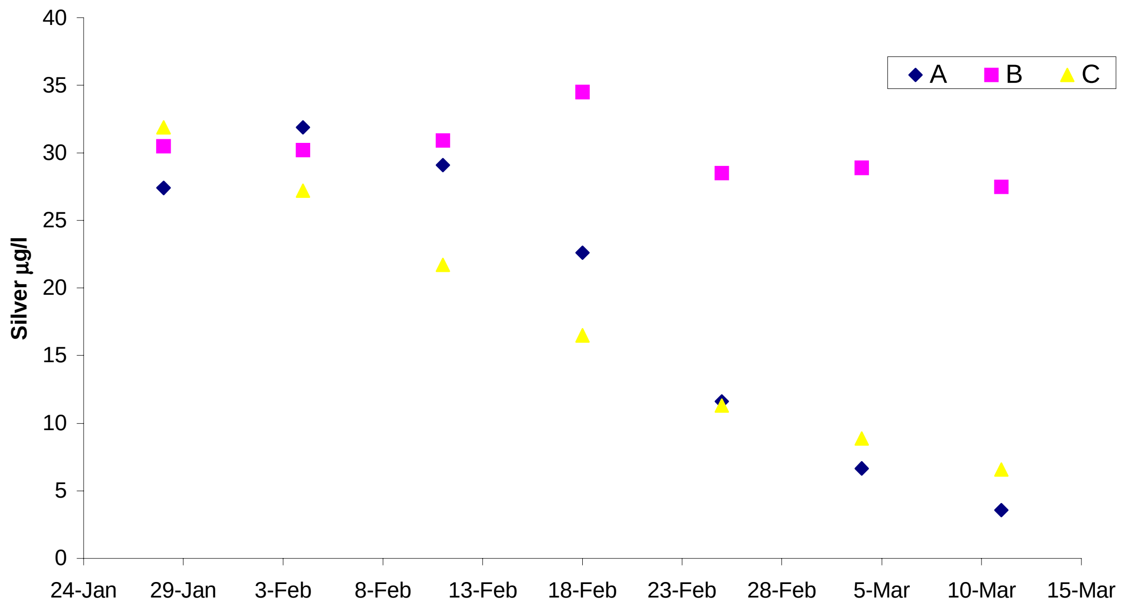

Figure 4.16 Silver leaching – Monday morning samples, Water X, 3rd litre

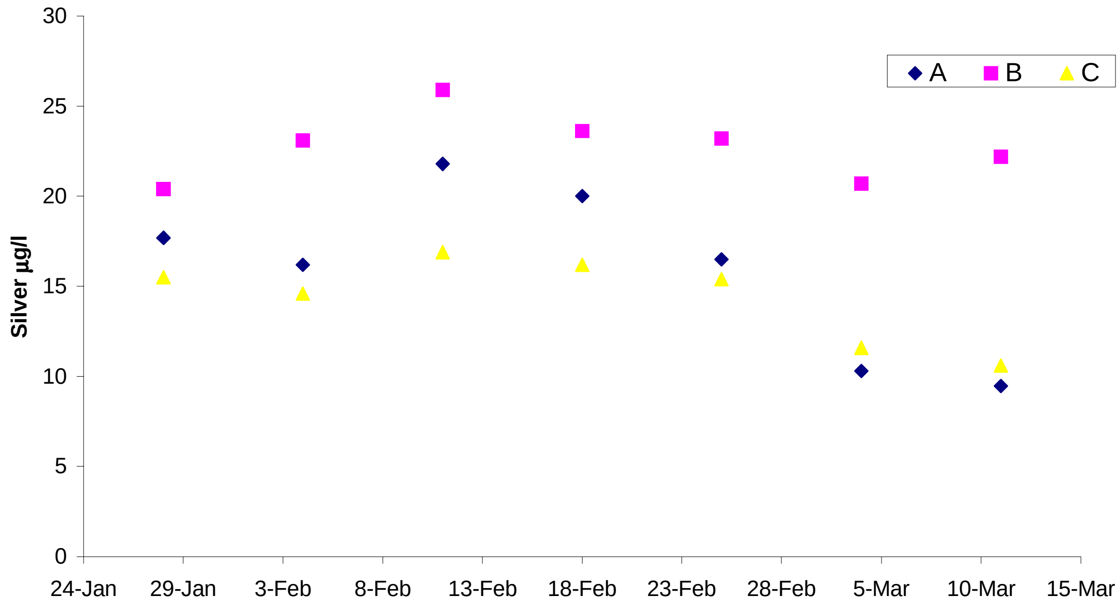

Figure 4.17 Silver leaching – Monday morning samples, Water Y, 1st litre

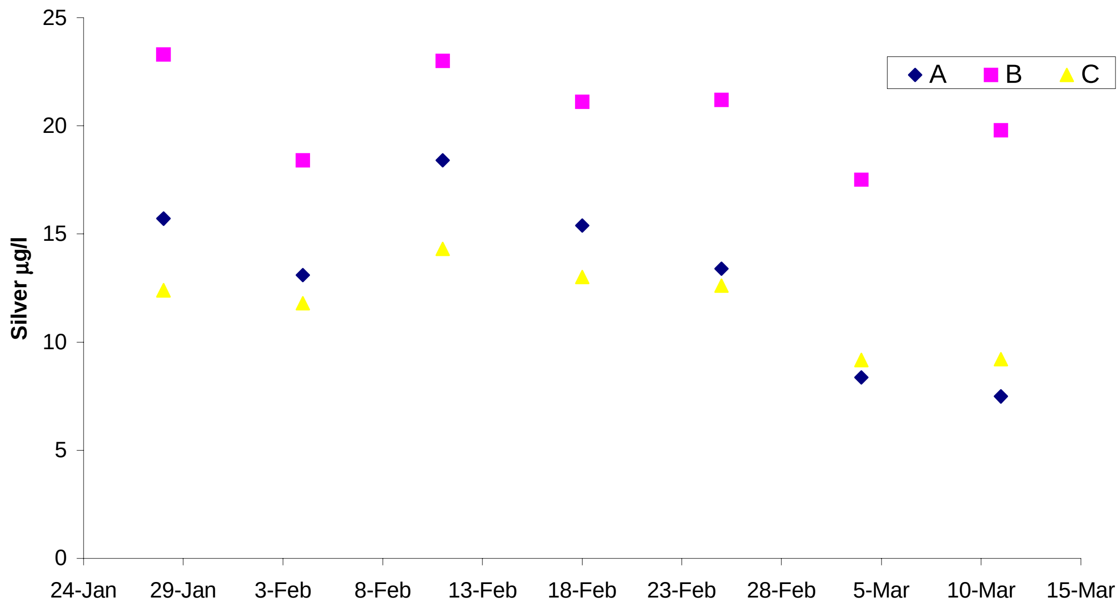

Figure 4.18 Silver leaching – Monday morning samples, Water Y, 3rd litre

Silver leaching results for Filter D are given in Table 4.11 and Table 4.12. Silver concentrations were very low, showing that Filter D does not incorporate silverised carbon. Sampling for silver was discontinued after approximately one month's operation.

Table 4.11 Silver concentrations (µg/l) - Filter D

			Water X		Water Y	
Day No	% Cap	Date	Feed	Filtrate	Feed	Filtrate
1	1	18-Feb-02	<0.1	<0.1	<0.1	<0.1
5	5	22-Feb-02	<0.1	<0.1	<0.1	0.39
12	10	01-Mar-02	0.12	0.15	<0.1	0.14
19	15	08-Mar-02	<0.1	<0.1	<0.1	<0.1
33	25	22-Mar-02	0.42	<0.1	<0.1	<0.1

Table 4.12 Silver concentrations (µg/l) - Filter D, Monday morning samples

		Water X		Water Y	
Date	Litre	Feed	Filtrate	Feed	Filtrate
25-Feb-02	1	<0.1	<0.1	<0.1	<0.1
25-Feb-02	3	<0.1	0.25	<0.1	<0.1
04-Mar-02	1	<0.1	<0.1	<0.1	<0.1
04-Mar-02	3	<0.1	<0.1	0.14	0.15
18-Mar-02	1	<0.1	<0.1	<0.1	<0.1
18-Mar-02	3	<0.1	1.06	<0.1	<0.1
25-Mar-02	1	<0.1	<0.1	<0.1	<0.1
25-Mar-02	3	<0.1	1.19	<0.1	<0.1

4.1.4 Odour and flavour

The results of odour and flavour testing are given in Appendix B. The trained panellists were presented with (unidentified) samples and asked to record whether they could detect an odour or flavour and, if so, to record a descriptor for the odour or flavour. In Appendix B the descriptor is given as "None" if the panellist did not detect an odour or flavour.

There was no evidence from these results to suggest that the filters caused deterioration in odour or flavour. Where panellists detected a difference between the filtered and unfiltered sample this was often because the filtered sample was less chlorinous.

4.2 Additional microbiological tests

4.2.1 Challenge tests

Following the procedure in Section 3.2.2, *E. coli* were only detected (100 cfu/100ml) in one sample: the first litre of filtrate from semi-mature Filter A immediately following inoculation with spiked water Y. No colonies were detected in any other samples of filtrate. Table 4.13 gives the results for the controls (spiked samples stored without filtration).

Table 4.13 Results for controls spiked with *E. coli* (cfu/100 ml)

Days after spiking	Water X	Water Y
0	0	1×10^5
1	0	1800
2	0	500
4	0	21
7	0	0

S. typhimurium was only detected in the first litre of filtrate from the filters immediately following inoculation with spiked water. These results are given in Table 4.16. No colonies were detected in any other samples of filtrate. Table 4.15 gives the results for the controls (no filtration).

Table 4.14 *S. typhimurium* (cfu/100 ml) in the first litre of filtrate

Water	Filter	Maturity	cfu/100 ml
X	A	Immature	0
X	B	Immature	0
X	C	Immature	3
X	A	Semi-mature	0
X	B	Semi-mature	0
X	C	Semi-mature	1
X	A	Mature	0
X	B	Mature	0
X	C	Mature	1
Y	A	Immature	1
Y	B	Immature	25
Y	C	Immature	48
Y	A	Semi-mature	0
Y	B	Semi-mature	2
Y	C	Semi-mature	22
Y	A	Mature	19
Y	B	Mature	0
Y	C	Mature	7

Table 4.15 Results for controls spiked with *S. typhimurium* (cfu/100 ml)

Days after spiking	Water X	Water Y
0	0	2.2×10^6
1	0	10000
2	0	800
4	0	0
7	0	0

Following the experiment, the filter cartridges were examined for the presence of *E. coli* and *S. typhimurium* but these organisms were not detected.

4.2.2 Effects of storage of filtered water

The results of the storage experiments are given in Table 4.16 to Table 4.19.

Table 4.16 Effects of storage on HPC (cfu/ml) – Water X, 4 °C

		HPC 22 °C				HPC 37 °C			
Day	Maturity	Feed	A	B	C	Feed	A	B	C
1	Immature	1	1	6	0	1	1	1	1
2	Immature	1	0	6	0	0	0	0	1
4	Immature	0	0	0	1	0	1	0	0
7	Immature	1	0	0	0	0	0	0	0
1	Semi-mature	0	0	0	0	0	0	0	0
2	Semi-mature	860	9	27	9	88	5	4	250
4	Semi-mature	0	0	0	0	0	0	0	0
7	Semi-mature	0	0	0	0	0	0	0	1
1	Mature	0	1	2	0	0	0	0	0
2	Mature	0	0	0	0	1	0	0	0
4	Mature	0	0	0	0	0	0	0	0
7	Mature	0	0	0	0	0	0	0	0

Table 4.17 Effects of storage on HPC (cfu/ml) – Water X, 20 °C

		HPC 22 °C				HPC 37 °C			
Day	Maturity	Feed	A	B	C	Feed	A	B	C
1	Immature	3	0	11	3	0	0	4	1
2	Immature	1	0	0	1	8	1	1	0
4	Immature	0	0	0	0	0	0	1	0
7	Immature	0	0	0	1	0	0	0	0
1	Semi-mature	0	0	0	0	0	0	0	0
2	Semi-mature	103	6	12	2320	138	10	10	89
4	Semi-mature	0	0	0	0	0	0	0	0
7	Semi-mature	0	6	0	0	0	4	0	0
1	Mature	0	1	1	0	0	0	0	1
2	Mature	0	0	0	4	0	0	0	0
4	Mature	0	0	110	0	24	0	0	0
7	Mature	0	0	132	2	11	0	10	0

Table 4.18 Effects of storage on HPC (cfu/ml) – Water Y, 4 °C

		HPC 22 °C				HPC 37 °C			
Day	Maturity	Feed	A	B	C	Feed	A	B	C
1	Immature	1	23	6	3	0	2	2	0
2	Immature	0	0	1	1	1	0	0	0
4	Immature	0	1	0	1	1	1	1	0
7	Immature	0	7	0	1	0	0	1	1
1	Semi-mature	7	1	2	4	13	2	0	0
2	Semi-mature	516	3	48	11	112	2	3	288
4	Semi-mature	17	0	0	2	11	0	0	0
7	Semi-mature	8	0	3	5	5	0	0	0
1	Mature	0	2645	8100	3172	1	167	86	67
2	Mature	10	2420	6980	3260	1	4	2	1
4	Mature	4	2600	9200	3100	0	0	0	1
7	Mature	12	3500	7727	4500	0	0	4	0

Table 4.19 Effects of storage on HPC (cfu/ml) – Water Y, 20 °C

		HPC 22 °C				HPC 37 °C			
Day	Maturity	Feed	A	B	C	Feed	A	B	C
1	Immature	1	11	7	1	0	6	3	1
2	Immature	4	1	0	0	0	18	1	4
4	Immature	0	0	0	0	0	0	1	1
7	Immature	1	10	2	0	0	0	0	0
1	Semi-mature	0	2	3	3	1	0	0	0
2	Semi-mature	414	300	TNTC	18	72	5	11	600
4	Semi-mature	1340	8200	9080	7200	1	1	1	0
7	Semi-mature	2260	12240	11360	8960	16	2	80	580
1	Mature	0	2690	8700	3845	0	160	59	49
2	Mature	93	15920	51120	20320	3	1	4	7
4	Mature	31300	100000	122000	100000	600	226	25	208
7	Mature	13	24700	4000	16800	1056	350	8	83

TNTC = Too Numerous To Count – approximately >10,000

4.2.3 Impact of prolonged non-use

Table 4.20 to Table 4.27 give the results of experiments on prolonged non-use of the filters.

Table 4.20 Effects of non-use on HPC (cfu/ml) – Water X, 4 °C, 1st litre

Day	Maturity	HPC 22 °C A	HPC 22 °C B	HPC 22 °C C	HPC 37 °C A	HPC 37 °C B	HPC 37 °C C
7	Immature	0	0	0	0	0	0
14	Immature	0	6	0	1	0	0
21	Immature	0	0	0	0	0	0
28	Immature	1	0	0	1	0	0
7	Semi-mature	9	0	0	0	0	0
14	Semi-mature	0	0	0	1	0	0
21	Semi-mature	0	0	0	0	0	0
28	Semi-mature	0	0	1	0	0	0
7	Mature	1	0	0	1	0	0
14	Mature	0	0	0	1	0	0
21	Mature	0	45	0	1	0	0
28	Mature	0	1	0	0	0	0

Table 4.21 Effects of non-use on HPC (cfu/ml) – Water X, 4 °C, 3rd litre

Day	Maturity	HPC 22 °C A	HPC 22 °C B	HPC 22 °C C	HPC 37 °C A	HPC 37 °C B	HPC 37 °C C
7	Immature	0	0	0	0	0	0
14	Immature	0	0	0	0	0	0
21	Immature	0	0	0	0	0	0
28	Immature	1	0	0	4	0	0
7	Semi-mature	0	0	0	0	3	0
14	Semi-mature	0	0	1	0	0	0
21	Semi-mature	0	0	90	0	0	0
28	Semi-mature	0	0	0	0	0	0
7	Mature	0	0	1	2	1	0
14	Mature	1	0	0	1	0	1
21	Mature	0	0	0	1	0	1
28	Mature	0	200	0	0	0	1

Table 4.22 Effects of non-use on HPC (cfu/ml) – Water X, 20 °C, 1st litre

			HPC 22 °C			HPC 37 °C	
Day	Maturity	A	B	C	A	B	C
7	Immature	0	100	0	0	7	0
14	Immature	50	0	0	40	0	0
21	Immature	0	0	0	0	0	0
28	Immature	0	0	0	0	0	0
7	Semi-mature	80	0	0	0	0	0
14	Semi-mature	0	0	1	0	0	0
21	Semi-mature	0	0	0	0	0	0
28	Semi-mature	0	0	1	4	0	0
7	Mature	0	0	0	0	1	1
14	Mature	0	130	0	3	63	0
21	Mature	0	520	0	0	0	0
28	Mature	0	900	2	1	0	1

Table 4.23 Effects of non-use on HPC (cfu/ml) – Water X, 20 °C, 3rd litre

			HPC 22 °C			HPC 37 °C	
Day	Maturity	A	B	C	A	B	C
7	Immature	0	0	0	0	0	0
14	Immature	30	40	0	40	0	0
21	Immature	0	0	0	0	0	0
28	Immature	0	0	0	0	0	1
7	Semi-mature	0	0	0	0	0	0
14	Semi-mature	0	0	2	0	0	0
21	Semi-mature	1	0	1	0	0	0
28	Semi-mature	#N/A	0	0	#N/A	1	0
7	Mature	0	1	0	0	0	1
14	Mature	0	3	2	0	3	1
21	Mature	3	45	0	1	0	0
28	Mature	0	400	0	0	0	0

#N/A = no data

Table 4.24 Effects of non-use on HPC (cfu/ml) – Water Y, 4 °C, 1st litre

Day	Maturity	HPC 22 °C A	HPC 22 °C B	HPC 22 °C C	HPC 37 °C A	HPC 37 °C B	HPC 37 °C C
7	Immature	150	250	450	0	3	80
14	Immature	90	100	4000	1	0	4
21	Immature	140	14	35	2	0	8
28	Immature	190	300	5400	2	9	0
7	Semi-mature	1920	1260	1250	10	6	2
14	Semi-mature	5600	3900	6500	5	20	15
21	Semi-mature	1500	180	4500	1	0	0
28	Semi-mature	4000	700	1800	7	0	9
7	Mature	7000	17000	13000	1	2	0
14	Mature	2200	5900	4300	0	0	0
21	Mature	22000	28000	49000	5	4	22
28	Mature	640	1860	740	20	380	780

Table 4.25 Effects of non-use on HPC (cfu/ml) – Water Y, 4 °C, 3rd litre

Day	Maturity	HPC 22 °C A	HPC 22 °C B	HPC 22 °C C	HPC 37 °C A	HPC 37 °C B	HPC 37 °C C
7	Immature	400	670	720	80	140	100
14	Immature	40	16	40	0	0	2
21	Immature	50	35	30	6	0	0
28	Immature	201	150	900	8	20	2
7	Semi-mature	927	1100	27	19	4	1
14	Semi-mature	5100	5300	5900	2	31	3
21	Semi-mature	500	180	0	0	0	0
28	Semi-mature	300	90	300	4	0	0
7	Mature	300	800	200	0	0	0
14	Mature	180	1000	600	0	0	0
21	Mature	6000	9600	5800	2	0	7
28	Mature	1250	1120	3330	20	130	2

Table 4.26 Effects of non-use on HPC (cfu/ml) – Water Y, 20 °C, 1st litre

Day	Maturity	HPC 22 °C			HPC 37 °C		
		A	B	C	A	B	C
7	Immature	900	220	470	260	0	20
14	Immature	11520	280	180	2	0	0
21	Immature	4700	65	6	3	0	0
28	Immature	44800	120	1300	250	1	0
7	Semi-mature	6180	4750	960	30	5	640
14	Semi-mature	31800	9400	88800	3	6	9
21	Semi-mature	23000	90	2600	1	0	0
28	Semi-mature	18000	7600	14200	6	1	0
7	Mature	2500	0	21500	4	4	4
14	Mature	90	24000	1000	1	1	0
21	Mature	24500	30000	51000	300	10	129
28	Mature	1600	1260	1800	3	1100	540

Table 4.27 Effects of non-use on HPC (cfu/ml) – Water Y, 20 °C, 3rd litre

Day	Maturity	HPC 22 °C			HPC 37 °C		
		A	B	C	A	B	C
7	Immature	530	680	120	20	4	0
14	Immature	1140	0	13	1	0	1
21	Immature	360	30	7	0	0	0
28	Immature	10500	6700	2560	60	50	20
7	Semi-mature	3254	2945	1200	11	5	108
14	Semi-mature	36600	33600	56000	2	6	9
21	Semi-mature	90	90	180	0	0	0
28	Semi-mature	4000	5300	2600	66	36	8
7	Mature	5000	9000	1500	4	0	1
14	Mature	360	900	90	0	1	1
21	Mature	27000	27000	27000	116	8	69
28	Mature	3800	1180	3210	50	250	260

4.3 Metals leaching

4.3.1 Initial tests

The results of the metals leaching tests are given in Tables 4.28 and 4.29 for Waters X and Z respectively[2]. The pH values of the feed waters and the filtrates were as follows:

Water X				Water Z			
Feed	Filter A	Filter B	Filter C	Feed	Filter A	Filter B	Filter C
7.03	5.12	5.57	4.15	7.76	4.16	6.15	3.94

Table 4.28 Metals leaching – Water X (28/3/02)

Sample[a]	Filter	Run	Ca mg/l	Cr µg/l	Fe µg/l	Ni µg/l
Feed			118	4.5	<20	4.13
CR	A	1	6.13	0.7	<20	6270
CR	A	2	6.27	<0.3	<20	5730
SP	A	1	6.93	0.4	40	4.13
SP	A	2	7.18	<0.3	<20	1.78
SS	A	1	7.05	<0.3	30	6.47
SS	A	2	6.94	<0.3	<20	2.52
Unboiled	A		6.59	2.6	<20	0.49
CR	B	1	8.06	3.3	260	788
CR	B	2	8.24	1.9	70	1960
SP	B	1	8.51	<0.3	40	4.34
SP	B	2	8.40	0.4	<20	1.64
SS	B	1	8.67	<0.3	<20	4.26
SS	B	2	8.27	<0.3	<20	1.57
Unboiled	B		8.76	0.6	<20	0.49
CR	C	1	2.44	2.6	130	6640
CR	C	2	2.37	<0.3	300	7220
SP	C	1	2.43	0.6	890	31.4
SP	C	2	2.56	0.9	690	30.8
SS	C	1	2.64	2.0	860	50.8
SS	C	2	2.60	0.5	600	19.0
Unboiled	C		2.77	<0.3	<20	0.51

[a] Feed = Unfiltered water, Unboiled = Filtered water, CR = Kettle K with exposed nickel-plated element, SS = Kettle J with flat bed stainless steel element, SP = Stainless steel saucepan.

[2] For comparison the Prescribed Concentrations or Values (PCVs) in the Water Supply (Water Quality) Regulations 1989 are: Cr 50 µg/l, Fe 200 µg/l and Ni 50 µg/l. In the 2000 Regulations the limit for Ni is reduced to 20 µg/l (this comes into effect on 1 January 2004).

Table 4.29 Metals leaching – Water Z (28/3/02)

Sample[a]	Filter	Run	Ca mg/l	Cr µg/l	Fe µg/l	Ni µg/l
Feed			21.4	<0.3	30	0.70
CR	A	1	0.12	0.5	60	1850
CR	A	2	0.22	<0.3	60	1700
SP	A	1	0.29	1.7	1000	28.9
SP	A	2	3.97	<0.3	30	1.31
SS	A	1	0.25	1.7	660	20.8
SS	A	2	3.54	<0.3	40	1.88
Unboiled	A		0.09	<0.3	<20	0.05
CR	B	1	1.08	1.4	70	515
CR	B	2	1.03	0.4	40	236
SP	B	1	1.11	<0.3	40	2.80
SP	B	2	1.11	<0.3	30	1.38
SS	B	1	1.11	<0.3	30	2.61
SS	B	2	1.13	<0.3	30	1.77
Unboiled	B		1.05	<0.3	30	0.11
CR	C	1	1.43	0.9	80	1300
CR	C	2	1.44	1.1	70	1140
SP	C	1	1.51	1.4	650	19.3
SP	C	2	1.42	1.7	550	23.9
SS	C	1	1.52	1.0	440	12.4
SS	C	2	1.54	1.4	410	12.6
Unboiled	C		1.41	<0.3	<20	0.15

[a] Feed = Unfiltered water, Unboiled = Filtered water, CR = Kettle K with exposed nickel-plated element, SS = Kettle J with flat bed stainless steel element, SP = Stainless steel saucepan.

The nickel concentrations in the unboiled filtrates were lower than in the feed water indicating that the jug filters remove nickel.

A second set of tests was run subsequently to examine the effects of boiling unfiltered water on metals leaching. In these tests, in addition, the water was sampled as before and also after standing in the kettle or pan for 24 hours. The results are given in Table 4.30.

Table 4.30 Metals leaching – Unfiltered water (17/4/02)

Sample[a]	Water[b]	Run	Ca mg/l	Cr µg/l	Fe µg/l	Ni µg/l
Feed	X	0	111	1.0	30	4.55
SS	X	1	66.1	<0.3	30	4.79
SS	X	1 + 24 h	60.8	2.4	30	4.89
SS	X	2	53.3	0.7	<20	5.67
SS	X	2 + 24 h	64.7	0.5	30	5.77
CR	X	1	84.8	2.0	40	292
CR	X	1 + 24 h	63.1	2.9	30	419
CR	X	2	82.7	2.0	40	196
CR	X	2 + 24 h	64.7	2.5	<20	268
SP	X	1	75.4	<0.3	50	5.69
SP	X	1 + 24 h	94.4	2.4	30	6.77
SP	X	2	67.2	1.5	<20	4.69
SP	X	2 + 24 h	62.4	<0.3	<20	4.88
Feed	Z	0	21.4	1.1	40	0.80
SS	Z	1	21.0	0.4	30	1.80
SS	Z	1 + 24 h	22.0	0.4	30	2.29
SS	Z	2	21.3	0.4	30	2.05
SS	Z	2 + 24 h	21.7	0.5	30	3.28
CR	Z	1	23.2	1.0	30	80.2
CR	Z	1 + 24 h	24.0	0.4	<20	307
CR	Z	2	22.0	0.8	40	21.7
CR	Z	2 + 24 h	23.1	1.0	30	48.8
SP	Z	1	20.1	0.5	40	1.59
SP	Z	1 + 24 h	20.6	0.4	<20	2.04
SP	Z	2	20.6	<0.3	40	1.64
SP	Z	2 + 24 h	20.9	0.7	<20	2.15

a Feed = Unfiltered water, CR = Kettle K with exposed nickel-plated element, SS = Kettle J with flat bed stainless steel element, SP = Stainless steel saucepan.

b Water X pH 7.29, Water Z pH 7.60

4.3.2 Extended tests

Laboratory tests

The tests were run over a four-week period from 23 September to 18 October 2002. The detailed results of the tests are tabulated in Appendix C. Figures 4.19 to 4.21 show the pH, alkalinity and calcium content of the test waters. For the jug filtered water samples the values plotted are the mean values for the eight samples of each model of filter tested on each sampling day. As expected, the filters reduced the pH, alkalinity and calcium concentration of the water; as the test progressed the values of these determinands rose towards those of the unfiltered water.

During the initial two weeks of the test the alkalinity and calcium concentration in the boiled water samples were similar to those in unboiled jug-filtered water. In the latter two weeks of the test, when the alkalinity and calcium concentrations in the jug filtrates were higher, the alkalinity and calcium concentrations in the boiled water were lower than in the unboiled jug filtered water. This indicates that deposition of calcium carbonate (scaling) was occurring in the kettles. (See results in Appendix C.)

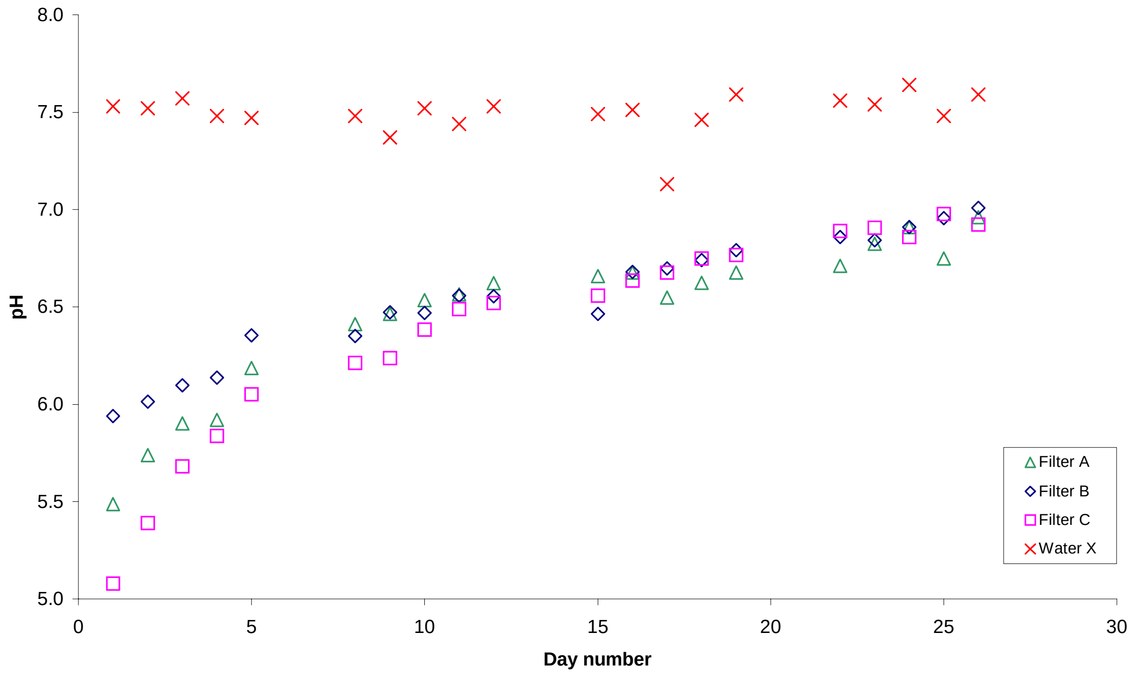

Figure 4.19 pH of water samples

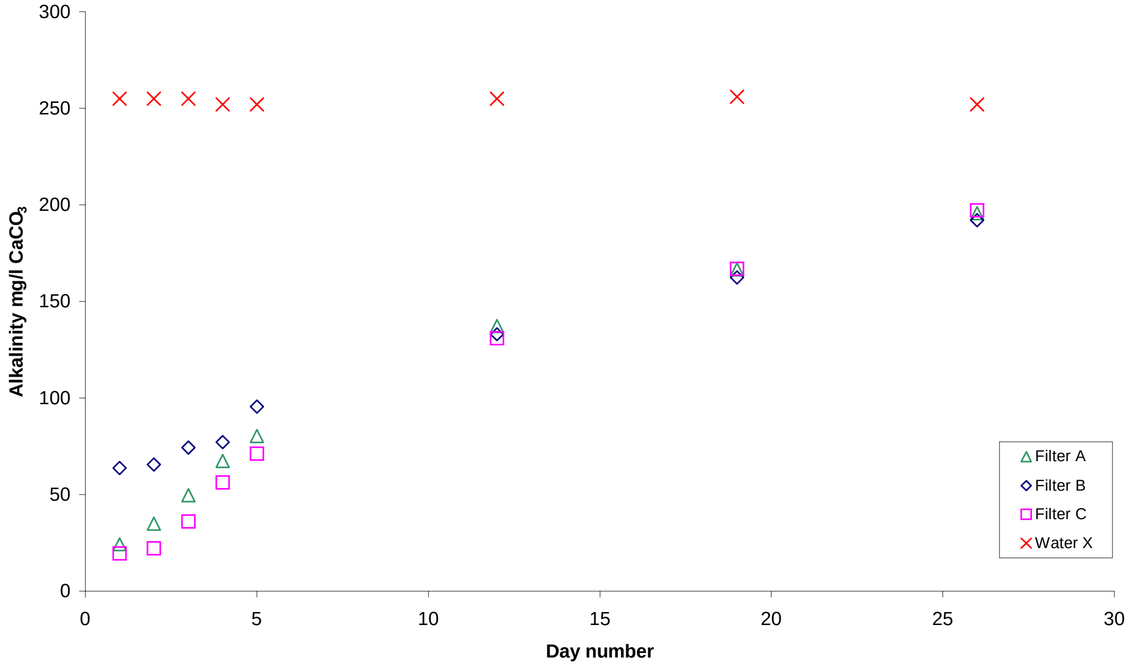

Figure 4.20 Alkalinity of water samples

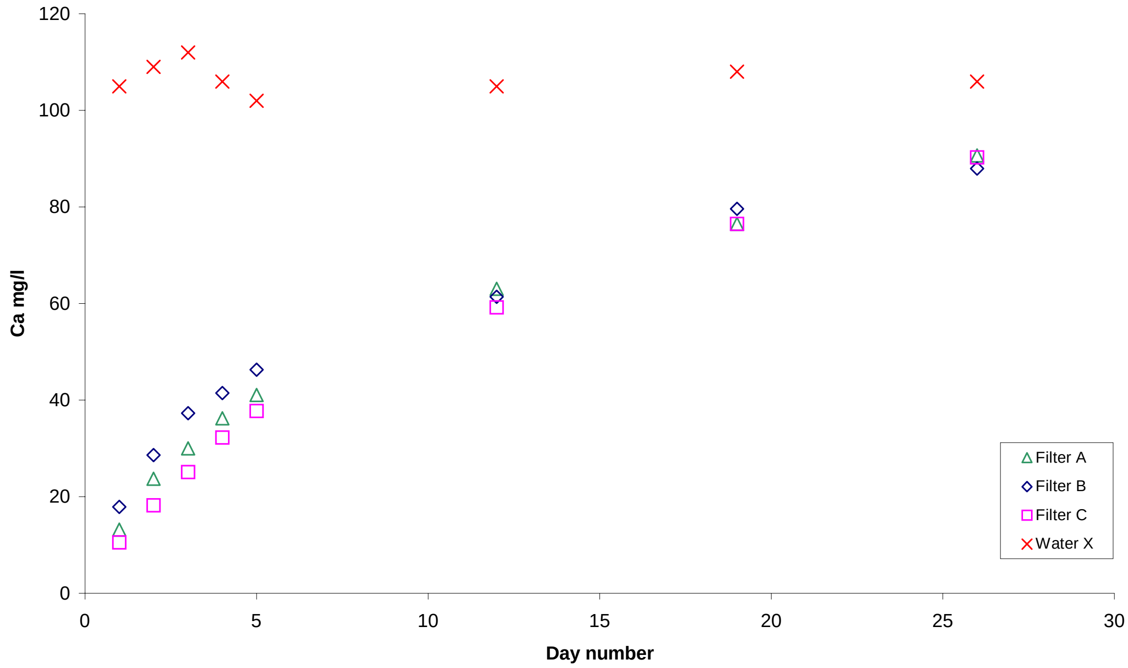

Figure 4.21 Calcium content of water samples

In the case of boiled unfiltered tap water, analyses were made on 0.45 µm filtered samples of the boiled water. There was essentially no difference between these results (corresponding to "dissolved" metals) and the results for samples that were not 0.45 µm filtered (total metals). This indicates that the metals were effectively completely in solution and not, for example, adsorbed onto particles of precipitated calcium carbonate. The results for both 0.45 µm filtered and unfiltered samples are given in Appendix C. The results presented below are total metals concentrations.

The results for Fe, total Cr and Cr(VI) were all low and analysis for these metals was discontinued after the first week of the test. The results for these metals are included in Appendix C.

On days 1 and 5 the two litres of boiled water were analysed separately. The two samples yielded results of the same order of magnitude but there were non-systematic differences between the two concentrations. This is illustrated by the results for nickel in Figure 4.22. In the results presented below, the average of the two concentrations is used in order to be comparable with the results for pooled samples that were taken on the other sampling days.

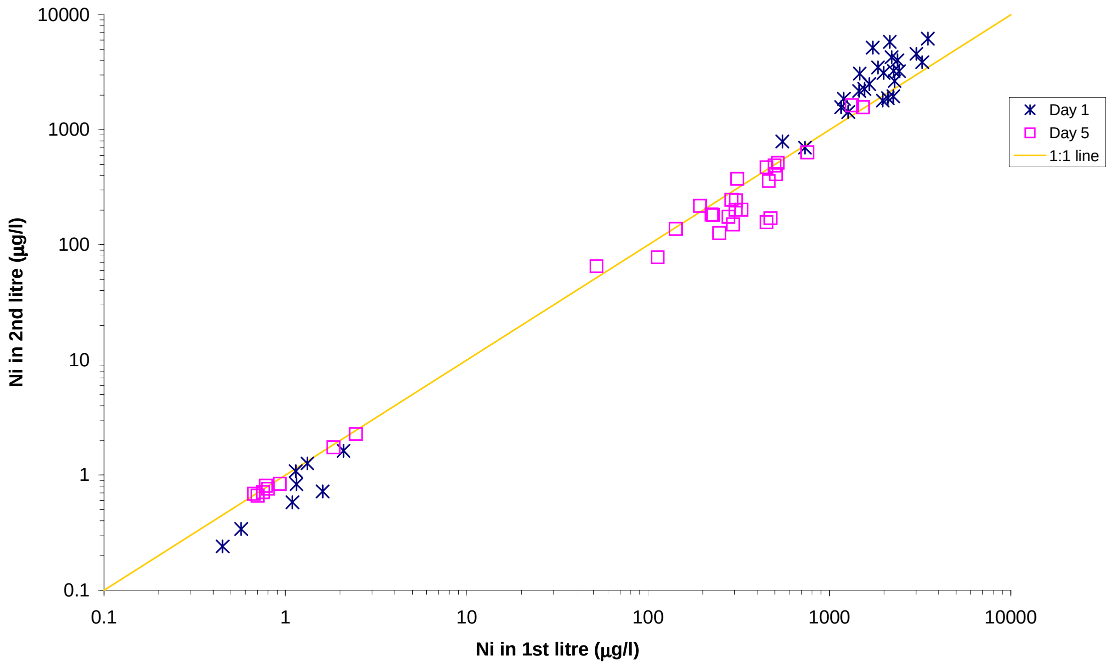

Figure 4.22 Nickel concentrations in 1st and 2nd litre of boiled water

The results for nickel are plotted in Figures 4.23 to 4.34. Kettles Q and R which had non-plated stainless steel elements gave consistently low nickel concentrations. The other kettles, which had nickel-plated elements, gave high nickel concentrations that gradually fell over time, levelling out after two or three weeks of the test. The nickel concentrations for Kettle K on Day 1 were different from (but of the same order as) those obtained in the initial tests.

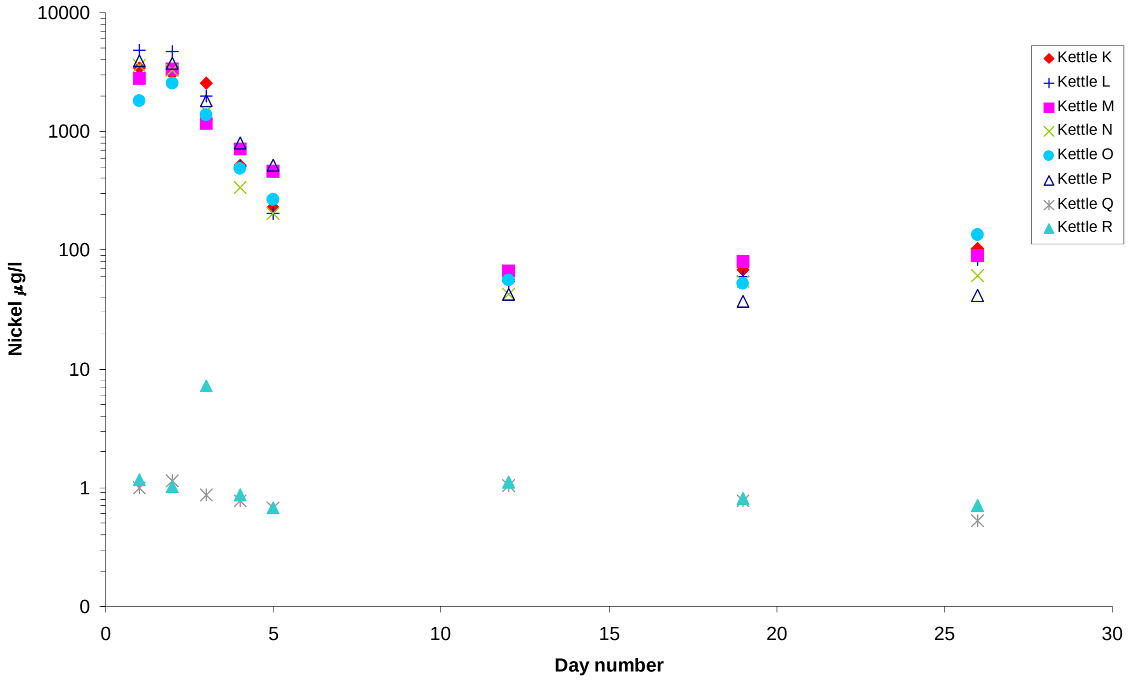

Figure 4.23 Nickel leaching – Filter A

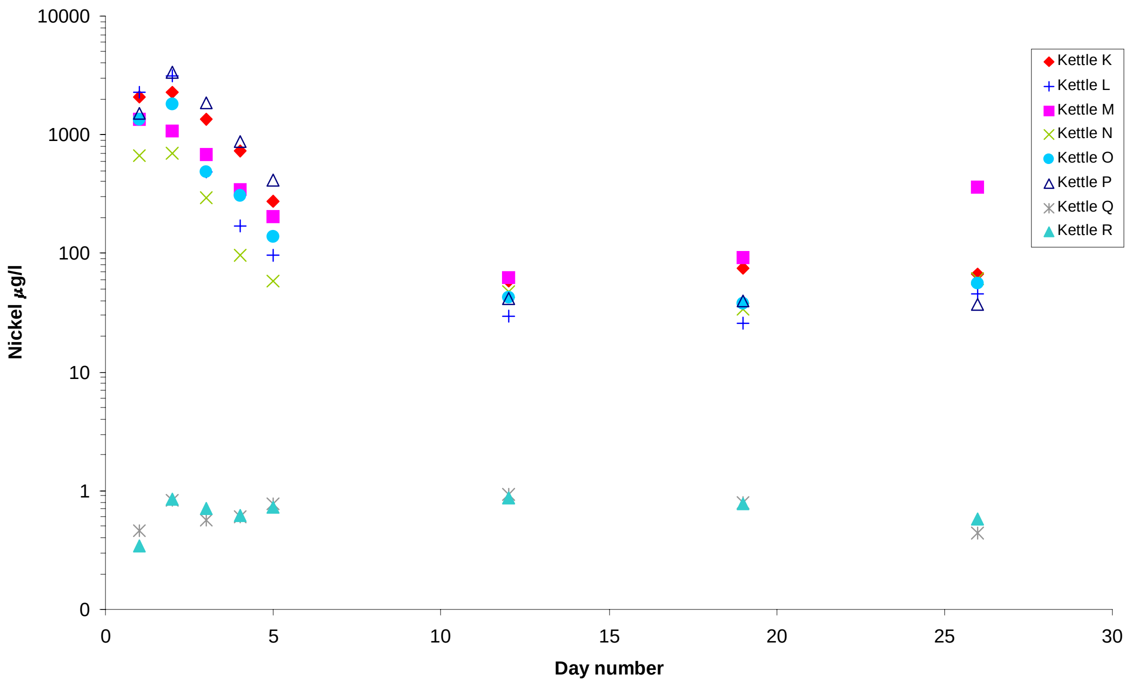

Figure 4.24 Nickel leaching – Filter B

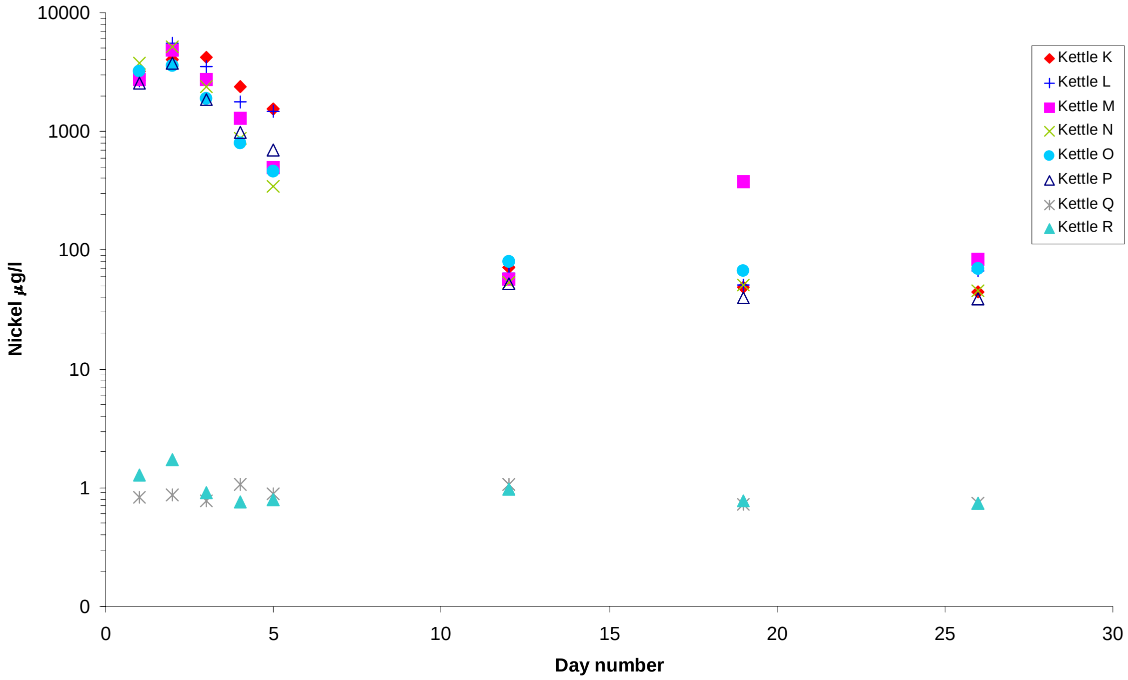

Figure 4.25 Nickel leaching – Filter C

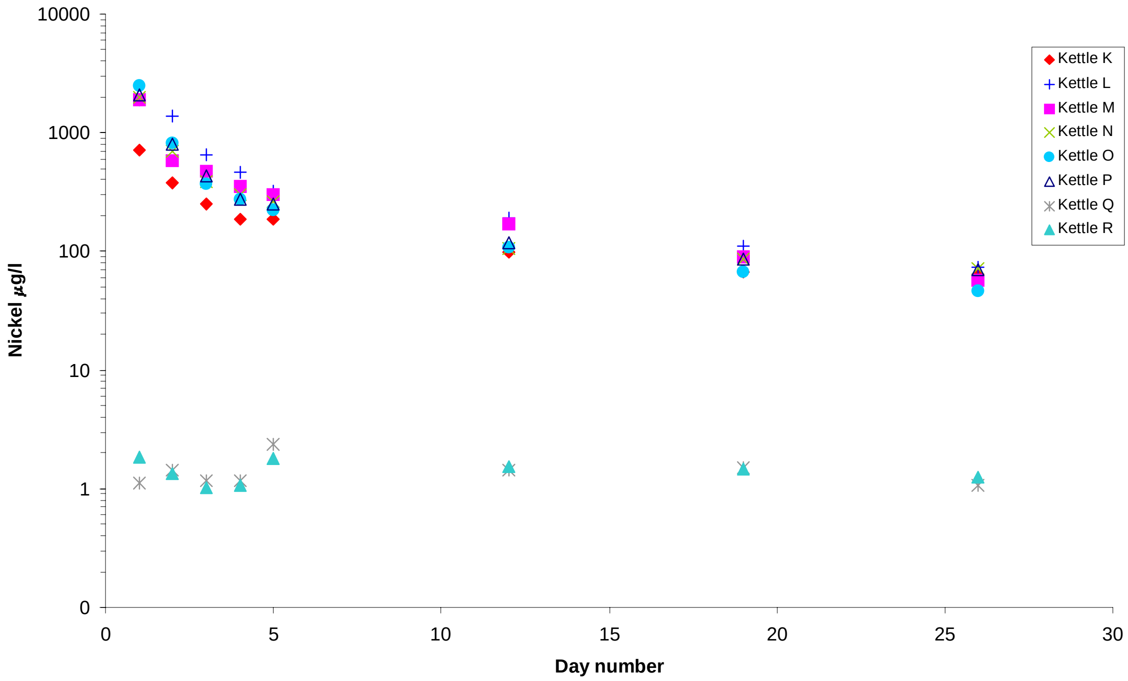

Figure 4.26 Nickel leaching – Water X

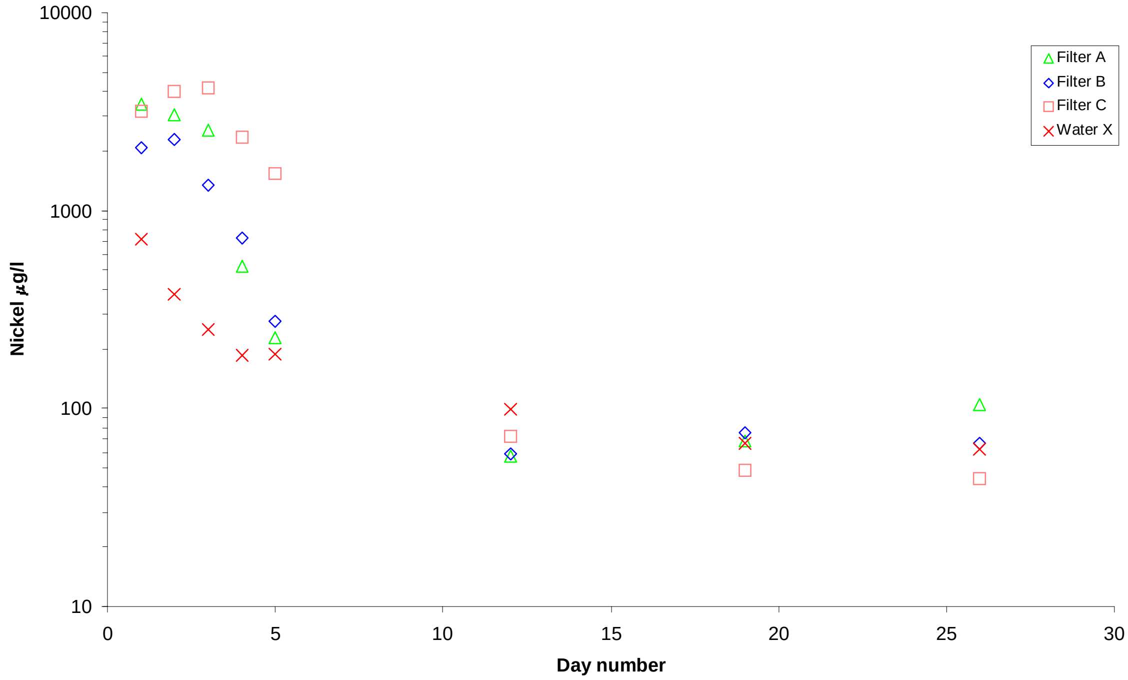

Figure 4.27 Nickel leaching – Kettle K

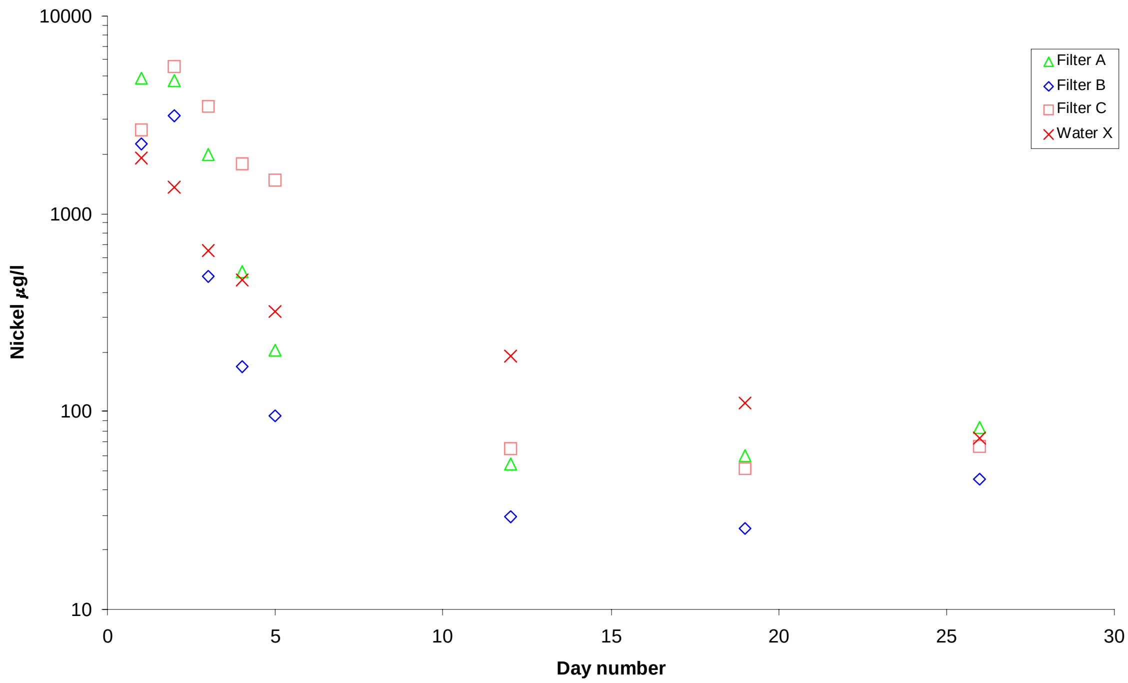

Figure 4.28 Nickel leaching – Kettle L

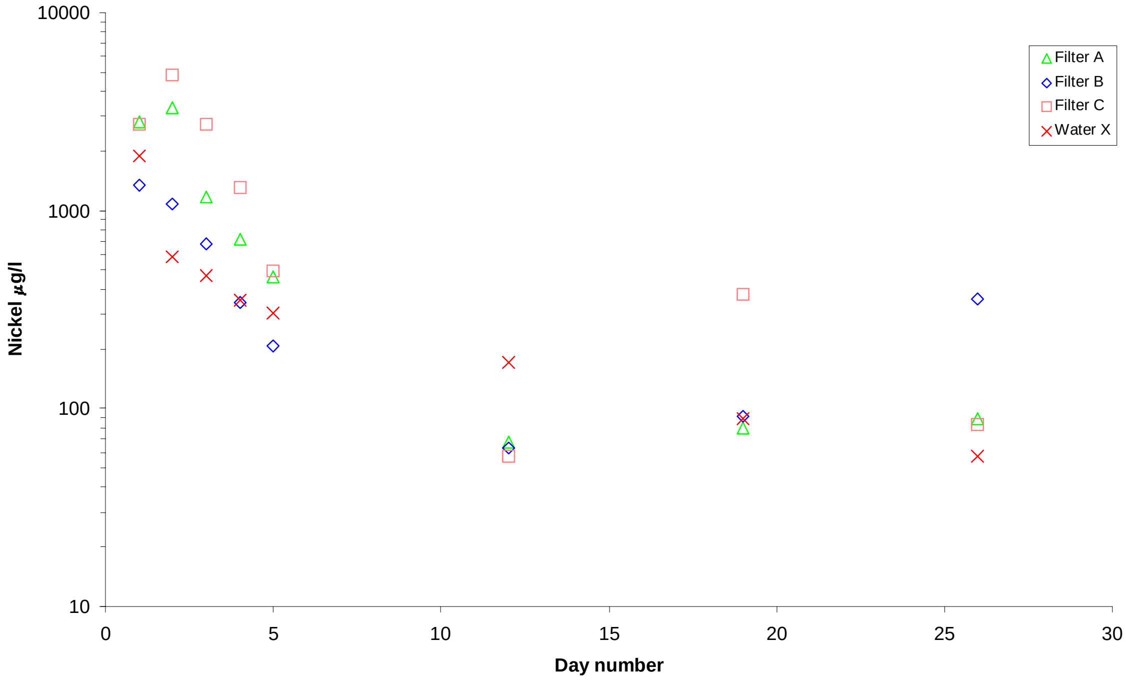

Figure 4.29 Nickel leaching – Kettle M

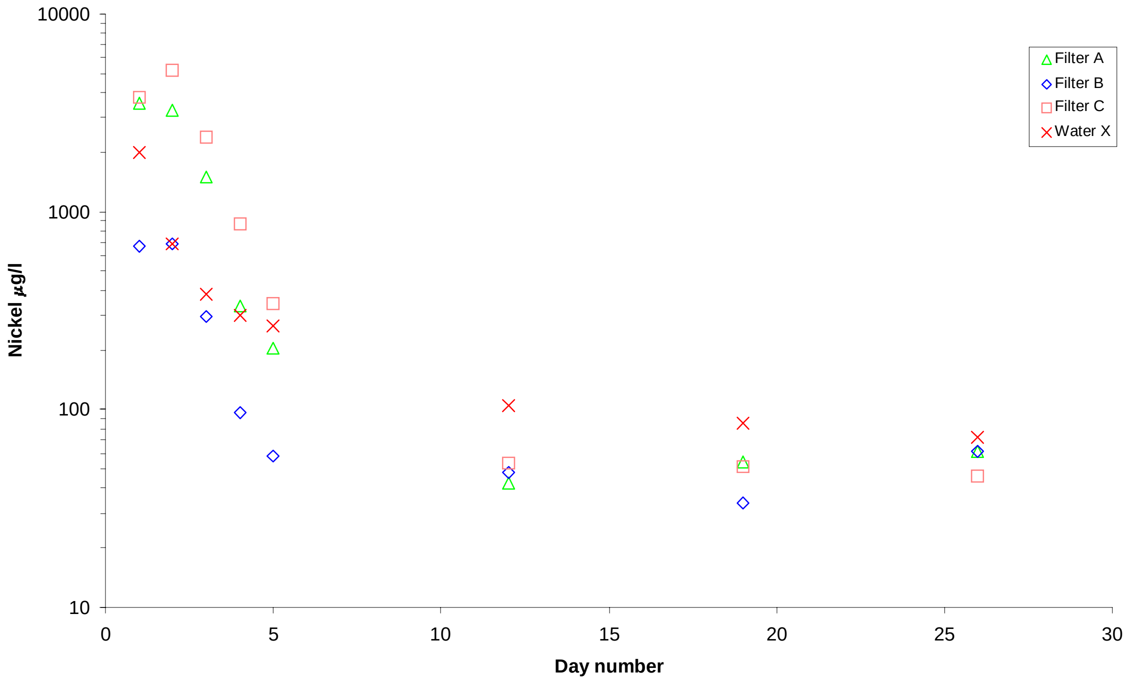

Figure 4.30 Nickel leaching – Kettle N

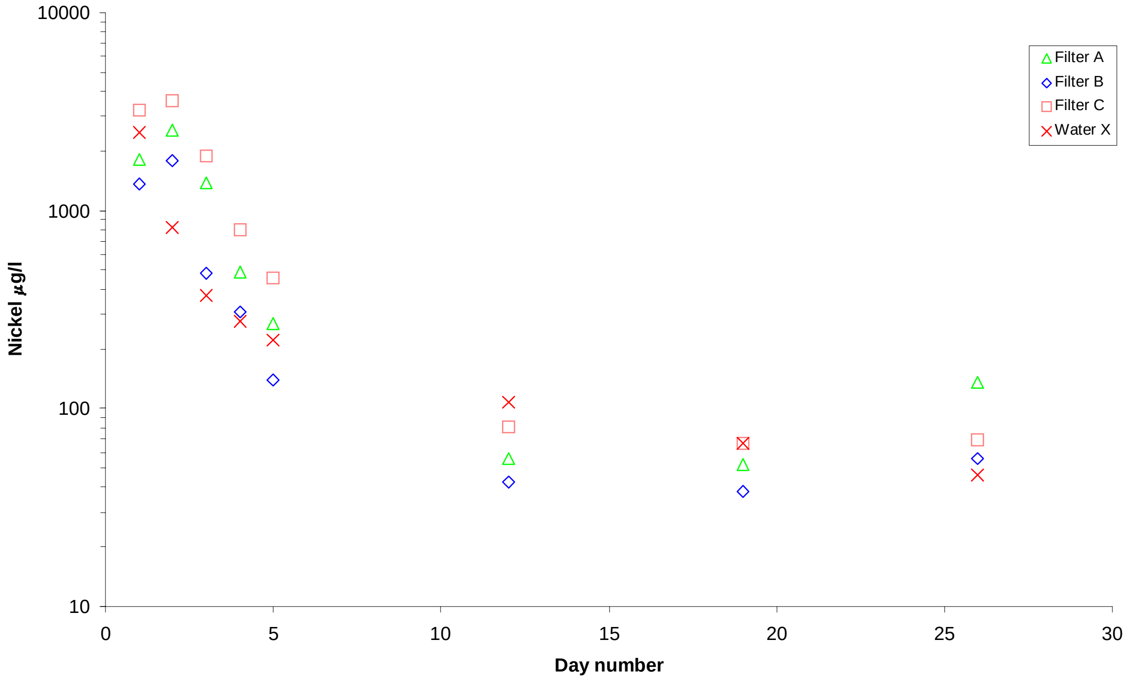

Figure 4.31 Nickel leaching – Kettle O

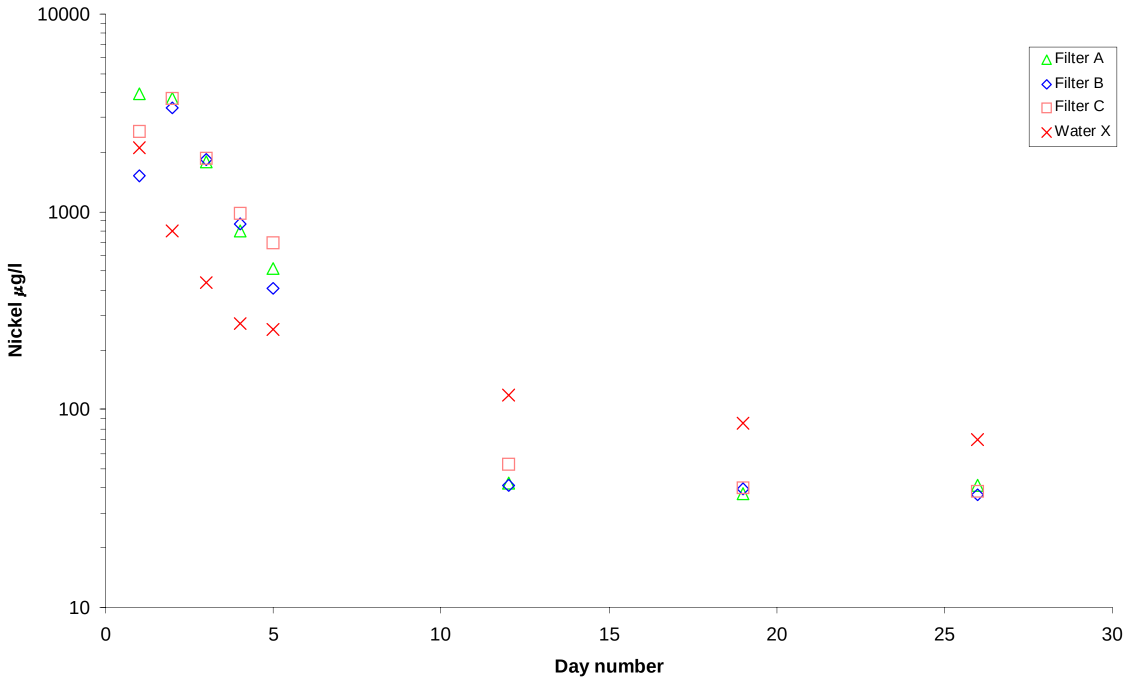

Figure 4.32 Nickel leaching – Kettle P

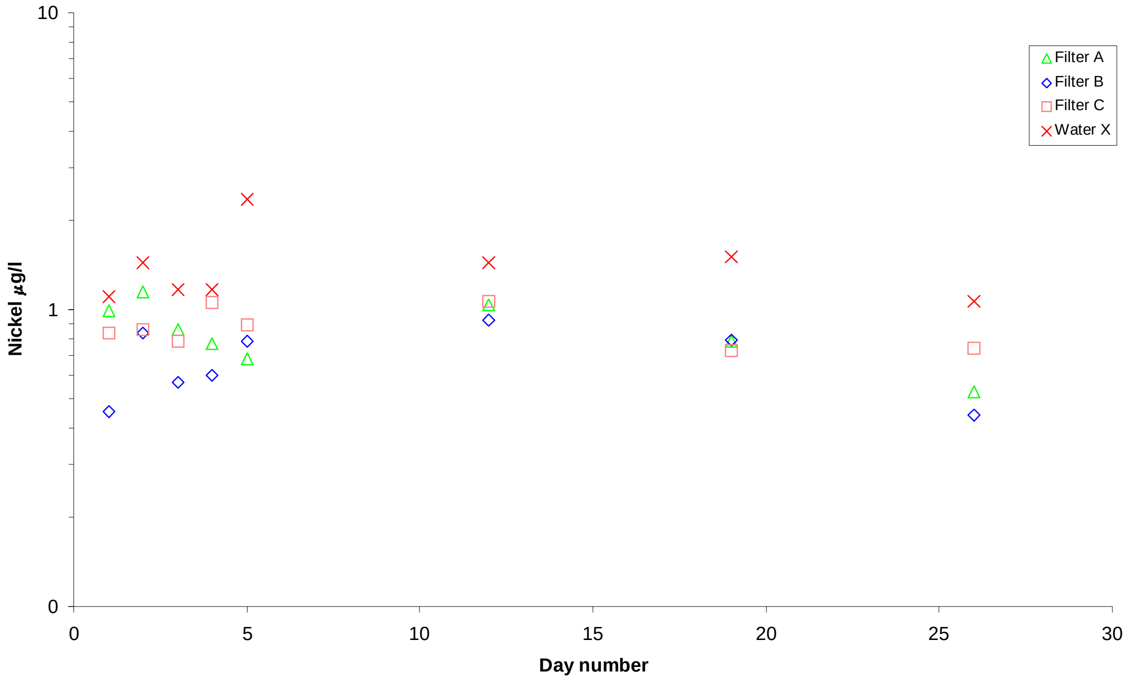

Figure 4.33 Nickel leaching – Kettle Q

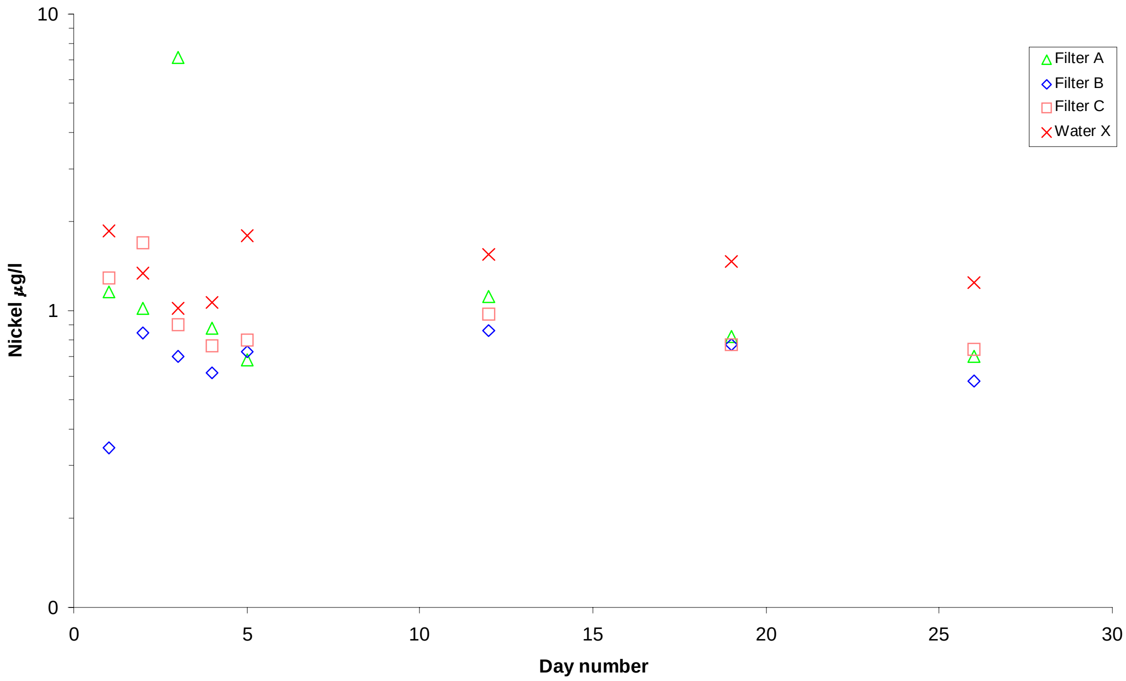

Figure 4.34 Nickel leaching – Kettle R

Table 4.31 summarises the nickel concentrations found during the first and last week of the tests with the kettles that leached appreciable amounts of nickel.

Table 4.31 Summary of nickel concentrations (µg/l)

	First week			Fourth week		
	Mean	Max.	Min.	Mean	Max.	Min.
Filter A	1892	4835	204	86	135	41
Filter B	1014	3350	59	104	358	37
Filter C	2492	5580	343	58	83	39
All filters	1799	5580	59	83	358	37
Unfiltered	723	2470	185	64	73	46

Figure 4.35 to Figure 4.44 show the cumulative quantities of nickel that were leached from the kettles that did not have stainless steel elements[3]. These plots demonstrate that most of the nickel leached during the first week of testing. They also serve to emphasise differences in the quantities of nickel leached from different Kettle/Filter combinations.

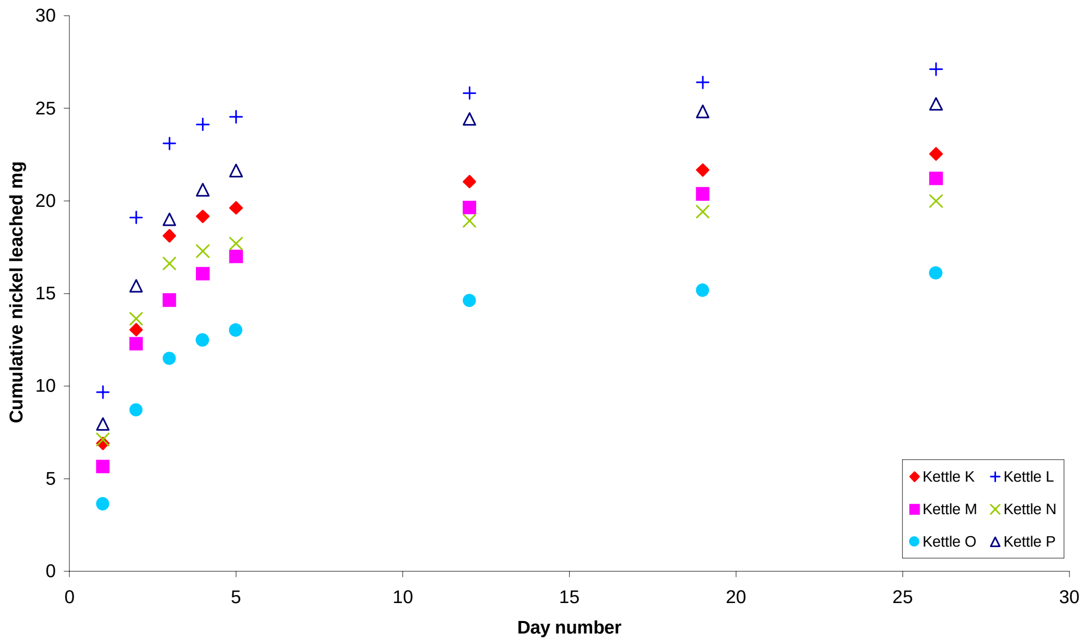

Figure 4.35 Cumulative nickel leaching – Filter A

[3] These cumulative quantities were calculated as follows. For the first week, during which analysis was carried out on each day's samples, the quantity of nickel was calculated as the product of the nickel concentration and the volume of water boiled (2 litres per day). For the subsequent weeks – in which only the "day 5" samples were analysed – the quantity of nickel was estimated from the product of the average of the current and previous week's "day 5" nickel concentration and the volume of water boiled (10 litres per week).

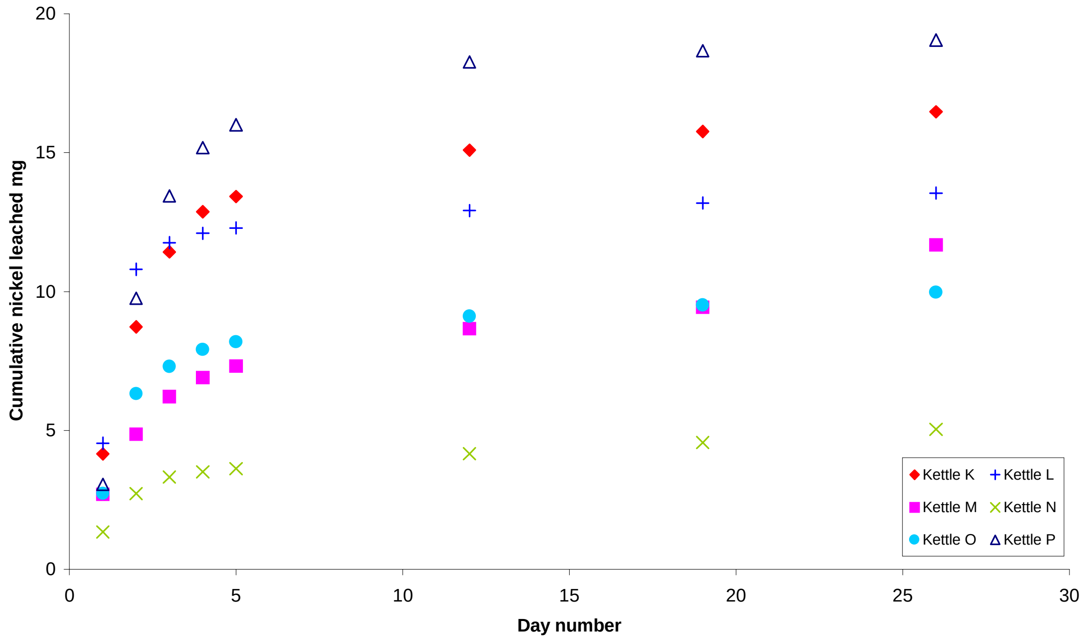

Figure 4.36 Cumulative nickel leaching – Filter B

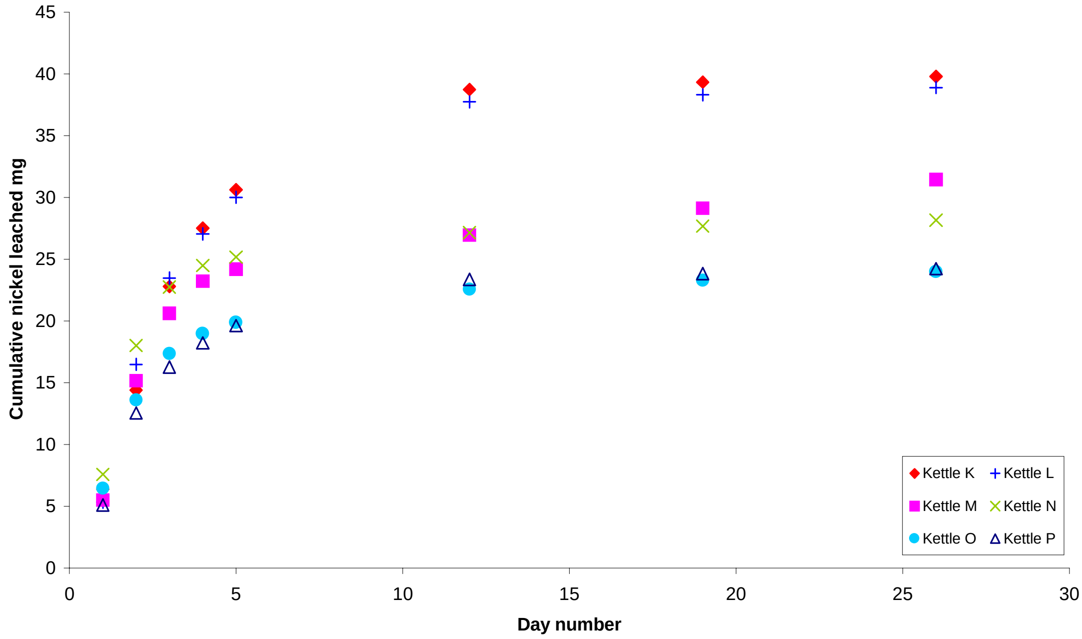

Figure 4.37 Cumulative nickel leaching – Filter C

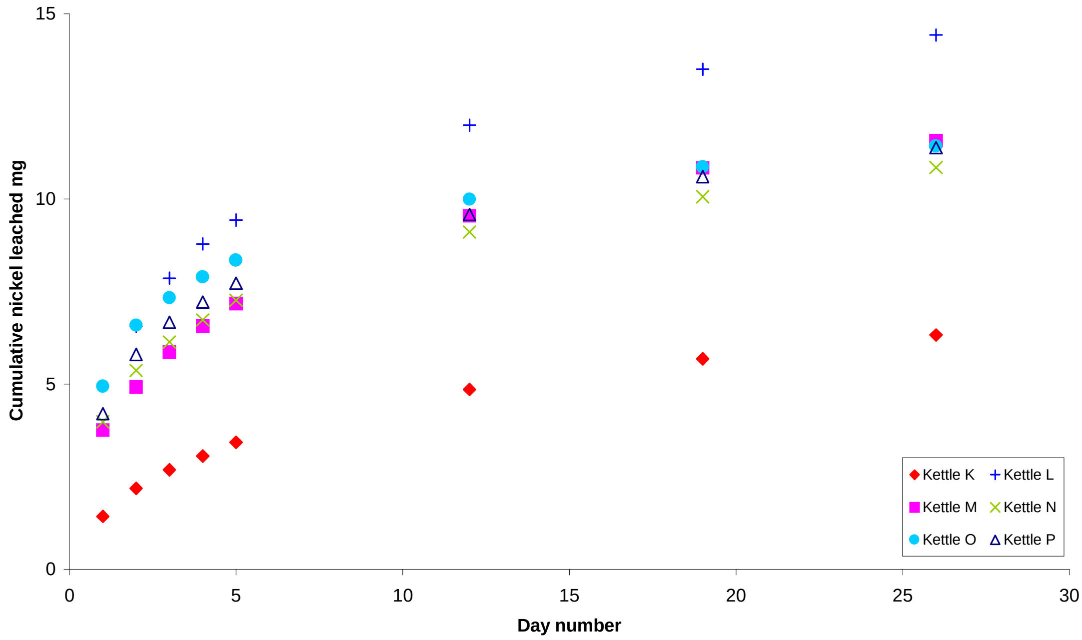

Figure 4.38 Cumulative nickel leaching – Water X

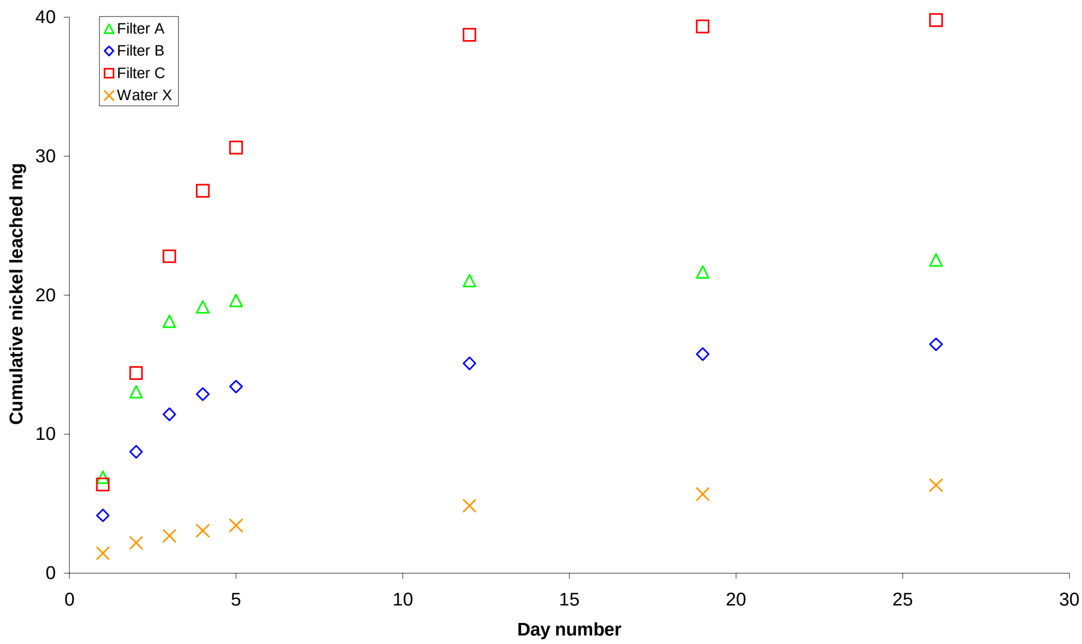

Figure 4.39 Cumulative nickel leaching – Kettle K

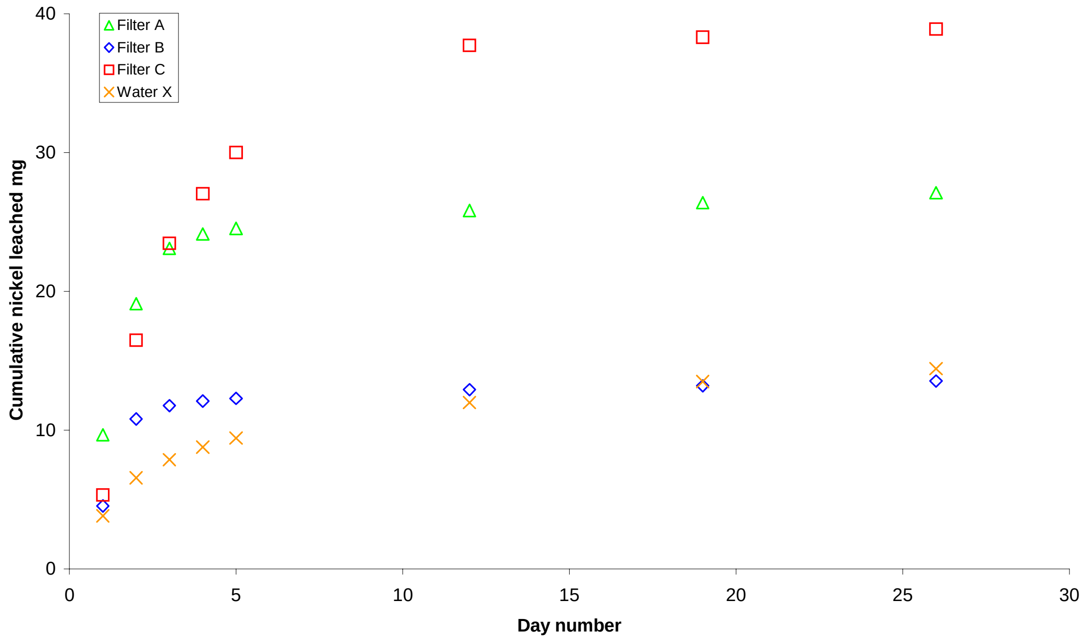

Figure 4.40 Cumulative nickel leaching – Kettle L

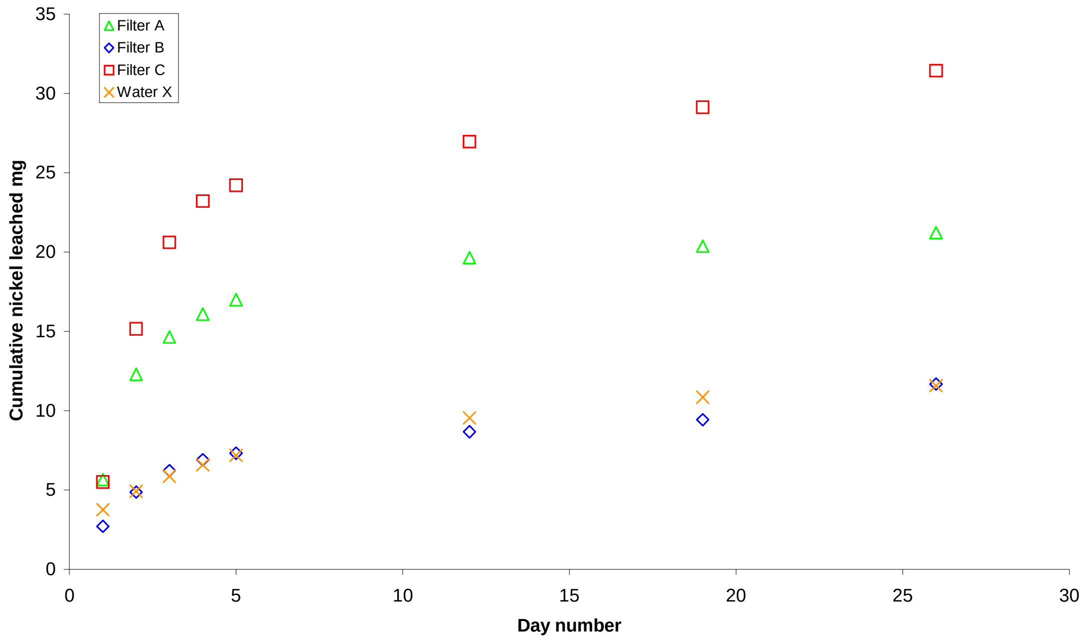

Figure 4.41 Cumulative nickel leaching – Kettle M

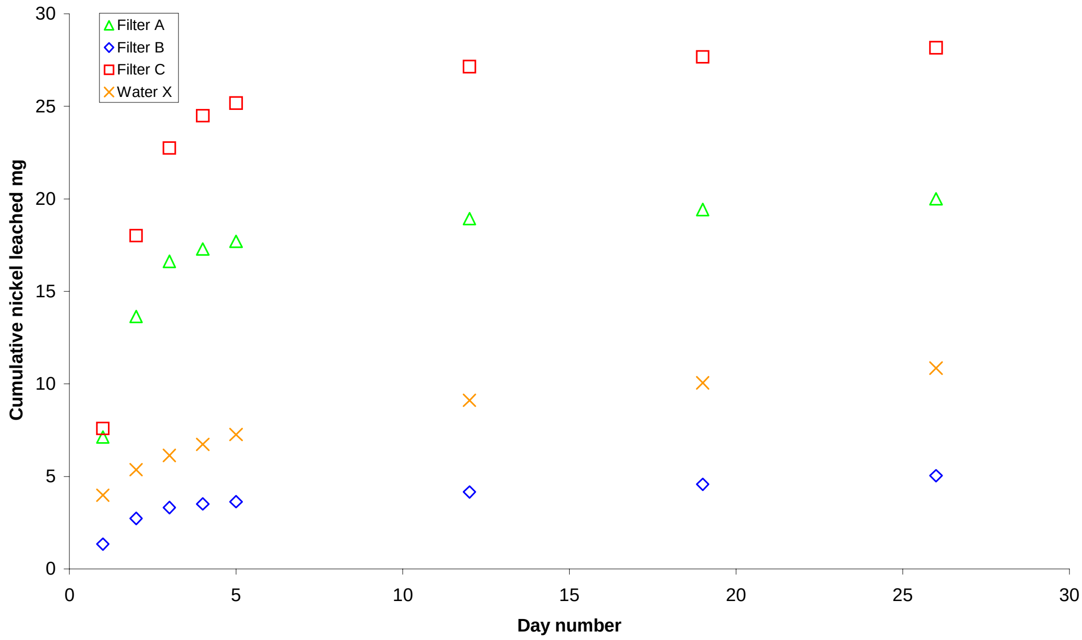

Figure 4.42 Cumulative nickel leaching – Kettle N

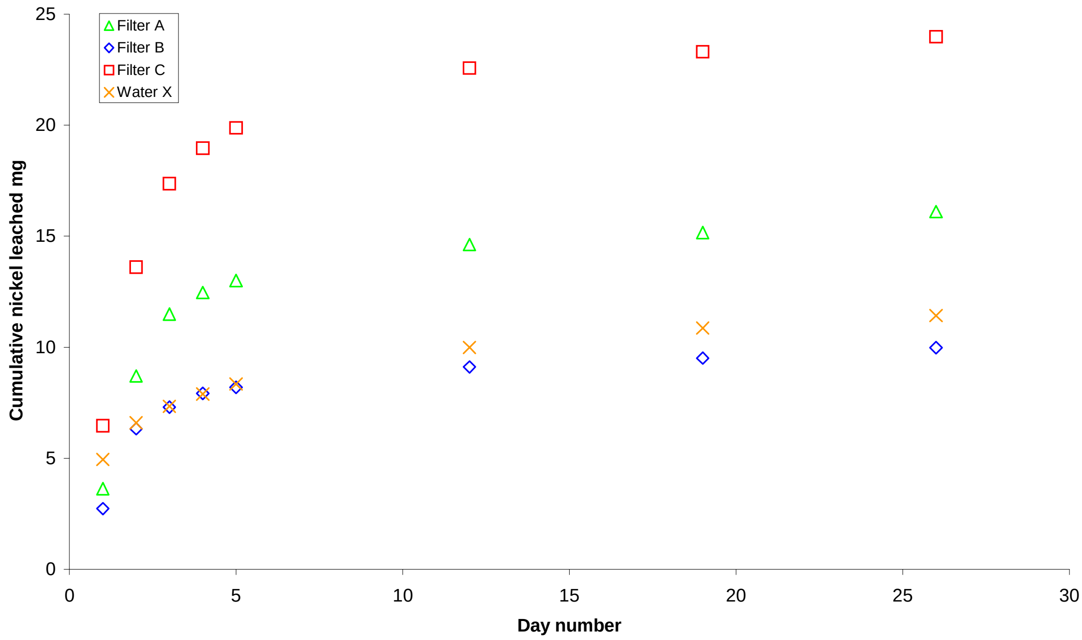

Figure 4.43 Cumulative nickel leaching – Kettle O

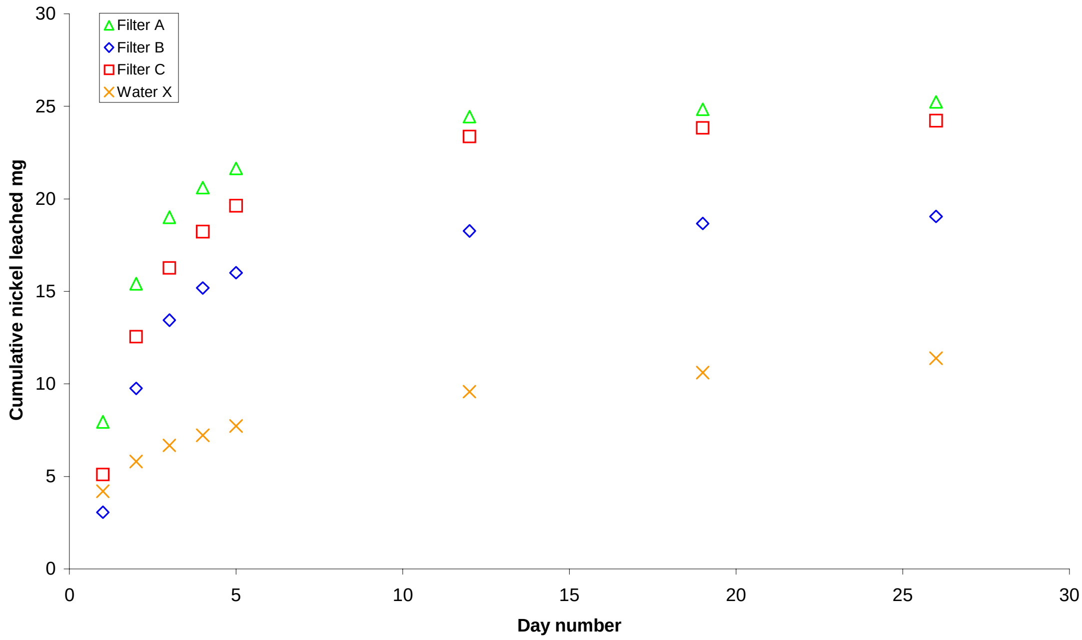

Figure 4.44 Cumulative nickel leaching – Kettle P

In the case of Kettle K and unfiltered Medmenham tap water, samples were taken immediately after boiling and again after one hour of standing (as for the other kettles). At the beginning of the test, the one hour standing produced much greater nickel concentrations, but as the test progressed (and nickel concentrations fell) there was a much smaller increase on standing (Figure 4.45).

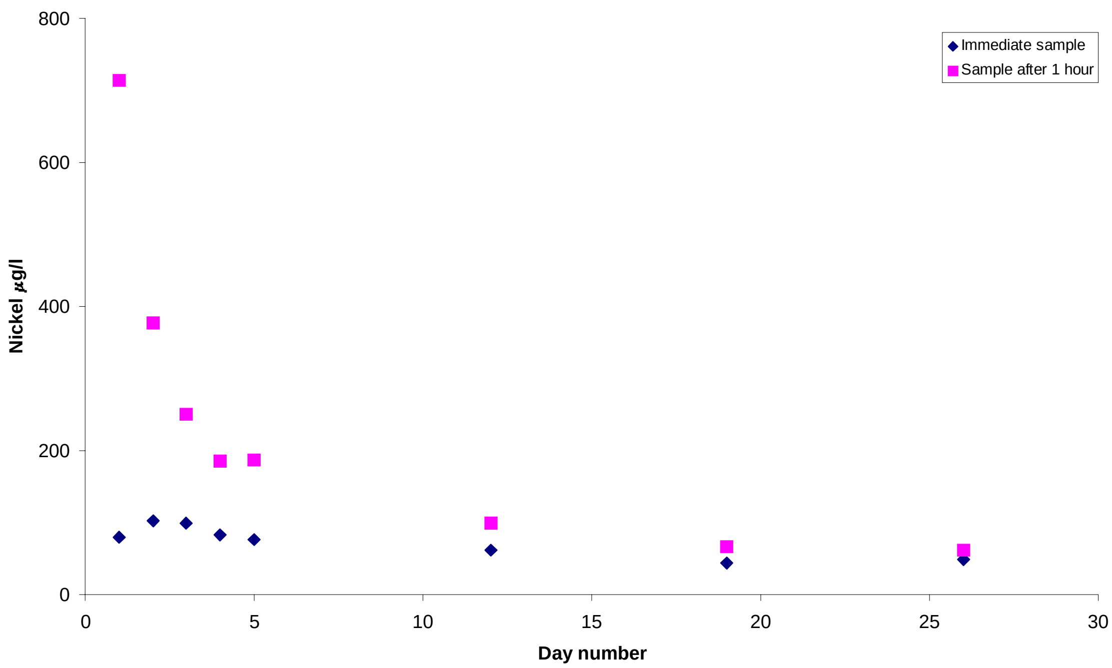

Figure 4.45 Nickel concentrations after 0 and 1 h standing – Water X, Kettle K

A test was run over four days using strong base cation-exchange softened Medmenham tap water boiled in different samples of Kettles K to R. The pH of the softened water was 7.5, with an alkalinity of 255 mg/l as $CaCO_3$ and calcium concentration less than 1 mg/l.

The results are given in Table C.9 with those for unsoftened Medmenham tap water for comparison. The results are plotted against the equivalent results for unsoftened Water X in Figure 4.46 (note the different scales for the two waters). Nickel leaching was substantially less in the softened water, even with Kettles Q and R that have non-plated stainless steel elements that only leach low quantities of nickel. These results suggest that nickel leaching is enhanced by the presence of calcium. This is in agreement with the observation that nickel leaching was less in soft Water Z compared to Water X (Table 4.30).

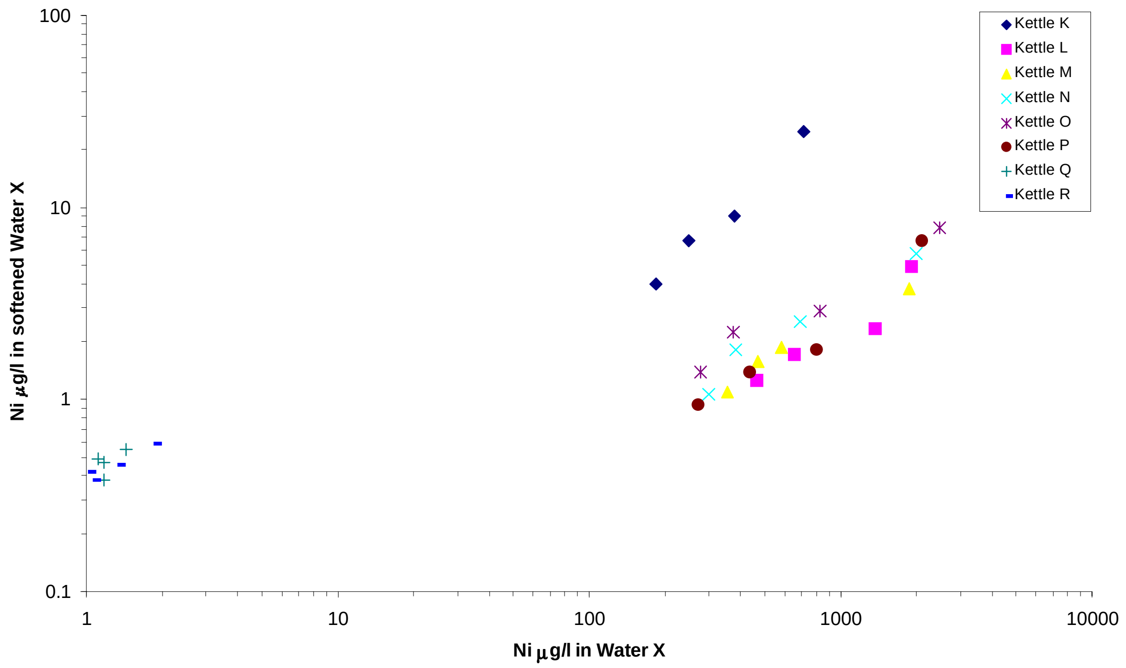

Figure 4.46 Nickel concentrations in softened water compared to Water X

At the end of the experiment one litre portions of tap water were repeatedly boiled using Kettles K and L. The results are given in Figure 4.47. After the first two boilings, the nickel concentrations gradually fell, reaching approximately 60% of the initial value after a total of seven boilings.

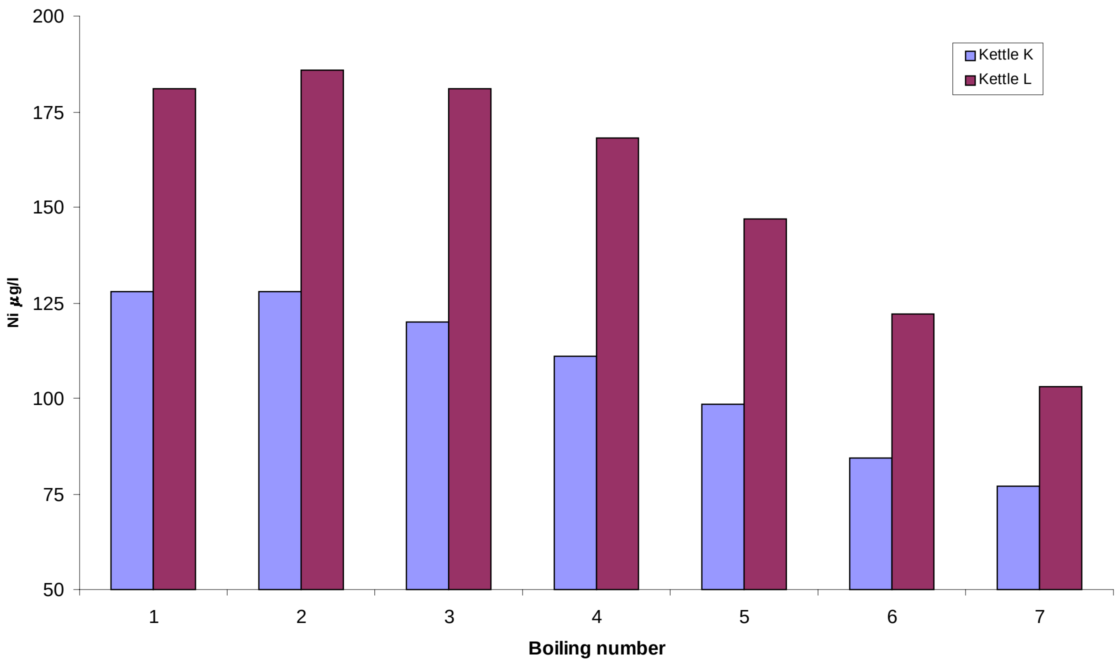

Figure 4.47 Nickel concentrations from repeat boilings

Composition of kettle elements

Following the boiling tests, the kettles that had been used with unfiltered Water X were submitted for analysis by optical microscopy and SEM/EDX to identify the composition of the plating (if any) on the elements.

The results of coating thickness measurements are summarised in Table 4.32. Of the eight kettle elements, six (K to P) were coated and two (Q and R) were uncoated. The coating thickness of the coated elements was between approximately 14 and 31 µm. The element from the Kettle N had the thinnest coating at 14 µm and Kettle M the thickest at 31 µm. The coating thickness appeared to be generally even for all of the elements examined. The Kettle P element showed the most variation in coating thickness, with areas of thin cover near areas with high coating thickness.

The chemical analyses of the kettle elements indicated that two basic types of element were present (Table 4.34). Elements K to P consisted of copper tubes coated with nickel. There was no evidence of any other coating layers on the specimens. The Q and R elements were uncoated and the analysis of tube material indicated that they were stainless steel, probably 304 grade material.

Table 4.32 Coating thickness measurements

Kettle	Coating thickness (μm) Min.	Max.	Mean	Comments
K	14	46	27	Even coating thickness
L	8	24	20	Even coating thickness
M	12	40	21	Even coating thickness
N	10	76	25	Thin layer under the main coating
O	4	34	14	Even coating thickness
P	4	64	31	Variable coating thickness
Q	–	–	–	Element not coated
R	–	–	–	Element not coated

Based on 12 measurements. Uncertainty of measurement ±2.6 μm.

Table 4.33 Coating and tube material analysis

Kettle	Elemental composition (%)											
	Coating						Tube					
	Cu	Ni	Fe	Cr	Mn	Si	Cu	Ni	Fe	Cr	Mn	Si
K	–	100	–	–	–	–	100	–	–	–	–	–
L	–	100	–	–	–	–	100	–	–	–	–	–
M	–	100	–	–	–	–	100	–	–	–	–	–
N	–	100	–	–	–	–	100	–	–	–	–	–
O	–	99.4	0.6	–	–	–	100	–	–	–	–	–
P	–	100	–	–	–	–	100	–	–	–	–	–
Q				#N/A			–	4	26.4	66	3.1	0.6
R				#N/A			–	6.59	22.07	71.26	–	–

Samples from consumers' premises

The results are summarised in Table 4.34. All of the householders were using Filter B brand jug filters. The "new" cartridges had been in use for at least one day before sampling. All of the kettles were at least two years old; none of the kettles was the same model as Kettles K to R.

Iron concentrations were low in all samples. Chromium concentrations were low except for House 1; chromium concentrations were not affected by boiling.

In the case of Houses 1 and 2, boiling the jug-filtered water gave moderately elevated nickel concentrations. With Houses 3 and 4 more substantial increases in nickel concentration were found. For House 5, boiling had no effect on nickel concentrations.

Table 4.34 Summary of results for consumers' premises

House	Cartridge	Sample	Alkalinity mg/l $CaCO_3$	Ca mg/l	Cr µg/l	Cr(VI) µg/l	Fe µg/l	Ni µg/l
1	Old	Tap	284	129	6.0	8.09	<20	4.32
		Filtered	205	99.8	5.0	5.67	<20	2.75
		Boiled	117	67.5	4.6	5.89	<20	15.6
	New	Tap	279	128	6.7	3.60	<20	3.88
		Filtered	22.9	32.7	3.3	2.73	<20	2.06
		Boiled	65.4	47.3	3.0	2.47	<20	20.4
2	Old	Tap	242	106	<0.3	0.08	<20	1.85
		Filtered	115	55.5	<0.3	0.06	<20	0.87
		Boiled	141	63.8	<0.3	0.08	<20	5.30
	New	Tap	245	101	<0.3	0.09	<20	1.84
		Filtered	53.6	11.5	<0.3	<0.06	<20	0.29
		Boiled	69.3	18.8	<0.3	<0.06	<20	7.73
3	Old	Tap	266	102	0.6	<0.06	<20	0.90
		Filtered	167	65.7	<0.3	<0.06	<20	0.60
		Boiled	138	53.9	<0.3	<0.06	<20	187
	New	Tap	268	102	<0.3	<0.06	<20	0.92
		Filtered	35.7	10.1	<0.3	<0.06	<20	0.15
		Boiled	64.1	17.9	<0.3	<0.06	<20	122
4	Old	Tap	228	92.9	<0.3	<0.06	<20	1.13
		Filtered	174	73.8	<0.3	<0.06	<20	1.14
		Boiled	162	71.3	<0.3	<0.06	<20	60.7
	New	Tap	226	94.7	<0.3	<0.06	<20	1.10
		Filtered	15.2	10.9	<0.3	<0.06	<20	0.41
		Boiled	47.3	23.4	<0.3	<0.06	<20	244
5	Old	Tap	224	92.9	<0.3	<0.06	<20	0.99
		Filtered	141	64.4	<0.3	<0.06	<20	0.78
		Boiled	138	63.5	<0.3	<0.06	<20	0.71
	New	Tap	223	93.2	<0.3	<0.06	<20	1.01
		Filtered	56.5	23.4	<0.3	<0.06	<20	0.52
		Boiled	62.7	29.9	<0.3	<0.06	<20	0.61

5. DISCUSSION

As expected, HPC levels were greater in Water Y than in Water X. The HPC levels in the feed waters rose over the period of testing. The fact that HPC levels were variable (as is expected with waters taken from supply) has to be taken into account in interpreting the results. It should also be noted that increases in HPC levels are not of themselves indicative of potential adverse health effects.

Whilst the HPC tests in this study were carried out under controlled conditions, using the same equipment, methods, culture media and personnel throughout, it should be noted that these tests are non-selective, and may be liable to greater variability in the results than selective bacterial assays such as those for coliform organisms.

It is known that HPC culturing methods only isolate a proportion (often a small one) of the total heterotrophic population that is present in a sample. Some types of heterotrophic bacteria therefore grow better on the culture medium employed in this test than others, and consequently any changes in the composition of the bacterial population may lead to apparent changes in the recovery efficiency of the method. This in turn will result in the HPC test showing greater variability than selective culturing tests which are designed to target specific groups of micro-organisms.

Both 22 °C and 37 °C HPC levels tended to be higher in the filtrates than in the feed water. For Filters A to C the 22 °C HPC levels with Water Y tended to increase over the period of testing for "regular" samples (Table 4.3) whereas in the Monday morning samples the levels peaked around the middle of the testing period. These results, obtained over a prolonged period of testing are reassuring in that there was no evidence of an "explosion" in HPC levels. In general the results are in line with expectations, with growth of HPC bacteria being greater with the high nutrient Water Y.

In general the HPC results reached much higher values in the filtrates from Filter D compared to the other three filters. Filter D did not contain silver as a bacteriostatic agent and was run for much longer than the other filters.

With the Monday morning samples, the HPC levels in the third litre filtered were generally (but not always) lower than in the first litre. Thus the manufacturers' recommendations to discard filtered water in order to flush the cartridge are partially effective. However, with Water Y the 22 °C HPC results for the third litre sampled were substantially greater than those for the "normal" samples at an equivalent stage of filter life.

Silver leached from three of the filters tested (Filters A to C). The concentrations were below the WHO recommendation (WHO 1993) that a concentration of 100 μg/l could be tolerated without risk to health for a lifetime's exposure assuming a consumption of two litres of water per day. However, it should be noted that this advice was based solely on the development of argyria (deposition of silver resulting in discoloration of skin etc.). There is a lack of long-term toxicity data that would enable a risk assessment to be made regarding exposure to silver in drinking water. The concentration of silver leached fell over the period of testing but the fall in silver levels was much smaller with Filter B compared to the other filters. With the Monday morning samples, the silver concentrations in the third litre filtered were almost always lower than in the first litre. The pattern of silver leaching over time was different for the two test waters. The small concentrations of silver recorded for some samples of feed water were probably as a result of contamination in the laboratory.

There was no evidence that the filters caused deterioration in odour or flavour; some panellists detected odour and flavour in some filtered water samples but there was no clear pattern or consistency when all of the panellists' results were considered. There was no deterioration in odour or flavour even for samples taken well past the recommended lifetime for the filter cartridges. These results indicate that the odour or flavour of the filtered water would not give any indication to consumers that the cartridge life had been exceeded.

Challenging the filters with *E. coli* and *Salmonella* showed that these organisms were only present – if at all – in the first filtrate following inoculation. Thereafter these bacteria were not detected in any filtrate, or in the filter media at the end of the experiment. These results are reassuring in that they indicate that pathogenic bacteria will not survive in the filtered water or in the filter media. This may be as a result of the presence of silver in the filter media but the effectiveness of silver in controlling the growth of bacteria was not examined in this project. With Water X neither organism was detected in control samples (not jug filtered); this is probably because there was sufficient residual chlorine in Water X to inactivate the spike. *Salmonella* was detected in the first litre of filtrate of Water X in some samples, probably as a result of removal of residual chlorine by the jug filters, allowing any organisms not already inactivated to survive.

Storage of filtered water had little effect on HPC levels in the low-nutrient Water X. In contrast, with Water Y the HPC levels increased with storage of the filtrate from mature filters with storage at 4 °C and from both semi-mature and mature filters with storage at both 4 °C and 20 °C. These increases were greater than occurred in control samples of Water Y. The results for the semi-mature filter, Day 2, are unrepresentative, possibly as a result of contamination of a bottle of culture medium. The pattern of results for the feed and filtered water 22 °C HPC demonstrate the pattern of growth commonly seen in waters with high AOC; a rapid initial rise reaching a peak after about four days after which plate counts decline, sometimes dramatically. Overall the results show that HPC levels increase with storage of the filtered water at 20 °C; storage of the unfiltered water also resulted in a less marked increase in HPC.

Allowing filters to stagnate for 7 days (prolonged non-use) with Water X had little effect on HPC levels in the filtrates except for mature Filter B stored at 20 °C. This is somewhat surprising since Filter B continued to leach silver even at 200% capacity. With Water Y the 22 °C HPC levels in the filtrates did increase when the filters were stored and the effects were greater with storage at 20 °C than at 4 °C. There appeared to be little effect on the 37 °C plate counts. The fact that increases in HPC were lower at 4 °C demonstrates that it is advisable to store filter cartridges in a refrigerator during periods of prolonged non-use.

The initial metals leaching tests showed substantial leaching of nickel into filtered hard Water X and soft Water Z when boiled in a kettle with an exposed nickel-plated elements. There was little leaching of the other metals that were tested for when water was boiled in a kettle with a flat bed stainless steel element or in a stainless steel saucepan (although some results for nickel were above the standard of 20 μg/l in the Water Quality Regulations 2000). High nickel concentrations were also found when unfiltered water samples were boiled in a kettles with an exposed nickel-plated element. However, nickel leaching was higher with filtered water.

Further tests confirmed that high quantities of nickel leach from some, but not all, models of kettle with exposed heating elements. Nickel leached in appreciable quantities from the six kettles with nickel-plated elements but little leaching occurred from the two kettles with stainless steel elements. Leaching occurred both with tap water and with jug-filtered tap water. Leaching was higher with water filtered using jugs with "new" filter cartridges; as the jug filter cartridges became exhausted the leaching of nickel fell to levels at or below those of non-filtered tap water. The increased leaching of nickel with jug filtered water is associated with the reduced pH and/or alkalinity but not with the reduced calcium concentration; limited experiments with softened water indicated that nickel leaching is lower in low-calcium water. The leached nickel is present in solution; however, the results of repeat boiling experiments suggest that some nickel may become incorporated into the scale on the heating element.

The results from households showed elevated nickel levels from certain kettles, the highest levels generally being associated with boiling water that had been filtered through jugs with new filter cartridges.

The results from this study are in broad agreement with those of other studies that have examined nickel leaching from kettles and other cookware (see Appendix D). However, other studies have not examined the effects of jug filtration on nickel leaching.

The WHO guideline value for nickel in drinking water is 20 μg/l. Nickel concentrations several hundred times this value were found with new kettles, and even after a month's use concentrations two to three times the guideline value were found consistently from several models of kettle.

6. CONCLUSIONS

Based on the results of the tests conducted the following conclusions are drawn.

1. The HPC levels tended to be higher in filtered water compared to the feed, particularly with high nutrient test water. There was no indication of an "explosion" in HPC levels. Increases in HPC are not by themselves indicators of adverse health effects.

2. HPC levels tended to be lower after flushing filters that had stood over the weekend. This supports the manufacturers' recommendation to discard the first few litres of filtrate following prolonged non-use of the filter. However, colony counts in these samples were still higher than those found during "normal" operation of the filters.

3. Three of the filters were impregnated with silver and they leached silver into the filtrate. There is a lack of toxicological data on long-term human exposure to silver in drinking water to determine whether the concentrations found are of concern to health.

4. Filters did not cause adverse effects on odour or flavour, even when used well after their recommended lifetime.

5. *Salmonella* and *E. coli* deliberately spiked into the feed water did not survive in the filtered water or colonise the filter media.

6. With high nutrient test water, storage of the filtered water resulted in increasing HPC levels. There was little effect in low nutrient water.

7. With high nutrient test water, prolonged non-use of the filter resulted in increasing HPC levels. The increases were smaller when the cartridge was stored at 4 °C, supporting a recommendation that cartridges should be stored in a refrigerator during prolonged periods of non-use. There was little effect in low nutrient water.

8. Overall, there was no evidence that jug water filter systems have adverse effects on microbial water quality, even when tested under conditions simulating abuse and contamination.

9. High nickel concentrations were found in both filtered and unfiltered water boiled in kettles with nickel-plated elements; the nickel concentrations were higher with water filtered through "new" cartridges. Water filtered through "old" cartridges leached nickel at concentrations at or below those found with unfiltered tap water. Nickel did not leach from kettles with stainless steel elements.

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APPENDIX A – ROUTINE MONITORING RESULTS

Table A.1 pH results – Filters A to C

Day number	Date	Water X	Water Y
1	21-Jan-02	6.92	7.11
2	22-Jan-02	7.05	7.25
3	23-Jan-02	7.03	6.89
4	24-Jan-02	6.73	6.76
5	25-Jan-02	7.05	7.29
8	28-Jan-02	6.92	6.96
9	29-Jan-02	7.06	7.30
10	30-Jan-02	7.04	7.10
11	31-Jan-02	7.10	7.33
12	01-Feb-02	6.93	7.31
15	04-Feb-02	7.32	7.34
16	05-Feb-02	7.12	7.21
17	06-Feb-02	7.03	7.12
18	07-Feb-02	7.12	7.18
19	08-Feb-02	6.97	6.94
22	11-Feb-02	7.06	7.00
23	12-Feb-02	6.88	6.86
24	13-Feb-02	7.22	7.36
25	14-Feb-02	7.09	7.43
26	15-Feb-02	7.03	7.15
29	18-Feb-02	7.13	7.20
30	19-Feb-02	6.82	6.93
31	20-Feb-02	6.71	6.96
32	21-Feb-02	7.39	7.55
33	22-Feb-02	6.90	6.99
36	25-Feb-02	7.10	7.08
37	26-Feb-02	7.07	7.19
38	27-Feb-02	7.11	7.38
39	28-Feb-02	7.05	7.38
40	01-Mar-02	7.01	7.05
43	04-Mar-02	6.97	6.91
44	05-Mar-02	7.01	7.04
45	06-Mar-02	6.92	7.18
46	07-Mar-02	7.08	7.04
47	08-Mar-02	7.14	7.27
50	11-Mar-02	6.95	6.96
51	12-Mar-02	7.25	7.23
52	13-Mar-02	7.05	7.41
53	14-Mar-02	7.09	7.50
54	15-Mar-02	6.95	7.27

Table A.2 pH results – Filter D

Day number	Date	Water X	Water Y
1	18-Feb-02	7.13	7.20
2	19-Feb-02	6.82	6.93
3	20-Feb-02	6.71	6.96
4	21-Feb-02	7.39	7.55
5	22-Feb-02	6.90	6.99
8	25-Feb-02	7.10	7.08
9	26-Feb-02	7.07	7.19
10	27-Feb-02	7.11	7.38
11	28-Feb-02	7.05	7.38
12	01-Mar-02	7.01	7.05
15	04-Mar-02	6.97	6.91
16	05-Mar-02	7.01	7.04
17	06-Mar-02	6.92	7.18
18	07-Mar-02	7.08	7.04
19	08-Mar-02	7.14	7.27
22	11-Mar-02	6.95	6.96
23	12-Mar-02	7.25	7.23
24	13-Mar-02	7.05	7.41
25	14-Mar-02	7.09	7.50
26	15-Mar-02	6.95	7.27
29	18-Mar-02	6.96	7.04
30	19-Mar-02	7.01	7.18
31	20-Mar-02	6.84	7.01
32	21-Mar-02	7.02	7.07
33	22-Mar-02	7.17	7.30
36	25-Mar-02	7.03	7.21
37	26-Mar-02	7.21	7.11
38	27-Mar-02	7.30	7.67
39	28-Mar-02	6.98	7.44
44	02-Apr-02	7.35	7.12
45	03-Apr-02	7.62	7.34
46	04-Apr-02	7.56	7.31
47	05-Apr-02	7.41	7.43
50	08-Apr-02	7.35	7.42
51	09-Apr-02	7.30	7.50
52	10-Apr-02	7.26	7.66
53	11-Apr-02	7.41	7.83
54	12-Apr-02	7.24	7.60
57	15-Apr-02	7.29	7.70
58	16-Apr-02	7.55	7.85

Table A.2 Continued

Day number	Date	Water X	Water Y
59	17-Apr-02	7.27	7.73
60	18-Apr-02	7.33	7.82
61	19-Apr-02	7.26	7.88
64	22-Apr-02	7.41	7.97
65	23-Apr-02	7.36	7.29
66	24-Apr-02	7.14	7.02
67	25-Apr-02	7.48	7.41
68	26-Apr-02	7.47	7.61
71	29-Apr-02	7.57	7.39
72	30-Apr-02	7.57	7.34
73	01-May-02	7.43	7.35
74	02-May-02	7.56	7.63
75	03-May-02	7.52	7.39
79	07-May-02	7.26	7.22
80	08-May-02	7.28	7.53
81	09-May-02	7.29	7.72
82	10-May-02	7.15	7.17
85	13-May-02	7.13	7.55
86	14-May-02	7.19	7.17
87	15-May-02	7.26	7.38
88	16-May-02	7.48	7.79
89	17-May-02	7.18	7.10
92	20-May-02	7.46	7.45
93	21-May-02	7.35	7.68
94	22-May-02	7.34	7.46
95	23-May-02	7.37	7.46
96	24-May-02	7.53	7.78
99	27-May-02	7.52	8.05
100	28-May-02	7.20	7.97
101	29-May-02	7.50	7.13
102	30-May-02	7.48	7.41
103	31-May-02	7.45	7.26
108	05-Jun-02	7.47	7.06
109	06-Jun-02	7.27	6.95
110	07-Jun-02	7.29	7.04
113	10-Jun-02	7.65	7.52
114	11-Jun-02	7.33	7.36
115	12-Jun-02	7.35	7.45
116	13-Jun-02	7.41	7.69
117	14-Jun-02	7.46	7.46
120	17-Jun-02	7.44	7.54

Table A.2 Continued

Day number	Date	Water X	Water Y
121	18-Jun-02	7.43	7.49
122	19-Jun-02	7.55	7.60
123	20-Jun-02	7.35	7.28
124	21-Jun-02	7.61	7.70
127	24-Jun-02	7.58	7.44
128	25-Jun-02	7.56	7.38
129	26-Jun-02	7.26	7.25
130	27-Jun-02	7.20	7.27
131	28-Jun-02	7.41	7.34
134	01-Jul-02	7.26	7.41
135	02-Jul-02	7.31	7.47
136	03-Jul-02	7.19	7.52
137	04-Jul-02	7.23	7.51
138	05-Jul-02	7.27	7.47

Table A.3 Alkalinity results (mg/l as $CaCO_3$) – Filters A to C

Day number	Date	Water X	Water Y
1	21-Jan-02	216	161
8	28-Jan-02	266	200
15	04-Feb-02	267	186
23	12-Feb-02	269	167
29	18-Feb-02	260	172
36	25-Feb-02	268	203
43	04-Mar-02	266	182
50	11-Mar-02	268	179

Table A.4 Alkalinity results (mg/l as $CaCO_3$) – Filter D

Day number	Date	Water X	Water Y
1	18-Feb-02	260	172
8	25-Feb-02	268	203
15	04-Mar-02	266	182
22	11-Mar-02	268	179
29	18-Mar-02	205	203
37	26-Mar-02	270	204
44	02-Apr-02	269	191
50	08-Apr-02	272	167
57	15-Apr-02	273	181
71	29-Apr-02	269	163
81	09-May-02	254	188
85	13-May-02	273	163
92	20-May-02	283	165
99	27-May-02	273	172
108	05-Jun-02	272	165
120	17-Jun-02	268	160
134	01-Jul-02	263	212

APPENDIX B – ODOUR AND FLAVOUR RESULTS

Table B.1 Odour results – Filters A to C

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
22-Jan-02	X	A	1	Earthy/clay	None
22-Jan-02	X	A	2	None	None
22-Jan-02	X	A	3	None	None
22-Jan-02	X	A	1	None	None
22-Jan-02	X	A	2	None	None
22-Jan-02	X	A	3	Less disinfectant than feed	Disinfectant
22-Jan-02	X	B	1	Earthy/clay	None
22-Jan-02	X	B	2	None	None
22-Jan-02	X	B	3	None	None
22-Jan-02	X	B	1	Bitter	None
22-Jan-02	X	B	2	None	None
22-Jan-02	X	B	3	None	Disinfectant
22-Jan-02	X	C	1	Earthy/clay	None
22-Jan-02	X	C	2	None	None
22-Jan-02	X	C	3	None	None
22-Jan-02	X	C	1	Bitter	None
22-Jan-02	X	C	2	None	None
22-Jan-02	X	C	3	Less disinfectant than feed	Disinfectant
22-Jan-02	Y	A	1	Earthy/clay	None

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
22-Jan-02	Y	A	2	None	Chlorinous
22-Jan-02	Y	A	3	None	None
22-Jan-02	Y	A	1	None	None
22-Jan-02	Y	A	2	Faint chlorinous	None
22-Jan-02	Y	A	3	Less disinfectant than feed	Disinfectant
22-Jan-02	Y	B	1	Earthy/clay	None
22-Jan-02	Y	B	2	None	Chlorinous
22-Jan-02	Y	B	3	None	None
22-Jan-02	Y	B	1	None	None
22-Jan-02	Y	B	2	Faint chlorinous	None
22-Jan-02	Y	B	3	Less disinfectant than feed	Disinfectant
22-Jan-02	Y	C	1	Earthy/clay	None
22-Jan-02	Y	C	2	None	Chlorinous
22-Jan-02	Y	C	3	None	None
22-Jan-02	Y	C	1	None	None
22-Jan-02	Y	C	2	None	None
22-Jan-02	Y	C	3	Less disinfectant than feed	Disinfectant
23-Jan-02	X	A	4	None	Astringent/chlorine
23-Jan-02	X	A	5	None	None
23-Jan-02	X	A	2	None	Chlorinous
23-Jan-02	X	B	4	None	Astringent/chlorine
23-Jan-02	X	B	5	None	None
23-Jan-02	X	B	2	None	Chlorinous

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
23-Jan-02	X	C	4	None	Astringent/chlorine
23-Jan-02	X	C	5	None	None
23-Jan-02	X	C	2	Chlorinous	Chlorinous
23-Jan-02	Y	A	4	None	Astringent/chlorine
23-Jan-02	Y	A	5	None	None
23-Jan-02	Y	A	2	None	Chlorinous
23-Jan-02	Y	B	4	None	Astringent/chlorine
23-Jan-02	Y	B	5	None	None
23-Jan-02	Y	B	2	None	Chlorinous
23-Jan-02	Y	C	4	None	Astringent/chlorine
23-Jan-02	Y	C	5	None	None
23-Jan-02	Y	C	2	None	Chlorinous
25-Jan-02	X	A	5	None	None
25-Jan-02	X	A	6	Musty	Faint chlorinous
25-Jan-02	X	A	2	None	None
25-Jan-02	X	B	5	None	None
25-Jan-02	X	B	6	Musty	Faint chlorinous
25-Jan-02	X	B	2	None	None
25-Jan-02	X	C	5	None	None
25-Jan-02	X	C	6	Musty	Faint chlorinous
25-Jan-02	X	C	2	None	None
25-Jan-02	Y	A	5	None	Chlorinous
25-Jan-02	Y	A	6	None	Chlorinous

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
25-Jan-02	Y	A	2	None	None
25-Jan-02	Y	B	5	None	None
25-Jan-02	Y	B	6	Musty	Chlorinous
25-Jan-02	Y	B	2	None	Chlorinous
25-Jan-02	Y	C	5	None	None
25-Jan-02	Y	C	6	Slightly musty	Chlorinous
25-Jan-02	Y	C	2	none	Chlorinous
1-Feb-02	X	A	4	Musty	Musty
1-Feb-02	X	A	7	Slightly more tarry	Slightly tarry
1-Feb-02	X	A	8	None	Vegetables/PVC
1-Feb-02	X	B	4	Musty	Musty
1-Feb-02	X	B	7	Slightly more tarry	Slightly tarry
1-Feb-02	X	B	8	None	Vegetables/PVC
1-Feb-02	X	C	4	Musty	Musty
1-Feb-02	X	C	7	Slightly more tarry	Slightly tarry
1-Feb-02	X	C	8	PVC	Vegetables/PVC
1-Feb-02	Y	A	4	Musty	Musty
1-Feb-02	Y	A	7	More tarry/woody	Tarry/woody
1-Feb-02	Y	A	8	None	PVC
1-Feb-02	Y	B	4	Musty	Musty
1-Feb-02	Y	B	7	More tarry/woody	Tarry/woody
1-Feb-02	Y	B	8	None	PVC
1-Feb-02	Y	C	4	Musty	Musty

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
1-Feb-02	Y	C	7	More tarry/woody	Tarry/woody
1-Feb-02	Y	C	8	None	PVC
8-Feb-02	X	A	4	None	More musty
8-Feb-02	X	A	1	Chalky	Chalky
8-Feb-02	X	A	9	None	None
8-Feb-02	X	B	4	Musty	More musty
8-Feb-02	X	B	1	Chalky	Chalky
8-Feb-02	X	B	9	None	None
8-Feb-02	X	C	4	Musty	More musty
8-Feb-02	X	C	1	Chalky	Chalky
8-Feb-02	X	C	9	None	None
8-Feb-02	Y	A	4	Musty	More musty
8-Feb-02	Y	A	1	Chalky	Chalky
8-Feb-02	Y	A	9	None	None
8-Feb-02	Y	B	4	Musty	More musty
8-Feb-02	Y	B	1	Chalky	Chalky
8-Feb-02	Y	B	9	None	None
8-Feb-02	Y	C	4	Musty	More musty
8-Feb-02	Y	C	1	Chalky	Chalky
8-Feb-02	Y	C	9	None	None
15-Feb-02	X	A	4	Musty	Musty
15-Feb-02	X	A	2	None	None
15-Feb-02	X	A	10	None	Fresh

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
15-Feb-02	X	B	4	Musty	Musty
15-Feb-02	X	B	2	None	None
15-Feb-02	X	B	10	None	Fresh
15-Feb-02	X	C	4	Musty	Musty
15-Feb-02	X	C	2	None	None
15-Feb-02	X	C	10	None	Fresh
15-Feb-02	Y	A	4	Musty	Musty
15-Feb-02	Y	A	2	None	Chlorinous
15-Feb-02	Y	A	10	None	Fresh
15-Feb-02	Y	B	4	Musty	Musty
15-Feb-02	Y	B	2	None	Chlorinous
15-Feb-02	Y	B	10	None	Fresh
15-Feb-02	Y	C	4	Musty	Musty
15-Feb-02	Y	C	2	None	Chlorinous
15-Feb-02	Y	C	10	None	Fresh
1-Mar-02	X	A	4	None	None
1-Mar-02	X	A	11	None	None
1-Mar-02	X	A	1	Clay	Musty/chlorine
1-Mar-02	X	B	4	None	None
1-Mar-02	X	B	11	None	None
1-Mar-02	X	B	1	Musty/chlorine	Musty/chlorine
1-Mar-02	X	C	4	None	None
1-Mar-02	X	C	11	None	None

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
1-Mar-02	X	C	1	Dry/clay	Musty/chlorine
1-Mar-02	Y	A	4	None	None
1-Mar-02	Y	A	11	None	None
1-Mar-02	Y	A	1	Clay	Musty/chlorine
1-Mar-02	Y	B	4	None	None
1-Mar-02	Y	B	11	None	None
1-Mar-02	Y	B	1	Musty	Musty/chlorine
1-Mar-02	Y	C	4	None	None
1-Mar-02	Y	C	11	None	None
1-Mar-02	Y	C	1	Clay	Musty/chlorine
15-Mar-02	X	A	1	Clay	Clay
15-Mar-02	X	A	4	None	None
15-Mar-02	X	A	12	None	None
15-Mar-02	X	B	1	Clay	Clay
15-Mar-02	X	B	4	None	None
15-Mar-02	X	B	12	None	None
15-Mar-02	X	C	1	Clay/chlorine	Clay
15-Mar-02	X	C	4	None	None
15-Mar-02	X	C	12	None	None
15-Mar-02	Y	A	1	Clay	Clay
15-Mar-02	Y	A	4	None	None
15-Mar-02	Y	A	12	None	None
15-Mar-02	Y	B	1	Clay	Clay

Table B.1 Continued

Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed
15-Mar-02	Y	B	4	None	None
15-Mar-02	Y	B	12	None	None
15-Mar-02	Y	C	1	Clay	Clay
15-Mar-02	Y	C	4	None	None
15-Mar-02	Y	C	12	None	None

Table B.2 Odour results – Monday morning samples – Filters A to C

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
28-Jan-02	X	A	1	1	Earthy/clay	Earthy/clay
28-Jan-02	X	A	1	4	None	None
28-Jan-02	X	A	1	2	None	None
28-Jan-02	X	A	3	1	Mouldy	Earthy/clay
28-Jan-02	X	A	3	4	None	None
28-Jan-02	X	A	3	2	None	None

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
28-Jan-02	X	B	1	1	Earthy/clay, slightly sweeter	Earthy/clay
28-Jan-02	X	B	1	4	None	None
28-Jan-02	X	B	1	2	None	None
28-Jan-02	X	B	3	1	Earthy	Earthy/clay
28-Jan-02	X	B	3	4	None	None
28-Jan-02	X	B	3	2	None	None
28-Jan-02	X	C	1	1	Earthy/clay	Earthy/clay
28-Jan-02	X	C	1	4	None	None
28-Jan-02	X	C	1	2	None	None
28-Jan-02	X	C	3	1	Earthy	Earthy/clay
28-Jan-02	X	C	3	4	None	None
28-Jan-02	X	C	3	2	None	None
28-Jan-02	Y	A	1	1	Earthy clay, sharper	Earthy/clay
28-Jan-02	Y	A	1	4	None	None
28-Jan-02	Y	A	1	2	None	None
28-Jan-02	Y	A	3	1	Earthy/clay	Earthy/clay
28-Jan-02	Y	A	3	4	None	None
28-Jan-02	Y	A	3	2	None	None
28-Jan-02	Y	B	1	1	Earthy/clay	Earthy/clay
28-Jan-02	Y	B	1	4	None	None
28-Jan-02	Y	B	1	2	None	None
28-Jan-02	Y	B	3	1	Earthy/clay	Earthy/clay
28-Jan-02	Y	B	3	4	None	None

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
28-Jan-02	Y	B	3	2	None	None
28-Jan-02	Y	C	1	1	Earthy/clay	Earthy/clay
28-Jan-02	Y	C	1	4	None	None
28-Jan-02	Y	C	1	2	Plastic	None
28-Jan-02	Y	C	3	1	Earthy/clay	Earthy/clay
28-Jan-02	Y	C	3	4	None	None
28-Jan-02	Y	C	3	2	None	None
4-Feb-02	X	A	1	1	Chlorine/chalky	Chlorine/chalky
4-Feb-02	X	A	1	4	None	Chlorinous
4-Feb-02	X	A	1	13	None	None
4-Feb-02	X	A	3	1	Chalky/sweet	Chlorine/chalky
4-Feb-02	X	A	3	4	None	Chlorinous
4-Feb-02	X	A	3	13	None	None
4-Feb-02	X	B	1	1	Chalky	Chlorine/chalky
4-Feb-02	X	B	1	4	Musty	Chlorinous
4-Feb-02	X	B	1	13	None	None
4-Feb-02	X	B	3	1	Chalky	Chlorine/chalky
4-Feb-02	X	B	3	4	None	Chlorinous
4-Feb-02	X	B	3	13	None	None
4-Feb-02	X	C	1	1	Chlorine/chalky	Chlorine/chalky
4-Feb-02	X	C	1	4	None	Chlorinous
4-Feb-02	X	C	1	13	None	None
4-Feb-02	X	C	3	1	Chlorine/chalky	Chlorine/chalky

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
4-Feb-02	X	C	3	4	Musty	Chlorinous
4-Feb-02	X	C	3	13	None	None
4-Feb-02	Y	A	1	1	Chalky	Chalky
4-Feb-02	Y	A	1	4	Musty	Musty
4-Feb-02	Y	A	1	13	None	None
4-Feb-02	Y	A	3	1	Chalky	Chalky
4-Feb-02	Y	A	3	4	Musty	Musty
4-Feb-02	Y	A	3	13	None	None
4-Feb-02	Y	B	1	1	Chalky	Chalky
4-Feb-02	Y	B	1	4	Musty	Musty
4-Feb-02	Y	B	1	13	None	None
4-Feb-02	Y	B	3	1	Chalky	Chalky
4-Feb-02	Y	B	3	4	Musty	Musty
4-Feb-02	Y	B	3	13	None	None
4-Feb-02	Y	C	1	1	Chalky/slightly sweeter	Chalky
4-Feb-02	Y	C	1	4	Musty	Musty
4-Feb-02	Y	C	1	13	None	None
4-Feb-02	Y	C	3	1	Chalky	Chalky
4-Feb-02	Y	C	3	4	Musty	Musty
4-Feb-02	Y	C	3	13	None	None
11-Feb-02	X	A	1	2	None	None
11-Feb-02	X	A	1	4	Musty	Musty
11-Feb-02	X	A	1	12	None	None

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
11-Feb-02	X	A	3	2	None	None
11-Feb-02	X	A	3	4	Musty	Musty
11-Feb-02	X	A	3	12	None	None
11-Feb-02	X	B	1	2	None	None
11-Feb-02	X	B	1	4	Musty	Musty
11-Feb-02	X	B	1	12	None	None
11-Feb-02	X	B	3	2	Chlorinous	None
11-Feb-02	X	B	3	4	Musty	Musty
11-Feb-02	X	B	3	12	None	None
11-Feb-02	X	C	1	2	None	None
11-Feb-02	X	C	1	4	Musty	Musty
11-Feb-02	X	C	1	12	None	None
11-Feb-02	X	C	3	2	None	None
11-Feb-02	X	C	3	4	Musty	Musty
11-Feb-02	X	C	3	12	None	None
11-Feb-02	Y	A	1	2	None	None
11-Feb-02	Y	A	1	4	Musty	Musty
11-Feb-02	Y	A	1	12	None	None
11-Feb-02	Y	A	3	2	None	None
11-Feb-02	Y	A	3	4	Musty	Musty
11-Feb-02	Y	A	3	12	None	None
11-Feb-02	Y	B	1	2	None	None
11-Feb-02	Y	B	1	4	Musty	Musty

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
11-Feb-02	Y	B	1	12	None	None
11-Feb-02	Y	B	3	2	None	None
11-Feb-02	Y	B	3	4	Musty	Musty
11-Feb-02	Y	B	3	12	None	None
11-Feb-02	Y	C	1	2	None	None
11-Feb-02	Y	C	1	4	Musty	Musty
11-Feb-02	Y	C	1	12	None	None
11-Feb-02	Y	C	3	2	None	None
11-Feb-02	Y	C	3	4	Musty	Musty
11-Feb-02	Y	C	3	12	None	None
18-Feb-02	X	A	1	2	None	Chlorinous
18-Feb-02	X	A	1	11	None	None
18-Feb-02	X	A	1	1	Sweet	Chlorinous
18-Feb-02	X	A	3	2	None	Chlorinous
18-Feb-02	X	A	3	11	Chemical	None
18-Feb-02	X	A	3	1	Chalky	Chlorinous
18-Feb-02	X	B	1	2	None	None
18-Feb-02	X	B	1	11	None	None
18-Feb-02	X	B	1	1	Chlorinous	Chlorinous
18-Feb-02	X	B	3	2	None	Chlorinous
18-Feb-02	X	B	3	11	None	None
18-Feb-02	X	B	3	1	Clay	Chlorinous
18-Feb-02	X	C	1	2	None	Chlorinous

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
18-Feb-02	X	C	1	11	None	None
18-Feb-02	X	C	1	1	Chlorine/clay	Chlorine/chalky
18-Feb-02	X	C	3	2	None	Chlorinous
18-Feb-02	X	C	3	11	None	None
18-Feb-02	X	C	3	1	Chalky	Chlorinous
18-Feb-02	Y	A	1	2	None	None
18-Feb-02	Y	A	1	11	None	None
18-Feb-02	Y	A	1	1	Pungent	Pungent
18-Feb-02	Y	A	3	2	None	None
18-Feb-02	Y	A	3	11	None	None
18-Feb-02	Y	A	3	1	Pungent	Pungent
18-Feb-02	Y	B	1	2	None	None
18-Feb-02	Y	B	1	11	None	None
18-Feb-02	Y	B	1	1	Pungent	Pungent
18-Feb-02	Y	B	3	2	None	None
18-Feb-02	Y	B	3	11	None	None
18-Feb-02	Y	B	3	1	Pungent	Pungent
18-Feb-02	Y	C	1	2	None	None
18-Feb-02	Y	C	1	11	Solvent	None
18-Feb-02	Y	C	1	1	Pungent	Pungent
18-Feb-02	Y	C	3	2	None	None
18-Feb-02	Y	C	3	11	None	None
18-Feb-02	Y	C	3	1	Pungent	Pungent

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
25-Feb-02	X	A	1	2	None	None
25-Feb-02	X	A	1	11	None	None
25-Feb-02	X	A	1	1	Dry/chalky	Dry/chlorine
25-Feb-02	X	A	3	2	None	None
25-Feb-02	X	A	3	11	None	None
25-Feb-02	X	A	3	1	Chlorinous	Dry/chlorine
25-Feb-02	X	B	1	2	None	None
25-Feb-02	X	B	1	11	None	None
25-Feb-02	X	B	1	1	Dry/chalky	Dry/chlorine
25-Feb-02	X	B	3	2	None	None
25-Feb-02	X	B	3	11	None	None
25-Feb-02	X	B	3	1	Chlorinous	Dry/chlorine
25-Feb-02	X	C	1	2	None	None
25-Feb-02	X	C	1	11	None	None
25-Feb-02	X	C	1	1	Dry/chalky/sharp	Dry/chlorine
25-Feb-02	X	C	3	2	None	None
25-Feb-02	X	C	3	11	None	None
25-Feb-02	X	C	3	1	Dry/chlorine	Dry/chlorine
25-Feb-02	Y	A	1	2	None	None
25-Feb-02	Y	A	1	11	None	None
25-Feb-02	Y	A	1	1	Dry/sharp	Mouldy/dry
25-Feb-02	Y	A	3	2	None	None
25-Feb-02	Y	A	3	11	None	None

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
25-Feb-02	Y	A	3	1	Clay	Mouldy/dry
25-Feb-02	Y	B	1	2	None	None
25-Feb-02	Y	B	1	11	None	None
25-Feb-02	Y	B	1	1	Dry/sharp	Mouldy/dry
25-Feb-02	Y	B	3	2	None	None
25-Feb-02	Y	B	3	11	None	None
25-Feb-02	Y	B	3	1	Clay	Mouldy/dry
25-Feb-02	Y	C	1	2	None	None
25-Feb-02	Y	C	1	11	None	None
25-Feb-02	Y	C	1	1	Clay	Mouldy/dry
25-Feb-02	Y	C	3	2	None	None
25-Feb-02	Y	C	3	11	Musty	None
25-Feb-02	Y	C	3	1	None	Mouldy/dry
4-Mar-02	X	A	1	4	None	Musty
4-Mar-02	X	A	1	12	None	None
4-Mar-02	X	A	1	2	None	Chlorinous
4-Mar-02	X	A	3	4	None	Musty
4-Mar-02	X	A	3	12	None	None
4-Mar-02	X	A	3	2	None	Chlorinous
4-Mar-02	X	B	1	4	None	Musty
4-Mar-02	X	B	1	12	None	None
4-Mar-02	X	B	1	2	None	Chlorinous
4-Mar-02	X	B	3	4	Musty	Musty

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
4-Mar-02	X	B	3	12	None	None
4-Mar-02	X	B	3	2	None	Chlorinous
4-Mar-02	X	C	1	4	None	Musty
4-Mar-02	X	C	1	12	None	None
4-Mar-02	X	C	1	2	None	Chlorinous
4-Mar-02	X	C	3	4	None	Musty
4-Mar-02	X	C	3	12	None	None
4-Mar-02	X	C	3	2	None	Chlorinous
4-Mar-02	Y	A	1	4	None	None
4-Mar-02	Y	A	1	12	None	None
4-Mar-02	Y	A	1	2	None	None
4-Mar-02	Y	A	3	4	None	None
4-Mar-02	Y	A	3	12	None	None
4-Mar-02	Y	A	3	2	None	None
4-Mar-02	Y	B	1	4	None	None
4-Mar-02	Y	B	1	12	None	None
4-Mar-02	Y	B	1	2	None	None
4-Mar-02	Y	B	3	4	None	None
4-Mar-02	Y	B	3	12	None	None
4-Mar-02	Y	B	3	2	None	None
4-Mar-02	Y	C	1	4	None	None
4-Mar-02	Y	C	1	12	None	None
4-Mar-02	Y	C	1	2	None	None

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
4-Mar-02	Y	C	3	4	None	None
4-Mar-02	Y	C	3	12	None	None
4-Mar-02	Y	C	3	2	None	None
11-Mar-02	X	A	1	1	Dry	Clay
11-Mar-02	X	A	1	4	None	None
11-Mar-02	X	A	1	2	None	None
11-Mar-02	X	A	3	1	Clay	Clay
11-Mar-02	X	A	3	4	None	None
11-Mar-02	X	A	3	2	None	None
11-Mar-02	X	B	1	1	Clay	None
11-Mar-02	X	B	1	4	None	None
11-Mar-02	X	B	1	2	None	None
11-Mar-02	X	B	3	1	Dry	Clay
11-Mar-02	X	B	3	4	None	None
11-Mar-02	X	B	3	2	None	None
11-Mar-02	X	C	1	1	Clay	Clay
11-Mar-02	X	C	1	4	None	None
11-Mar-02	X	C	1	2	None	None
11-Mar-02	X	C	3	1	Clay	Clay
11-Mar-02	X	C	3	4	None	None
11-Mar-02	X	C	3	2	None	None
11-Mar-02	Y	A	1	1	None	Clay
11-Mar-02	Y	A	1	4	None	None

Table B.2 Continued

Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed
11-Mar-02	Y	A	1	2	None	None
11-Mar-02	Y	A	3	1	None	Clay
11-Mar-02	Y	A	3	4	None	None
11-Mar-02	Y	A	3	2	None	None
11-Mar-02	Y	B	1	1	Clay	Clay
11-Mar-02	Y	B	1	4	None	None
11-Mar-02	Y	B	1	2	None	None
11-Mar-02	Y	B	3	1	Clay	Clay
11-Mar-02	Y	B	3	4	None	None
11-Mar-02	Y	B	3	2	None	None
11-Mar-02	Y	C	1	1	Clay	Clay
11-Mar-02	Y	C	1	4	None	None
11-Mar-02	Y	C	1	2	None	None
11-Mar-02	Y	C	3	1	None	Clay
11-Mar-02	Y	C	3	4	None	None
11-Mar-02	Y	C	3	2	None	None

Table B.3 Flavour results – Filters A to C

				1:1 dilution with feed water		Neat filtrate	
Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed	Descriptor filtered	Descriptor feed
22-Jan-02	X	A	1	None	None	None	None
22-Jan-02	X	A	2	None	None	None	None
22-Jan-02	X	A	3	None	None	None	None
22-Jan-02	X	A	1	None	None	None	None
22-Jan-02	X	A	2	None	None	None	None
22-Jan-02	X	A	3	None	None	None	None
22-Jan-02	X	B	1	None	None	None	None
22-Jan-02	X	B	2	None	None	Dry/plastic	None
22-Jan-02	X	B	3	None	None	None	None
22-Jan-02	X	B	1	None	None	None	None
22-Jan-02	X	B	2	None	None	None	None
22-Jan-02	X	B	3	None	None	None	None
22-Jan-02	X	C	1	None	None	None	None
22-Jan-02	X	C	2	None	None	None	None
22-Jan-02	X	C	3	None	None	None	None
22-Jan-02	X	C	1	Slightly sweet	None	Slightly sweet	None
22-Jan-02	X	C	2	None	None	None	None
22-Jan-02	X	C	3	None	None	None	None
22-Jan-02	Y	A	1	None	None	None	None
22-Jan-02	Y	A	2	None	None	Dry	None
22-Jan-02	Y	A	3	Soapy	None	Soapy	None
22-Jan-02	Y	A	1	None	None	Sweet	None

Table B.3 Continued

Test Date	Water	Filter	Panellist	1:1 dilution with feed water Descriptor filtered	 Descriptor feed	Neat filtrate Descriptor filtered	 Descriptor feed
22-Jan-02	Y	A	2	None	None	None	None
22-Jan-02	Y	A	3	None	Yes	None	Yes
22-Jan-02	Y	B	1	None	None	Dry	None
22-Jan-02	Y	B	2	None	None	None	None
22-Jan-02	Y	B	3	None	None	None	None
22-Jan-02	Y	B	1	None	None	Sharp	None
22-Jan-02	Y	B	2	None	None	None	None
22-Jan-02	Y	B	3	None	Flavour	Rancid/chemical	Rancid/chemical
22-Jan-02	Y	C	1	None	None	None	None
22-Jan-02	Y	C	2	None	None	None	None
22-Jan-02	Y	C	3	None	None	None	None
22-Jan-02	Y	C	1	None	None	None	None
22-Jan-02	Y	C	2	None	None	None	None
22-Jan-02	Y	C	3	None	Yes	None	Yes
23-Jan-02	X	A	4	None	None	None	None
23-Jan-02	X	A	5	None	None	None	None
23-Jan-02	X	A	2	None	None	None	None
23-Jan-02	X	B	4	None	None	None	None
23-Jan-02	X	B	5	None	None	None	None
23-Jan-02	X	B	2	None	None	None	None
23-Jan-02	X	C	4	None	None	None	None

Table B.3 Continued

Test Date	Water	Filter	Panellist	1:1 dilution with feed water Descriptor filtered	Descriptor feed	Neat filtrate Descriptor filtered	Descriptor feed
23-Jan-02	X	C	5	None	None	None	None
23-Jan-02	X	C	2	None	None	None	None
23-Jan-02	Y	A	4	None	None	None	None
23-Jan-02	Y	A	5	None	None	None	None
23-Jan-02	Y	A	2	None	None	None	None
23-Jan-02	Y	B	4	Slight flavour	None	Slight flavour	None
23-Jan-02	Y	B	5	None	None	None	None
23-Jan-02	Y	B	2	None	None	None	None
23-Jan-02	Y	C	4	None	None	None	None
23-Jan-02	Y	C	5	None	None	None	None
23-Jan-02	Y	C	2	None	None	None	None
25-Jan-02	X	A	5	None	None	None	None
25-Jan-02	X	A	6	Chlorinous	Chlorinous	None	Chlorinous
25-Jan-02	X	A	2	None	None	None	None
25-Jan-02	X	B	5	None	None	None	None
25-Jan-02	X	B	6	Chlorinous	Chlorinous	None	Chlorinous
25-Jan-02	X	B	2	None	None	None	None
25-Jan-02	X	C	5	None	None	None	None
25-Jan-02	X	C	6	Chlorinous (slight)	Chlorinous	None	Chlorinous
25-Jan-02	X	C	2	None	None	None	None
25-Jan-02	Y	A	5	Chlorinous	Chlorinous	None	Chlorinous
25-Jan-02	Y	A	6	None	None	None	None

Table B.3 Continued

Test Date	Water	Filter	Panellist	1:1 dilution with feed water Descriptor filtered	 Descriptor feed	Neat filtrate Descriptor filtered	 Descriptor feed
25-Jan-02	Y	A	2	None	None	None	None
25-Jan-02	Y	B	5	None	None	None	None
25-Jan-02	Y	B	6	Chlorine	Chlorine	Chlorine	Chlorine
25-Jan-02	Y	B	2	None	None	None	None
25-Jan-02	Y	C	5	None	None	None	None
25-Jan-02	Y	C	6	Chlorinous	Chlorinous	None	Chlorinous
25-Jan-02	Y	C	2	None	None	None	None
1-Feb-02	X	A	4	None	None	None	None
1-Feb-02	X	A	7	None	None	None	None
1-Feb-02	X	A	8	None	None	None	None
1-Feb-02	X	B	4	None	None	None	None
1-Feb-02	X	B	7	Wax	None	None	None
1-Feb-02	X	B	8	None	None	None	None
1-Feb-02	X	C	4	None	None	None	None
1-Feb-02	X	C	7	None	None	None	None
1-Feb-02	X	C	8	None	None	None	Chlorinous
1-Feb-02	Y	A	4	None	None	None	None
1-Feb-02	Y	A	7	None	None	None	None
1-Feb-02	Y	A	8	None	None	None	None
1-Feb-02	Y	B	4	None	None	None	None
1-Feb-02	Y	B	7	Soapy	None	Soapy	None
1-Feb-02	Y	B	8	None	None	None	None

Table B.3 Continued

Test Date	Water	Filter	Panellist	1:1 dilution with feed water Descriptor filtered	Descriptor feed	Neat filtrate Descriptor filtered	Descriptor feed
1-Feb-02	Y	C	4	None	None	None	None
1-Feb-02	Y	C	7	None	None	None	None
1-Feb-02	Y	C	8	None	None	None	None
8-Feb-02	X	A	4	None	None	None	None
8-Feb-02	X	A	1	None	None	None	None
8-Feb-02	X	A	9	None	None	None	None
8-Feb-02	X	B	4	None	None	None	None
8-Feb-02	X	B	1	None	None	None	None
8-Feb-02	X	B	9	None	None	None	None
8-Feb-02	X	C	4	None	None	None	None
8-Feb-02	X	C	1	None	None	None	None
8-Feb-02	X	C	9	None	None	None	None
8-Feb-02	Y	A	4	None	None	None	None
8-Feb-02	Y	A	1	None	None	None	None
8-Feb-02	Y	A	9	None	None	None	None
8-Feb-02	Y	B	4	None	None	None	None
8-Feb-02	Y	B	1	None	None	None	None
8-Feb-02	Y	B	9	None	None	None	None
8-Feb-02	Y	C	4	None	None	None	None
8-Feb-02	Y	C	1	None	None	None	None
8-Feb-02	Y	C	9	None	None	None	None
15-Feb-02	X	A	4	None	None	None	None

Table B.3 Continued

				1:1 dilution with feed water		Neat filtrate	
Test Date	Water	Filter	Panellist	Descriptor filtered	Descriptor feed	Descriptor filtered	Descriptor feed
15-Feb-02	X	A	2	None	None	None	None
15-Feb-02	X	A	10	None	None	None	None
15-Feb-02	X	B	4	None	None	None	None
15-Feb-02	X	B	2	None	None	None	None
15-Feb-02	X	B	10	None	None	None	None
15-Feb-02	X	C	4	None	None	None	None
15-Feb-02	X	C	2	None	None	None	None
15-Feb-02	X	C	10	None	None	None	None
15-Feb-02	Y	A	4	None	None	None	None
15-Feb-02	Y	A	2	None	None	None	None
15-Feb-02	Y	A	10	None	None	None	None
15-Feb-02	Y	B	4	None	None	None	None
15-Feb-02	Y	B	2	None	None	None	None
15-Feb-02	Y	B	10	None	None	None	None
15-Feb-02	Y	C	4	None	None	None	None
15-Feb-02	Y	C	2	None	None	None	None
15-Feb-02	Y	C	10	Yes	None	Yes	None
1-Mar-02	X	A	11	None	None	None	None
1-Mar-02	X	A	4	None	None	None	None
1-Mar-02	X	A	1	None	None	None	None
1-Mar-02	X	B	11	Chemical	None	None	None
1-Mar-02	X	B	4	None	None	None	None

Table B.3 Continued

Test Date	Water	Filter	Panellist	1:1 dilution with feed water Descriptor filtered	Descriptor feed	Neat filtrate Descriptor filtered	Descriptor feed
1-Mar-02	X	B	1	None	None	None	None
1-Mar-02	X	C	11	None	None	None	None
1-Mar-02	X	C	4	None	None	None	None
1-Mar-02	X	C	1	None	None	None	None
1-Mar-02	Y	A	11	Chalky	None	None	None
1-Mar-02	Y	A	4	None	None	None	None
1-Mar-02	Y	A	1	None	None	None	None
1-Mar-02	Y	B	11	None	None	None	None
1-Mar-02	Y	B	4	None	None	None	None
1-Mar-02	Y	B	1	None	None	None	None
1-Mar-02	Y	C	11	None	None	None	None
1-Mar-02	Y	C	4	None	None	None	None
1-Mar-02	Y	C	1	None	None	None	None
15-Mar-02	X	A	1	None	None	None	None
15-Mar-02	X	A	4	None	None	None	None
15-Mar-02	X	A	12	None	None	None	None
15-Mar-02	X	B	1	None	None	None	None
15-Mar-02	X	B	4	None	None	None	None
15-Mar-02	X	B	12	None	None	None	None
15-Mar-02	X	C	1	None	None	None	None
15-Mar-02	X	C	4	None	None	None	None
15-Mar-02	X	C	12	None	None	None	None

Table B.3 Continued

Test Date	Water	Filter	Panellist	1:1 dilution with feed water Descriptor filtered	 Descriptor feed	Neat filtrate Descriptor filtered	 Descriptor feed
15-Mar-02	Y	A	1	None	None	None	None
15-Mar-02	Y	A	4	None	None	None	None
15-Mar-02	Y	A	12	None	None	None	None
15-Mar-02	Y	B	1	None	None	None	None
15-Mar-02	Y	B	4	None	None	None	None
15-Mar-02	Y	B	12	None	None	None	None
15-Mar-02	Y	C	1	None	None	None	None
15-Mar-02	Y	C	4	None	None	None	None
15-Mar-02	Y	C	12	None	None	None	None

Table B.4 Flavour results – Monday morning samples – Filters A to C

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	Descriptor feed	Neat filtered water Descriptor filtered	Descriptor feed
28-Jan-02	X	A	1	1	None	None	None	None
28-Jan-02	X	A	1	4	Slight chlorinous	None	None	None
28-Jan-02	X	A	1	2	None	None	None	None
28-Jan-02	X	A	3	1	Slightly sweet	None	Slightly sweet	None
28-Jan-02	X	A	3	4	None	None	None	None
28-Jan-02	X	A	3	2	None	None	None	None
28-Jan-02	X	B	1	1	None	None	None	None
28-Jan-02	X	B	1	4	Slight chlorinous	None	None	None
28-Jan-02	X	B	1	2	None	None	None	None
28-Jan-02	X	B	3	1	Slightly sharp	None	Slightly sharp	None
28-Jan-02	X	B	3	4	None	None	None	None
28-Jan-02	X	B	3	2	None	None	None	None
28-Jan-02	X	C	1	1	None	None	None	None
28-Jan-02	X	C	1	4	None	None	None	None
28-Jan-02	X	C	1	2	None	None	None	None
28-Jan-02	X	C	3	1	None	None	None	None
28-Jan-02	X	C	3	4	None	None	None	None
28-Jan-02	X	C	3	2	None	None	None	None
28-Jan-02	Y	A	1	1	None	None	None	None
28-Jan-02	Y	A	1	4	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	Descriptor feed	Neat filtered water Descriptor filtered	Descriptor feed
28-Jan-02	Y	A	1	2	None	None	None	None
28-Jan-02	Y	A	3	1	None	None	None	None
28-Jan-02	Y	A	3	4	None	None	None	None
28-Jan-02	Y	A	3	2	None	None	None	None
28-Jan-02	Y	B	1	1	None	None	None	None
28-Jan-02	Y	B	1	4	None	None	None	None
28-Jan-02	Y	B	1	2	None	None	None	None
28-Jan-02	Y	B	3	1	None	None	None	None
28-Jan-02	Y	B	3	4	None	None	None	None
28-Jan-02	Y	B	3	2	None	None	None	None
28-Jan-02	Y	C	1	1	None	None	None	None
28-Jan-02	Y	C	1	4	None	None	None	None
28-Jan-02	Y	C	1	2	None	None	None	None
28-Jan-02	Y	C	3	1	None	None	None	None
28-Jan-02	Y	C	3	4	None	None	None	None
28-Jan-02	Y	C	3	2	None	None	None	None
4-Feb-02	X	A	1	1	Musty	None	Musty	None
4-Feb-02	X	A	1	4	Chlorinous	Chlorinous	Chlorinous	Chlorinous
4-Feb-02	X	A	1	13	None	None	None	None
4-Feb-02	X	A	3	1	None	None	None	None
4-Feb-02	X	A	3	4	None	Chlorinous	None	Chlorinous
4-Feb-02	X	A	3	13	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	1:1 dilution with feed Descriptor feed	Neat filtered water Descriptor filtered	Neat filtered water Descriptor feed
4-Feb-02	X	B	1	1	None	None	None	None
4-Feb-02	X	B	1	4	Chlorinous	Chlorinous	Chlorinous	Chlorinous
4-Feb-02	X	B	1	13	None	None	None	None
4-Feb-02	X	B	3	1	None	None	None	None
4-Feb-02	X	B	3	4	None	None	None	None
4-Feb-02	X	B	3	13	None	None	None	None
4-Feb-02	X	C	1	1	None	None	None	None
4-Feb-02	X	C	1	4	TCP	Chlorinous	None	Chlorine
4-Feb-02	X	C	1	13	None	None	None	None
4-Feb-02	X	C	3	1	None	None	None	None
4-Feb-02	X	C	3	4	None	Chlorinous	None	Chlorinous
4-Feb-02	X	C	3	13	None	None	None	None
4-Feb-02	Y	A	1	1	None	None	None	None
4-Feb-02	Y	A	1	4	None	None	None	None
4-Feb-02	Y	A	1	13	None	None	None	None
4-Feb-02	Y	A	3	1	None	None	None	None
4-Feb-02	Y	A	3	4	None	None	None	None
4-Feb-02	Y	A	3	13	None	None	None	None
4-Feb-02	Y	B	1	1	None	None	None	None
4-Feb-02	Y	B	1	4	None	None	None	None
4-Feb-02	Y	B	1	13	None	None	None	None
4-Feb-02	Y	B	3	1	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	 Descriptor feed	Neat filtered water Descriptor filtered	 Descriptor feed
4-Feb-02	Y	B	3	4	None	None	None	None
4-Feb-02	Y	B	3	13	None	None	None	None
4-Feb-02	Y	C	1	1	None	None	None	None
4-Feb-02	Y	C	1	4	None	None	None	None
4-Feb-02	Y	C	1	13	None	None	None	None
4-Feb-02	Y	C	3	1	None	None	None	None
4-Feb-02	Y	C	3	4	None	None	None	None
4-Feb-02	Y	C	3	13	None	None	None	None
11-Feb-02	X	A	1	2	None	None	None	None
11-Feb-02	X	A	1	4	None	None	None	None
11-Feb-02	X	A	1	12	None	None	None	None
11-Feb-02	X	A	3	2	None	None	None	None
11-Feb-02	X	A	3	4	None	None	None	None
11-Feb-02	X	A	3	12	None	None	None	None
11-Feb-02	X	B	1	2	None	None	None	None
11-Feb-02	X	B	1	4	None	None	None	None
11-Feb-02	X	B	1	12	None	None	None	None
11-Feb-02	X	B	3	2	None	None	None	None
11-Feb-02	X	B	3	4	None	None	None	None
11-Feb-02	X	B	3	12	None	None	None	None
11-Feb-02	X	C	1	2	None	None	None	None
11-Feb-02	X	C	1	4	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	1:1 dilution with feed Descriptor feed	Neat filtered water Descriptor filtered	Neat filtered water Descriptor feed
11-Feb-02	X	C	1	12	None	None	None	None
11-Feb-02	X	C	3	2	None	None	None	None
11-Feb-02	X	C	3	4	None	None	None	None
11-Feb-02	X	C	3	12	None	None	None	None
11-Feb-02	Y	A	1	2	None	None	None	None
11-Feb-02	Y	A	1	4	None	None	None	None
11-Feb-02	Y	A	1	12	None	None	None	None
11-Feb-02	Y	A	3	2	None	None	None	None
11-Feb-02	Y	A	3	4	None	None	None	None
11-Feb-02	Y	A	3	12	None	None	None	None
11-Feb-02	Y	B	1	2	None	None	None	None
11-Feb-02	Y	B	1	4	None	None	None	None
11-Feb-02	Y	B	1	12	None	None	None	None
11-Feb-02	Y	B	3	2	None	None	None	None
11-Feb-02	Y	B	3	4	None	None	None	None
11-Feb-02	Y	B	3	12	None	None	None	None
11-Feb-02	Y	C	1	2	None	None	None	None
11-Feb-02	Y	C	1	4	None	None	None	None
11-Feb-02	Y	C	1	12	None	None	None	None
11-Feb-02	Y	C	3	2	None	None	None	None
11-Feb-02	Y	C	3	4	None	None	None	None
11-Feb-02	Y	C	3	12	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	Descriptor feed	Neat filtered water Descriptor filtered	Descriptor feed
18-Feb-02	X	A	1	2	None	None	None	None
18-Feb-02	X	A	1	11	None	None	None	None
18-Feb-02	X	A	1	1	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet
18-Feb-02	X	A	3	2	None	None	None	None
18-Feb-02	X	A	3	11	None	None	None	None
18-Feb-02	X	A	3	1	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet
18-Feb-02	X	B	1	2	None	None	None	None
18-Feb-02	X	B	1	11	None	None	None	None
18-Feb-02	X	B	1	1	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet
18-Feb-02	X	B	3	2	None	None	None	None
18-Feb-02	X	B	3	11	Mouldy	None	None	None
18-Feb-02	X	B	3	1	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet
18-Feb-02	X	C	1	2	None	None	None	None
18-Feb-02	X	C	1	11	None	None	None	None
18-Feb-02	X	C	1	1	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet
18-Feb-02	X	C	3	2	None	None	None	None
18-Feb-02	X	C	3	11	None	None	None	None
18-Feb-02	X	C	3	1	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet	Metal/fresh/sweet
18-Feb-02	Y	A	1	2	None	None	None	None
18-Feb-02	Y	A	1	11	None	None	None	None
18-Feb-02	Y	A	1	1	None	None	None	None
18-Feb-02	Y	A	3	2	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	Descriptor feed	Neat filtered water Descriptor filtered	Descriptor feed
18-Feb-02	Y	A	3	11	None	None	None	None
18-Feb-02	Y	A	3	1	None	None	None	None
18-Feb-02	Y	B	1	2	None	None	None	None
18-Feb-02	Y	B	1	11	None	None	None	None
18-Feb-02	Y	B	1	1	None	None	None	None
18-Feb-02	Y	B	3	2	None	None	Plastic	None
18-Feb-02	Y	B	3	11	None	None	None	None
18-Feb-02	Y	B	3	1	None	None	None	None
18-Feb-02	Y	C	1	2	None	None	None	None
18-Feb-02	Y	C	1	11	None	None	None	None
18-Feb-02	Y	C	1	1	None	None	None	None
18-Feb-02	Y	C	3	2	None	None	None	None
18-Feb-02	Y	C	3	11	None	None	None	None
18-Feb-02	Y	C	3	1	None	None	None	None
25-Feb-02	X	A	1	2	None	None	None	None
25-Feb-02	X	A	1	11	Rancid	None	None	None
25-Feb-02	X	A	1	1	Sharp/metallic	Sharp/metallic	Sharp/metallic	Sharp/metallic
25-Feb-02	X	A	3	2	None	None	None	None
25-Feb-02	X	A	3	11	Rancid	None	None	None
25-Feb-02	X	A	3	1	Sharp/metallic	Sharp/metallic	Sharp/metallic	Sharp/metallic
25-Feb-02	X	B	1	2	None	None	None	None
25-Feb-02	X	B	1	11	Rancid	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	1:1 dilution with feed Descriptor feed	Neat filtered water Descriptor filtered	Neat filtered water Descriptor feed
25-Feb-02	X	B	1	1	Sharp/metallic	Sharp/metallic	Sharp/metallic	Sharp/metallic
25-Feb-02	X	B	3	2	None	None	None	None
25-Feb-02	X	B	3	11	Rancid	None	None	None
25-Feb-02	X	B	3	1	Sharp/metallic	Sharp/metallic	Sharp/metallic	Sharp/metallic
25-Feb-02	X	C	1	2	None	None	None	None
25-Feb-02	X	C	1	11	Rancid	None	None	None
25-Feb-02	X	C	1	1	Sharp/metallic	Sharp/metallic	Sharp/metallic	Sharp/metallic
25-Feb-02	X	C	3	2	None	None	None	None
25-Feb-02	X	C	3	11	Rancid	None	Rancid	None
25-Feb-02	X	C	3	1	Sharp/metallic	Sharp/metallic	Sharp/metallic	Sharp/metallic
25-Feb-02	Y	A	1	2	None	None	None	None
25-Feb-02	Y	A	1	11	None	None	None	None
25-Feb-02	Y	A	1	1	None	None	None	None
25-Feb-02	Y	A	3	2	None	None	None	None
25-Feb-02	Y	A	3	11	None	None	None	None
25-Feb-02	Y	A	3	1	None	None	None	None
25-Feb-02	Y	B	1	2	None	None	None	None
25-Feb-02	Y	B	1	11	None	None	None	None
25-Feb-02	Y	B	1	1	None	None	None	None
25-Feb-02	Y	B	3	2	None	None	None	None
25-Feb-02	Y	B	3	11	None	None	None	None
25-Feb-02	Y	B	3	1	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed: Descriptor filtered	1:1 dilution with feed: Descriptor feed	Neat filtered water: Descriptor filtered	Neat filtered water: Descriptor feed
25-Feb-02	Y	C	1	2	None	None	None	None
25-Feb-02	Y	C	1	11	None	None	None	None
25-Feb-02	Y	C	1	1	None	None	None	None
25-Feb-02	Y	C	3	2	None	None	None	None
25-Feb-02	Y	C	3	11	None	None	None	None
25-Feb-02	Y	C	3	1	Metallic	None	Metallic	None
4-Mar-02	X	A	1	4	None	None	None	None
4-Mar-02	X	A	1	12	None	None	None	None
4-Mar-02	X	A	1	2	None	None	None	None
4-Mar-02	X	A	3	4	None	None	None	None
4-Mar-02	X	A	3	12	None	None	None	None
4-Mar-02	X	A	3	2	None	None	None	None
4-Mar-02	X	B	1	4	None	None	None	None
4-Mar-02	X	B	1	12	None	None	None	None
4-Mar-02	X	B	1	2	None	None	None	None
4-Mar-02	X	B	3	4	None	None	None	None
4-Mar-02	X	B	3	12	None	None	None	None
4-Mar-02	X	B	3	2	None	None	None	None
4-Mar-02	X	C	1	4	None	None	None	None
4-Mar-02	X	C	1	12	None	None	None	None
4-Mar-02	X	C	1	2	None	None	None	None
4-Mar-02	X	C	3	4	None	None	None	None

Table B.4 Continued

					1:1 dilution with feed		Neat filtered water	
Test Date	Water	Filter	Litre No	Panellist	Descriptor filtered	Descriptor feed	Descriptor filtered	Descriptor feed
4-Mar-02	X	C	3	12	None	None	None	None
4-Mar-02	X	C	3	2	None	None	None	None
4-Mar-02	Y	A	1	4	None	None	None	None
4-Mar-02	Y	A	1	12	None	None	None	None
4-Mar-02	Y	A	1	2	None	None	None	None
4-Mar-02	Y	A	3	4	None	None	None	None
4-Mar-02	Y	A	3	12	None	None	None	None
4-Mar-02	Y	A	3	2	None	None	None	None
4-Mar-02	Y	B	1	4	None	None	None	None
4-Mar-02	Y	B	1	12	None	None	None	None
4-Mar-02	Y	B	1	2	None	None	None	None
4-Mar-02	Y	B	3	4	None	None	None	None
4-Mar-02	Y	B	3	12	None	None	None	None
4-Mar-02	Y	B	3	2	None	None	None	None
4-Mar-02	Y	C	1	4	None	None	None	None
4-Mar-02	Y	C	1	12	None	None	None	None
4-Mar-02	Y	C	1	2	None	None	None	None
4-Mar-02	Y	C	3	4	None	None	None	None
4-Mar-02	Y	C	3	12	None	None	None	None
4-Mar-02	Y	C	3	2	None	None	None	None
11-Mar-02	X	A	1	1	None	None	None	None
11-Mar-02	X	A	1	4	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	 Descriptor feed	Neat filtered water Descriptor filtered	 Descriptor feed
11-Mar-02	X	A	1	2	None	None	None	None
11-Mar-02	X	A	3	1	None	None	None	None
11-Mar-02	X	A	3	4	None	None	None	None
11-Mar-02	X	A	3	2	None	None	None	None
11-Mar-02	X	B	1	1	None	None	None	None
11-Mar-02	X	B	1	4	None	None	None	None
11-Mar-02	X	B	1	2	None	None	None	None
11-Mar-02	X	B	3	1	None	None	None	None
11-Mar-02	X	B	3	4	None	None	None	None
11-Mar-02	X	B	3	2	None	None	None	None
11-Mar-02	X	C	1	1	None	None	None	None
11-Mar-02	X	C	1	4	None	None	None	None
11-Mar-02	X	C	1	2	None	None	None	None
11-Mar-02	X	C	3	1	None	None	None	None
11-Mar-02	X	C	3	4	None	None	None	None
11-Mar-02	X	C	3	2	None	None	None	None
11-Mar-02	Y	A	1	1	None	None	None	None
11-Mar-02	Y	A	1	4	None	None	None	None
11-Mar-02	Y	A	1	2	None	None	None	None
11-Mar-02	Y	A	3	1	None	None	None	None
11-Mar-02	Y	A	3	4	None	None	None	None
11-Mar-02	Y	A	3	2	None	None	None	None

Table B.4 Continued

Test Date	Water	Filter	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	Descriptor feed	Neat filtered water Descriptor filtered	Descriptor feed
11-Mar-02	Y	B	1	1	None	None	None	None
11-Mar-02	Y	B	1	4	None	None	None	None
11-Mar-02	Y	B	1	2	None	None	None	None
11-Mar-02	Y	B	3	1	None	None	None	None
11-Mar-02	Y	B	3	4	None	None	None	None
11-Mar-02	Y	B	3	2	None	None	None	None
11-Mar-02	Y	C	1	1	None	None	None	None
11-Mar-02	Y	C	1	4	None	None	None	None
11-Mar-02	Y	C	1	2	None	None	Stale	None
11-Mar-02	Y	C	3	1	None	None	None	None
11-Mar-02	Y	C	3	4	None	None	None	None
11-Mar-02	Y	C	3	2	None	None	None	None

Table B.5 Odour results – Filter D

Test Date	Water	Panellist	Descriptor filtered	Descriptor feed
18-Feb-02	X	1	Chlorine	Chlorine
18-Feb-02	X	2	None	None
18-Feb-02	X	11	None	White spirit
18-Feb-02	Y	1	Chalky	Sweet/sharp
18-Feb-02	Y	2	None	Slight chlorinous
18-Feb-02	Y	11	None	None
22-Feb-02	X	1	Chalky	Chlorine
22-Feb-02	X	10	None	Fair rubber
22-Feb-02	X	12	None	None
22-Feb-02	Y	1	Chalky	More chalky
22-Feb-02	Y	10	None	Slight rubber
22-Feb-02	Y	12	None	Mushroom
01-Mar-02	X	1	Clay	Clay
01-Mar-02	X	4	None	None
01-Mar-02	X	11	None	None
01-Mar-02	Y	1	Clay	Musty/chlorine
01-Mar-02	Y	4	None	None
01-Mar-02	Y	11	None	None
08-Mar-02	X	1	Musty/clay	Musty/clay
08-Mar-02	X	4	Musty	Musty
08-Mar-02	X	12	None	None

Table B.5 Continued

Test Date	Water	Panellist	Descriptor filtered	Descriptor feed
08-Mar-02	Y	1	Musty/clay	Musty/clay
08-Mar-02	Y	4	Slightly musty	Musty
08-Mar-02	Y	12	None	None
22-Mar-02	X	1	Slightly musty	Musty/chlorine
22-Mar-02	X	4	None	None
22-Mar-02	X	14	Slight musty/earthy/plastic	Earthy/musty/plastic
22-Mar-02	Y	1	Slightly musty	Musty
22-Mar-02	Y	4	None	Slightly musty
22-Mar-02	Y	14	Slight musty/earthy/plastic	Earthy/musty/plastic
26-Apr-02	X	1	Bitter	Bitter
26-Apr-02	X	11	None	None
26-Apr-02	X	12	None	None
26-Apr-02	Y	1	Chalk/dry	Chalk/dry
26-Apr-02	Y	11	None	None
26-Apr-02	Y	12	None	None
31-May-02	X	4	None	None
31-May-02	X	9	None	None
31-May-02	X	15	None	None
31-May-02	Y	4	None	None
31-May-02	Y	9	None	None
31-May-02	Y	15	None	None
05-Jul-02	X	1	Sweet	Musty
05-Jul-02	X	4	None	None

Table B.5 Continued

Test Date	Water	Panellist	Descriptor filtered	Descriptor feed
05-Jul-02	X	12	None	None
05-Jul-02	Y	1	Musty	Musty
05-Jul-02	Y	4	None	None
05-Jul-02	Y	12	None	None

Table B.6 Odour results – Monday morning samples – Filter D

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
25-Feb-02	X	1	2	None	Slight chlorinous
25-Feb-02	X	1	11	None	None
25-Feb-02	X	1	1	Dry/chalky	Dry/chalky
25-Feb-02	X	3	2	None	Slight chlorinous
25-Feb-02	X	3	11	None	None
25-Feb-02	X	3	1	Dry/chalky	Dry/chalky
25-Feb-02	Y	1	2	None	None
25-Feb-02	Y	1	11	None	None
25-Feb-02	Y	1	1	Musty/chalky	Musty/chalky
25-Feb-02	Y	3	2	None	None
25-Feb-02	Y	3	11	None	None
25-Feb-02	Y	3	1	Dry/chalky	Dry/chalky
4-Mar-02	X	1	4	None	None
4-Mar-02	X	1	12	None	None
4-Mar-02	X	1	2	None	Slight chlorinous
4-Mar-02	X	3	4	None	None
4-Mar-02	X	3	12	None	None
4-Mar-02	X	3	2	None	None
4-Mar-02	Y	1	4	None	None
4-Mar-02	Y	1	12	None	None
4-Mar-02	Y	1	2	None	None

Table B.6 Continued

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
4-Mar-02	Y	3	4	None	None
4-Mar-02	Y	3	12	None	None
4-Mar-02	Y	3	2	None	None
11-Mar-02	X	1	4	None	None
11-Mar-02	X	1	1	Clay	Bitter
11-Mar-02	X	1	2	None	None
11-Mar-02	X	3	4	None	None
11-Mar-02	X	3	1	None	None
11-Mar-02	X	3	2	None	None
11-Mar-02	Y	1	4	None	None
11-Mar-02	Y	1	1	Slightly spicy/bitter	Slightly spicy/bitter
11-Mar-02	Y	1	2	None	None
11-Mar-02	Y	3	4	None	None
11-Mar-02	Y	3	1	Clay	Slightly spicy/bitter
11-Mar-02	Y	3	2	None	None
18-Mar-02	X	1	4	None	None
18-Mar-02	X	1	1	Sweet	Clay/chlorine
18-Mar-02	X	1	14	None	None
18-Mar-02	X	3	4	None	None
18-Mar-02	X	3	1	Dry/sweet	Clay/chlorine
18-Mar-02	X	3	14	Slight metallic	None
18-Mar-02	Y	1	4	None	None
18-Mar-02	Y	1	1	Slightly musty	None

Table B.6 Continued

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
18-Mar-02	Y	1	14	None	None
18-Mar-02	Y	3	4	None	None
18-Mar-02	Y	3	1	Slightly musty	None
18-Mar-02	Y	3	14	None	None
25-Mar-02	X	1	14	None	None
25-Mar-02	X	1	1	Bitter/chalky	Bitter/chalky
25-Mar-02	X	1	4	Faint musty	None
25-Mar-02	X	3	14	None	None
25-Mar-02	X	3	1	Bitter/chalky	Bitter/chalky
25-Mar-02	X	3	4	Faint musty	None
25-Mar-02	Y	1	14	None	Plastic
25-Mar-02	Y	1	1	Chalky	Chalky
25-Mar-02	Y	1	4	Faint musty	Musty
25-Mar-02	Y	3	14	Slightly musty	Plastic
25-Mar-02	Y	3	1	Chalky	Chalky
25-Mar-02	Y	3	4	None	Musty
2-Apr-02[a]	X	1	12	None	None
2-Apr-02[a]	X	1	4	None	None
2-Apr-02[a]	X	1	11	None	None
2-Apr-02[a]	X	3	12	None	None
2-Apr-02[a]	X	3	4	None	None
2-Apr-02[a]	X	3	11	None	None
2-Apr-02[a]	Y	1	12	None	None

Table B.6 Continued

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
2-Apr-02[a]	Y	1	4	None	None
2-Apr-02[a]	Y	1	11	None	None
2-Apr-02[a]	Y	3	12	None	None
2-Apr-02[a]	Y	3	4	None	None
2-Apr-02[a]	Y	3	11	None	None
8-Apr-02	X	1	12	None	None
8-Apr-02	X	1	1	Stale/musty	Stale/musty
8-Apr-02	X	1	2	None	None
8-Apr-02	X	3	12	None	None
8-Apr-02	X	3	1	Stale/musty	Stale/musty
8-Apr-02	X	3	2	None	None
8-Apr-02	Y	1	12	None	None
8-Apr-02	Y	1	1	Peppery	Stale curry
8-Apr-02	Y	1	2	None	None
8-Apr-02	Y	3	12	None	None
8-Apr-02	Y	3	1	Stale/peppery	Stale curry
8-Apr-02	Y	3	2	None	None
22-Apr-02	X	1	1	Smelly feet	Sharp/vegetables
22-Apr-02	X	1	2	None	None
22-Apr-02	X	1	11	None	None
22-Apr-02	X	3	1	Bitter	Bitter
22-Apr-02	X	3	2	None	None
22-Apr-02	X	3	11	None	None

Table B.6 Continued

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
22-Apr-02	Y	1	1	Chalky/feet	Slightly chalky
22-Apr-02	Y	1	2	None	None
22-Apr-02	Y	1	11	None	None
22-Apr-02	Y	3	1	Sweet/chalky	Slightly chalky
22-Apr-02	Y	3	2	None	None
22-Apr-02	Y	3	11	None	None
7-May-02[a]	X	1	12	None	None
7-May-02[a]	X	1	1	Musty/chalky	Musty/chalky
7-May-02[a]	X	1	2	None	None
7-May-02[a]	X	3	12	None	None
7-May-02[a]	X	3	1	Musty/chalky	Musty/chalky
7-May-02[a]	X	3	2	None	None
7-May-02[a]	Y	1	12	None	None
7-May-02[a]	Y	1	1	Chalky	Chalky
7-May-02[a]	Y	1	2	None	None
7-May-02[a]	Y	3	12	None	None
7-May-02[a]	Y	3	1	Chalky	Chalky
7-May-02[a]	Y	3	2	None	None
20-May-02	X	1	12	None	None
20-May-02	X	1	15	None	None
20-May-02	X	1	10	None	None
20-May-02	X	3	12	None	None
20-May-02	X	3	15	None	None

Table B.6 Continued

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
20-May-02	X	3	10	None	None
20-May-02	Y	1	12	None	None
20-May-02	Y	1	15	None	None
20-May-02	Y	1	10	None	None
20-May-02	Y	3	12	None	None
20-May-02	Y	3	15	None	None
20-May-02	Y	3	10	None	None
5-Jun-02[b]	X	1	12	None	None
5-Jun-02[b]	X	1	1	Dry/chalky	Slightly fishy
5-Jun-02[b]	X	1	4	None	None
5-Jun-02[b]	X	3	12	None	None
5-Jun-02[b]	X	3	1	Dry/chalky	Slightly fishy
5-Jun-02[b]	X	3	4	None	None
5-Jun-02[b]	Y	1	12	None	None
5-Jun-02[b]	Y	1	1	None	None
5-Jun-02[b]	Y	1	4	None	None
5-Jun-02[b]	Y	3	12	None	None
5-Jun-02[b]	Y	3	1	None	None
5-Jun-02[b]	Y	3	4	None	None
17-Jun-02	X	1	15	None	None
17-Jun-02	X	1	1	Sweet	Sweet
17-Jun-02	X	1	16	None	None
17-Jun-02	X	3	15	None	None

Table B.6 Continued

Test Date	Water	Litre No	Panellist	Descriptor filtered	Descriptor feed
17-Jun-02	X	3	1	Sweet	Sweet
17-Jun-02	X	3	16	None	None
17-Jun-02	Y	1	15	None	None
17-Jun-02	Y	1	1	Dry/bitter	Dry/bitter
17-Jun-02	Y	1	16	None	None
17-Jun-02	Y	3	15	None	None
17-Jun-02	Y	3	1	Dry/bitter	Dry/bitter
17-Jun-02	Y	3	16	None	None
1-Jul-02	X	1	15	None	None
1-Jul-02	X	1	1	Musty	Musty
1-Jul-02	X	1	12	None	None
1-Jul-02	X	3	15	None	None
1-Jul-02	X	3	1	Musty	Musty
1-Jul-02	X	3	12	None	None
1-Jul-02	Y	1	15	None	None
1-Jul-02	Y	1	1	Musty	Musty
1-Jul-02	Y	1	12	None	None
1-Jul-02	Y	3	15	None	None
1-Jul-02	Y	3	1	Musty	Musty
1-Jul-02	Y	3	12	None	None

a Sampled on Tuesday (after 3 days standing)

b Sampled on Wednesday (after 4 days standing

Table B.7 Flavour results – Filter D

			1:1 dilution with feed		Neat filtered water	
Test Date	Water	Panellist	Descriptor filtered	Descriptor feed	Descriptor filtered	Descriptor feed
18-Feb-02	X	1	None	None	None	None
18-Feb-02	X	2	None	None	None	None
18-Feb-02	X	11	None	None	None	None
18-Feb-02	Y	1	None	None	None	None
18-Feb-02	Y	2	None	None	None	None
18-Feb-02	Y	11	None	None	None	None
22-Feb-02	X	1	None	None	None	None
22-Feb-02	X	10	None	Slightly salty	None	Slightly salty
22-Feb-02	X	12	None	None	None	None
22-Feb-02	Y	1	None	None	None	None
22-Feb-02	Y	10	Slightly chlorinous	Fresh	Slightly chlorinous	Fresh
22-Feb-02	Y	12	None	None	None	None
1-Mar-02	X	1	None	None	None	None
1-Mar-02	X	4	None	None	None	None
1-Mar-02	X	11	None	None	None	None
1-Mar-02	Y	1	None	None	None	None
1-Mar-02	Y	4	None	None	None	None
1-Mar-02	Y	11	None	Rubbery	None	Rubbery
8-Mar-02	X	1	None	None	None	None
8-Mar-02	X	4	None	None	None	None

Table B.7 Continued

Test Date	Water	Panellist	1:1 dilution with feed: Descriptor filtered	1:1 dilution with feed: Descriptor feed	Neat filtered water: Descriptor filtered	Neat filtered water: Descriptor feed
8-Mar-02	X	12	None	None	None	None
8-Mar-02	Y	1	None	None	None	None
8-Mar-02	Y	4	None	None	None	None
8-Mar-02	Y	12	None	None	None	None
22-Mar-02	X	1	None	None	None	None
22-Mar-02	X	4	None	None	None	None
22-Mar-02	X	14	Slight plastic	None	Rubbery	None
22-Mar-02	Y	1	None	None	None	None
22-Mar-02	Y	4	None	None	None	None
22-Mar-02	Y	14	Slight plastic	Plastic	Slight plastic	Plastic
26-Apr-02	X	1	None	None	None	None
26-Apr-02	X	11	None	None	None	None
26-Apr-02	X	12	None	None	None	None
26-Apr-02	Y	1	None	None	None	None
26-Apr-02	Y	11	None	None	None	None
26-Apr-02	Y	12	None	None	None	None
31-May-02	X	4	None	None	None	None
31-May-02	X	9	None	None	None	None
31-May-02	X	15	None	None	None	None
31-May-02	Y	4	None	None	None	None
31-May-02	Y	9	None	None	None	None
31-May-02	Y	15	None	None	None	None

Table B.7 Continued

Test Date	Water	Panellist	1:1 dilution with feed Descriptor filtered	1:1 dilution with feed Descriptor feed	Neat filtered water Descriptor filtered	Neat filtered water Descriptor feed
5-Jul-02	X	1	None	None	None	None
5-Jul-02	X	4	None	None	None	None
5-Jul-02	X	12	None	None	None	None
5-Jul-02	Y	1	None	None	None	None
5-Jul-02	Y	4	None	None	None	None
5-Jul-02	Y	12	None	None	None	None

Table B.8 Flavour results – Monday morning samples – Filter D

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	 Descriptor feed	Neat filtered water Descriptor filtered	 Descriptor feed
25-Feb-02	X	1	2	None	None	None	None
25-Feb-02	X	1	11	None	None	None	None
25-Feb-02	X	1	1	None	None	None	None
25-Feb-02	X	3	2	None	None	None	None
25-Feb-02	X	3	11	None	None	None	None
25-Feb-02	X	3	1	None	None	None	None
25-Feb-02	Y	1	2	None	None	None	None
25-Feb-02	Y	1	11	None	None	None	None
25-Feb-02	Y	1	1	None	None	None	None
25-Feb-02	Y	3	2	None	None	None	None
25-Feb-02	Y	3	11	None	None	None	None
25-Feb-02	Y	3	1	None	None	None	None
4-Mar-02	X	1	4	None	None	None	None
4-Mar-02	X	1	12	None	None	None	None
4-Mar-02	X	1	2	None	None	None	None
4-Mar-02	X	3	4	None	None	None	None
4-Mar-02	X	3	12	None	None	None	None
4-Mar-02	X	3	2	None	None	None	None
4-Mar-02	Y	1	4	None	None	None	None
4-Mar-02	Y	1	12	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	 Descriptor feed	Neat filtered water Descriptor filtered	 Descriptor feed
4-Mar-02	Y	1	2	None	None	None	None
4-Mar-02	Y	3	4	None	None	None	None
4-Mar-02	Y	3	12	None	None	None	None
4-Mar-02	Y	3	2	None	None	None	None
11-Mar-02	X	1	4	None	None	None	None
11-Mar-02	X	1	1	None	None	None	None
11-Mar-02	X	1	2	None	None	None	None
11-Mar-02	X	3	4	None	None	None	None
11-Mar-02	X	3	1	None	None	None	None
11-Mar-02	X	3	2	None	None	None	None
11-Mar-02	Y	1	4	None	None	None	None
11-Mar-02	Y	1	1	None	None	None	None
11-Mar-02	Y	1	2	None	None	None	None
11-Mar-02	Y	3	4	None	None	None	None
11-Mar-02	Y	3	1	None	None	None	None
11-Mar-02	Y	3	2	None	None	None	None
18-Mar-02	X	1	4	None	None	None	None
18-Mar-02	X	1	1	None	None	None	None
18-Mar-02	X	1	14	None	None	None	None
18-Mar-02	X	3	4	None	None	None	None
18-Mar-02	X	3	1	None	None	None	None
18-Mar-02	X	3	14	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	1:1 dilution with feed Descriptor feed	Neat filtered water Descriptor filtered	Neat filtered water Descriptor feed
18-Mar-02	Y	1	4	None	None	None	None
18-Mar-02	Y	1	1	None	None	None	None
18-Mar-02	Y	1	14	Old/musty	Earthy/mud	Dull	Earthy/mud
18-Mar-02	Y	3	4	None	None	None	None
18-Mar-02	Y	3	1	None	None	None	None
18-Mar-02	Y	3	14	Old/musty	Old/musty	Old/musty	Old/musty
25-Mar-02	X	1	14	None	None	None	None
25-Mar-02	X	1	1	None	None	None	None
25-Mar-02	X	1	4	None	None	None	None
25-Mar-02	X	3	14	None	None	None	None
25-Mar-02	X	3	1	None	None	None	None
25-Mar-02	X	3	4	None	None	None	None
25-Mar-02	Y	1	14	None	None	None	None
25-Mar-02	Y	1	1	None	None	None	None
25-Mar-02	Y	1	4	None	None	None	None
25-Mar-02	Y	3	14	None	None	None	None
25-Mar-02	Y	3	1	None	None	None	None
25-Mar-02	Y	3	4	None	None	None	None
2-Apr-02[a]	X	1	12	None	None	None	None
2-Apr-02[a]	X	1	4	None	None	None	None
2-Apr-02[a]	X	1	11	None	None	None	None
2-Apr-02[a]	X	3	12	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	Descriptor feed	Neat filtered water Descriptor filtered	Descriptor feed
2-Apr-02[a]	X	3	4	None	None	None	None
2-Apr-02[a]	X	3	11	None	None	None	None
2-Apr-02[a]	Y	1	12	None	None	None	None
2-Apr-02[a]	Y	1	4	None	None	None	None
2-Apr-02[a]	Y	1	11	None	None	None	None
2-Apr-02[a]	Y	3	12	None	None	None	None
2-Apr-02[a]	Y	3	4	None	None	None	None
2-Apr-02[a]	Y	3	11	None	None	None	None
8-Apr-02	X	1	12	None	None	None	None
8-Apr-02	X	1	1	None	None	None	None
8-Apr-02	X	1	2	None	None	None	None
8-Apr-02	X	3	12	None	None	None	None
8-Apr-02	X	3	1	None	None	None	None
8-Apr-02	X	3	2	None	None	None	None
8-Apr-02	Y	1	12	None	None	None	None
8-Apr-02	Y	1	1	None	None	None	None
8-Apr-02	Y	1	2	None	None	None	None
8-Apr-02	Y	3	12	None	None	None	None
8-Apr-02	Y	3	1	None	None	None	None
8-Apr-02	Y	3	2	None	None	None	None
22-Apr-02	X	1	1	None	None	None	None
22-Apr-02	X	1	2	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	 Descriptor feed	Neat filtered water Descriptor filtered	 Descriptor feed
22-Apr-02	X	1	11	None	None	None	None
22-Apr-02	X	3	1	None	None	None	None
22-Apr-02	X	3	2	None	None	None	None
22-Apr-02	X	3	11	None	None	None	None
22-Apr-02	Y	1	1	None	None	None	None
22-Apr-02	Y	1	2	None	None	None	None
22-Apr-02	Y	1	11	None	None	None	None
22-Apr-02	Y	3	1	None	None	None	None
22-Apr-02	Y	3	2	None	None	None	None
22-Apr-02	Y	3	11	None	None	None	None
7-May-02[a]	X	1	12	None	None	None	None
7-May-02[a]	X	1	1	None	None	None	None
7-May-02[a]	X	1	2	None	None	None	None
7-May-02[a]	X	3	12	None	None	None	None
7-May-02[a]	X	3	1	None	None	None	None
7-May-02[a]	X	3	2	None	None	None	None
7-May-02[a]	Y	1	12	None	None	None	None
7-May-02[a]	Y	1	1	None	None	None	None
7-May-02[a]	Y	1	2	None	None	None	None
7-May-02[a]	Y	3	12	None	None	None	None
7-May-02[a]	Y	3	1	None	None	None	None
7-May-02[a]	Y	3	2	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed: Descriptor filtered	1:1 dilution with feed: Descriptor feed	Neat filtered water: Descriptor filtered	Neat filtered water: Descriptor feed
20-May-02	X	1	12	None	None	None	None
20-May-02	X	1	15	None	Metallic	None	Metallic
20-May-02	X	1	10	None	None	None	None
20-May-02	X	3	12	None	None	None	None
20-May-02	X	3	15	None	None	None	None
20-May-02	X	3	10	None	None	None	None
20-May-02	Y	1	12	None	None	None	None
20-May-02	Y	1	15	None	None	None	None
20-May-02	Y	1	10	None	None	None	None
20-May-02	Y	3	12	None	None	None	None
20-May-02	Y	3	15	None	None	None	None
20-May-02	Y	3	10	None	None	None	None
5-Jun-02[b]	X	1	12	None	None	None	None
5-Jun-02[b]	X	1	1	None	None	None	None
5-Jun-02[b]	X	1	4	None	None	None	None
5-Jun-02[b]	X	3	12	None	None	None	None
5-Jun-02[b]	X	3	1	None	None	None	None
5-Jun-02[b]	X	3	4	None	None	None	None
5-Jun-02[b]	Y	1	12	None	None	None	None
5-Jun-02[b]	Y	1	1	None	None	None	None
5-Jun-02[b]	Y	1	4	None	None	None	None
5-Jun-02[b]	Y	3	12	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	1:1 dilution with feed Descriptor feed	Neat filtered water Descriptor filtered	Neat filtered water Descriptor feed
5-Jun-02[b]	Y	3	1	None	None	None	None
5-Jun-02[b]	Y	3	4	None	None	None	None
17-Jun-02	X	1	15	None	None	None	None
17-Jun-02	X	1	1	Metallic	Sweet/metallic	Metallic	Sweet/metallic
17-Jun-02	X	1	16	Medicine	Medicine	Medicine	Medicine
17-Jun-02	X	3	15	None	None	None	None
17-Jun-02	X	3	1	Metallic	Sweet/metallic	Metallic	Sweet/metallic
17-Jun-02	X	3	16	Medicine	Medicine	Medicine	Medicine
17-Jun-02	Y	1	15	None	None	None	None
17-Jun-02	Y	1	1	None	None	None	None
17-Jun-02	Y	1	16	None	None	None	None
17-Jun-02	Y	3	15	None	None	None	None
17-Jun-02	Y	3	1	None	None	None	None
17-Jun-02	Y	3	16	None	None	None	None
1-Jul-02	X	1	15	None	None	None	None
1-Jul-02	X	1	1	None	Sweetish	None	Sweetish
1-Jul-02	X	1	12	None	None	None	None
1-Jul-02	X	3	15	None	None	None	None
1-Jul-02	X	3	1	None	None	None	None
1-Jul-02	X	3	12	None	Sweetish	None	Sweetish
1-Jul-02	Y	1	15	None	None	None	None
1-Jul-02	Y	1	1	None	None	None	None

Table B.8 Continued

Test Date	Water	Litre No	Panellist	1:1 dilution with feed Descriptor filtered	 Descriptor feed	Neat filtered water Descriptor filtered	 Descriptor feed
1-Jul-02	Y	1	12	None	None	None	None
1-Jul-02	Y	3	15	None	None	None	None
1-Jul-02	Y	3	1	None	None	None	None
1-Jul-02	Y	3	12	None	None	None	None

a Sampled on Tuesday (after 3 days standing)
b Sampled on Wednesday (after 4 days standing

APPENDIX C – DETAILED RESULTS – EXTENDED METALS LEACHING TESTING

Table C.1 pH

	Day	1	2	3	4	5	8	9	10	11	12	15	16	17	18	19	22	23	24	25	26
Kettle K	Filter A	5.63	5.89	5.87	5.96	6.24	6.41	6.48	6.55	6.60	6.61	6.63	6.66	6.46	6.73	6.60	6.64	6.79	7.02	6.76	6.92
Kettle L	Filter A	5.21	5.78	6.13	6.28	6.36	6.54	6.58	6.61	6.55	6.78	6.75	6.67	6.66	6.89	7.05	6.80	7.04	7.03	7.05	7.13
Kettle M	Filter A	5.44	5.64	5.95	5.92	6.07	6.34	6.28	6.62	6.57	6.56	6.63	6.62	6.74	6.69	6.66	6.75	6.85	6.77	6.75	6.97
Kettle N	Filter A	5.50	5.70	5.79	5.87	6.31	6.35	6.39	6.56	6.57	6.62	6.64	6.66	6.70	6.73	6.66	6.70	6.75	6.74	6.72	6.99
Kettle O	Filter A	5.54	5.79	5.73	5.83	6.18	6.41	6.43	6.47	6.58	6.65	6.65	6.71	6.40	6.77	6.61	6.93	6.85	6.89	6.69	7.00
Kettle P	Filter A	5.59	5.65	5.79	5.88	6.10	6.46	6.51	6.53	6.51	6.57	6.64	6.72	6.47	6.43	6.61	6.65	6.78	6.93	6.70	7.03
Kettle Q	Filter A	5.44	5.69	6.07	5.89	6.10	6.36	6.41	6.43	6.52	6.56	6.63	6.70	6.50	6.44	6.65	6.63	6.82	6.87	6.71	6.90
Kettle R	Filter A	5.54	5.76	5.88	5.73	6.14	6.42	6.62	6.51	6.61	6.62	6.70	6.66	6.46	6.31	6.56	6.58	6.72	7.03	6.61	6.74
MEAN	Filter A	5.49	5.74	5.90	5.92	6.19	6.41	6.46	6.54	6.56	6.62	6.66	6.68	6.55	6.62	6.68	6.71	6.83	6.91	6.75	6.96
Kettle K	Filter B	5.86	6.13	6.11	6.16	6.41	6.36	6.52	6.50	6.63	6.61	6.61	6.73	6.75	6.85	6.81	6.91	6.87	6.91	7.01	7.02
Kettle L	Filter B	6.03	6.20	6.38	6.23	6.35	6.35	6.51	6.43	6.56	6.54	6.55	6.63	6.67	6.70	6.77	6.84	6.78	6.85	6.94	6.99
Kettle M	Filter B	5.96	6.08	6.10	6.09	6.39	6.41	6.49	6.40	6.57	6.52	6.58	6.63	6.72	6.73	6.76	6.84	6.80	6.86	6.92	6.97
Kettle N	Filter B	5.94	6.01	6.01	6.14	6.41	6.40	6.48	6.47	6.54	6.52	6.56	6.64	6.71	6.75	6.78	6.84	6.86	6.92	6.96	6.97
Kettle O	Filter B	5.86	6.01	6.23	6.15	6.37	6.37	6.51	6.47	6.56	6.56	5.69	6.68	6.72	6.75	6.85	6.86	6.87	6.93	6.96	7.02
Kettle P	Filter B	5.98	5.77	5.90	6.02	6.21	6.34	6.37	6.41	6.49	6.56	6.57	6.68	6.69	6.71	6.77	6.86	6.86	6.96	6.94	7.03
Kettle Q	Filter B	6.05	6.11	6.14	6.20	6.34	6.23	6.47	6.60	6.53	6.62	6.60	6.78	6.72	6.73	6.80	6.86	6.87	6.94	6.98	7.06
Kettle R	Filter B	5.83	5.79	5.91	6.11	6.34	6.35	6.43	6.48	6.58	6.50	6.54	6.67	6.60	6.70	6.79	6.87	6.83	6.91	6.94	7.00
MEAN	Filter B	5.94	6.01	6.10	6.14	6.35	6.35	6.47	6.47	6.56	6.55	6.46	6.68	6.70	6.74	6.79	6.86	6.84	6.91	6.96	7.01
Kettle K	Filter C	4.84	5.48	5.49	5.65	5.90	6.17	6.20	6.30	6.35	6.40	6.57	6.59	6.60	6.63	6.66	6.80	6.82	6.86	6.84	6.80
Kettle L	Filter C	5.51	5.50	5.62	5.99	6.24	6.20	6.28	6.35	6.50	6.54	6.52	6.64	6.74	6.74	6.78	6.98	6.89	6.96	7.08	7.02

Table C.1 Continued

	Day	1	2	3	4	5	8	9	10	11	12	15	16	17	18	19	22	23	24	25	26
Kettle M	Filter C	4.87	4.83	5.64	5.88	6.16	6.22	6.35	6.44	6.53	6.59	6.64	6.68	6.72	6.85	6.72	6.94	6.93	6.93	7.09	7.03
Kettle N	Filter C	4.92	5.09	5.66	5.95	6.19	6.22	6.26	6.41	6.47	6.53	6.57	6.64	6.66	6.77	6.75	6.95	6.92	6.92	7.06	7.03
Kettle O	Filter C	4.91	5.65	5.65	5.95	6.03	6.25	6.37	6.41	6.69	6.56	6.57	6.66	6.75	6.78	6.86	6.92	6.89	6.91	6.94	7.04
Kettle P	Filter C	5.25	5.59	5.74	5.59	5.79	6.14	6.03	6.36	6.42	6.44	6.57	6.62	6.63	6.70	6.79	6.88	6.98	6.55	6.91	6.81
Kettle Q	Filter C	5.65	5.83	6.02	5.89	6.06	6.35	6.40	6.48	6.55	6.62	6.56	6.67	6.70	6.80	6.81	6.84	6.89	6.91	6.95	6.83
Kettle R	Filter C	4.69	5.15	5.63	5.80	6.05	6.14	6.00	6.32	6.39	6.48	6.47	6.58	6.61	6.72	6.76	6.81	6.93	6.84	6.95	6.83
MEAN	Filter C	5.08	5.39	5.68	5.84	6.05	6.21	6.24	6.38	6.49	6.52	6.56	6.64	6.68	6.75	6.77	6.89	6.91	6.86	6.98	6.92
All kettles	Water X	7.53	7.52	7.57	7.48	7.47	7.48	7.37	7.52	7.44	7.53	7.49	7.51	7.13	7.46	7.59	7.56	7.54	7.64	7.48	7.59

Table C.2 Alkalinity (mg/l $CaCO_3$) – Unboiled samples

	Day	1	2	3	4	5	12	19	26
Kettle K	Filter A	30.8	47.3	49.1	78.6	93.2	143	164	192
Kettle L	Filter A	12.4	36.9	64.7	85.1	106	151	183	205
Kettle M	Filter A	24.8	28.1	55.3	65.4	72.3	132	160	194
Kettle N	Filter A	25.5	32.6	40.8	62.1	88.9	113	168	195
Kettle O	Filter A	24.6	37.3	37.6	60.9	79.9	149	166	193
Kettle P	Filter A	30.3	30.1	39.4	60.4	66.2	134	167	196

Table C.2 Continued

	Day	1	2	3	4	5	12	19	26
Kettle Q	Filter A	23.0	31.9	65.9	62.9	62.2	133	165	199
Kettle R	Filter A	22.4	36.1	46.4	64.0	73.4	144	159	191
MEAN	Filter A	24.2	35.0	49.9	67.4	80.3	138	167	196
Kettle K	Filter B	57.8	72.8	77.4	81.5	101	148	170	195
Kettle L	Filter B	86.8	91.4	102	79.7	107	135	160	192
Kettle M	Filter B	63.3	74.2	72.2	77.4	92.5	124	158	192
Kettle N	Filter B	56.1	63.9	70.3	80.4	99.2	131	162	193
Kettle O	Filter B	58.2	61.5	99.1	79.9	94.0	135	165	196
Kettle P	Filter B	62.5	44.2	49.1	63.2	81.9	129	159	192
Kettle Q	Filter B	70.8	70.4	69.0	81.4	99.3	136	159	190
Kettle R	Filter B	55.1	46.2	55.2	74.1	88.8	127	166	186
MEAN	Filter B	63.8	65.6	74.3	77.2	95.5	133	162	192
Kettle K	Filter C	10.7	20.3	27.4	57.3	70.2	118	151	189
Kettle L	Filter C	31.6	21.6	28.4	65.9	69.0	130	168	201
Kettle M	Filter C	19.2	5.0	33.3	50.2	69.2	137	171	200
Kettle N	Filter C	13.7	11.3	34.0	54.8	76.5	130	175	201
Kettle O	Filter C	11.2	30.6	34.2	58.4	72.0	143	172	200
Kettle P	Filter C	16.9	29.7	40.4	45.9	64.0	121	171	192
Kettle Q	Filter C	48.9	45.1	60.4	75.1	88.2	147	168	202
Kettle R	Filter C	<5	13.5	30.8	44.3	60.4	122	160	193
MEAN	Filter C	19.7	22.1	36.1	56.5	71.2	131	167	197
All kettles	Water X	255	255	255	252	252	255	256	252

Table C.3 Calcium (mg/l Ca) – Unboiled samples

	Day	1	2	3	4	5	12	19	26
Kettle K	Filter A	16.1	28.9	28.8	40.9	44.8	63.1	75.7	90.0
Kettle L	Filter A	7.9	24.5	35.1	43.0	51.0	70.0	83.4	93.2
Kettle M	Filter A	12.1	21.6	32.2	34.6	37.5	61.0	73.1	90.5
Kettle N	Filter A	14.1	22.8	27.4	34.4	44.9	64.0	75.6	89.8
Kettle O	Filter A	13.9	25.0	26.4	34.7	41.5	64.4	75.9	89.5
Kettle P	Filter A	15.2	22.1	26.3	33.9	36.2	59.8	77.3	90.7
Kettle Q	Filter A	12.4	22.0	35.0	35.3	34.3	59.0	76.7	92.1
Kettle R	Filter A	14.0	23.1	29.0	33.4	38.7	63.0	74.4	89.2
MEAN	Filter A	13.2	23.8	30.0	36.3	41.1	63.0	76.5	90.6
Kettle K	Filter B	18.0	32.6	39.4	42.8	48.4	64.9	83.4	91.7
Kettle L	Filter B	19.5	36.5	47.5	42.4	46.0	61.6	76.7	87.7
Kettle M	Filter B	18.7	32.3	37.1	40.6	46.3	61.7	75.8	89.8
Kettle N	Filter B	19.4	27.4	34.6	43.5	48.5	61.6	79.6	86.2
Kettle O	Filter B	16.2	29.8	46.1	43.1	47.2	61.8	79.5	89.7
Kettle P	Filter B	11.9	16.8	27.3	36.3	41.6	58.7	80.6	86.6
Kettle Q	Filter B	22.6	31.5	35.3	43.4	48.9	61.6	79.8	86.7
Kettle R	Filter B	16.8	22.0	31.1	40.0	43.6	59.5	81.4	85.3
MEAN	Filter B	17.9	28.6	37.3	41.5	46.3	61.4	79.6	88.0
Kettle K	Filter C	8.4	17.9	21.9	32.3	36.8	53.5	70.6	85.4
Kettle L	Filter C	14.5	18.1	23.2	36.4	37.5	60.5	76.6	94.8
Kettle M	Filter C	8.8	12.5	23.9	28.9	37.5	62.6	77.3	91.5
Kettle N	Filter C	7.9	13.2	24.7	32.6	39.1	58.9	77.6	91.2
Kettle O	Filter C	8.2	21.4	24.1	32.8	38.3	64.4	79.6	90.7

Table C.3 Continued

	Day	1	2	3	4	5	12	19	26
Kettle P	Filter C	12.0	20.7	26.0	28.5	34.9	53.7	78.1	86.8
Kettle Q	Filter C	18.4	26.3	33.6	39.1	44.3	63.8	79.2	92.2
Kettle R	Filter C	6.6	15.3	23.5	27.9	33.8	56.2	73.1	89.5
MEAN	Filter C	10.6	18.2	25.1	32.3	37.8	59.2	76.5	90.3
All kettles	Water X	105	109	112	106	102	105	108	106

Table C.4 Alkalinity (mg/l $CaCO_3$) – Boiled samples

				Day							
		Litre	0.45 µm	1	2	3	4	5	12	19	26
Kettle K	Filter A	1	No	53.1	–	–	–	95.0	–	–	–
Kettle K	Filter A	2	No	53.3	–	–	–	86.8	–	–	–
Kettle K	Filter A	Pooled	No	53.2	62.8	43.1	82.0	90.9	129	133	137
Kettle L	Filter A	1	No	21.4	–	–	–	107	–	–	–
Kettle L	Filter A	2	No	22.1	–	–	–	107	–	–	–
Kettle L	Filter A	Pooled	No	21.8	46.7	68.5	87.9	107	153	128	117
Kettle M	Filter A	1	No	38.7	–	–	–	109	–	–	–

Table C.4 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle M	Filter A	2	No	35.6	–	–	–	73.9	–	–	–
Kettle M	Filter A	Pooled	No	37.2	38.0	60.3	67.2	91.5	126	125	126
Kettle N	Filter A	1	No	39.4	–	–	–	88.2	–	–	–
Kettle N	Filter A	2	No	36.7	–	–	–	96.7	–	–	–
Kettle N	Filter A	Pooled	No	38.1	40.8	46.2	65.7	92.5	182	126	128
Kettle O	Filter A	1	No	37.1	–	–	–	84.3	–	–	–
Kettle O	Filter A	2	No	34.6	–	–	–	85.1	–	–	–
Kettle O	Filter A	Pooled	No	35.9	46.4	45.4	64.8	84.7	87.2	130	133
Kettle P	Filter A	1	No	44.9	–	–	–	68.0	–	–	–
Kettle P	Filter A	2	No	46.0	–	–	–	68.9	–	–	–
Kettle P	Filter A	Pooled	No	45.5	40.5	47.4	62.6	68.5	134	140	136
Kettle Q	Filter A	1	No	56.1	–	–	–	62.6	–	–	–
Kettle Q	Filter A	2	No	47.1	–	–	–	67.1	–	–	–
Kettle Q	Filter A	Pooled	No	51.6	46.0	58.5	65.5	64.9	135	140	139
Kettle R	Filter A	1	No	52.9	–	–	–	74.6	–	–	–
Kettle R	Filter A	2	No	48.1	–	–	–	76.8	–	–	–
Kettle R	Filter A	Pooled	No	50.5	46.8	51.4	67.5	75.7	139	132	126
Kettle K	Filter B	1	No	60.1	–	–	–	106	–	–	–
Kettle K	Filter B	2	No	60.5	–	–	–	10	–	–	–
Kettle K	Filter B	Pooled	No	60.3	80.1	86.8	89.5	106	138	134	145
Kettle L	Filter B	1	No	80.4	–	–	–	94.8	–	–	–
Kettle L	Filter B	2	No	78.1	–	–	–	96.4	–	–	–

Table C.4 Continued

				Day							
		Litre	0.45 μm	1	2	3	4	5	12	19	26
Kettle L	Filter B	Pooled	No	79.3	95.2	104.0	87.7	95.6	136	123	125
Kettle M	Filter B	1	No	67.1	–	–	–	98.5	–	–	–
Kettle M	Filter B	2	No	67.5	–	–	–	100	–	–	–
Kettle M	Filter B	Pooled	No	67.3	81.1	75.6	83.0	99.3	125	121	121
Kettle N	Filter B	1	No	68.6	–	–	–	105	–	–	–
Kettle N	Filter B	2	No	66.9	–	–	–	103	–	–	–
Kettle N	Filter B	Pooled	No	67.8	63.2	69.1	87.3	104	117	125	127
Kettle O	Filter B	1	No	60.7	–	–	–	99.9	–	–	–
Kettle O	Filter B	2	No	59.1	–	–	–	98.4	–	–	–
Kettle O	Filter B	Pooled	No	59.9	65.4	96.8	85.1	99.2	130	135	139
Kettle P	Filter B	1	No	62.8	–	–	–	88.9	–	–	–
Kettle P	Filter B	2	No	63.7	–	–	–	84.4	–	–	–
Kettle P	Filter B	Pooled	No	63.3	47.8	54.6	125	86.7	129	136	132
Kettle Q	Filter B	1	No	73.6	–	–	–	105	–	–	–
Kettle Q	Filter B	2	No	72.8	–	–	–	110	–	–	–
Kettle Q	Filter B	Pooled	No	73.2	73.7	74.7	87.3	108	105	137	137
Kettle R	Filter B	1	No	75.8	–	–	–	90.6	–	–	–
Kettle R	Filter B	2	No	70.1	–	–	–	92.5	–	–	–
Kettle R	Filter B	Pooled	No	73.0	57.0	63.2	79.5	91.6	127	133	128
Kettle K	Filter C	1	No	34.2	–	–	–	74.4	–	–	–
Kettle K	Filter C	2	No	29.7	–	–	–	124	–	–	–
Kettle K	Filter C	Pooled	No	32.0	36.5	38.8	62.3	99.2	119	140	144

Table C.4 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle L	Filter C	1	No	37.0	–	–	–	73.8	–	–	–
Kettle L	Filter C	2	No	36.4	–	–	–	75.1	–	–	–
Kettle L	Filter C	Pooled	No	36.7	33.9	37.2	87.7	74.5	130	128	125
Kettle M	Filter C	1	No	29.2	–	–	–	71.0	–	–	–
Kettle M	Filter C	2	No	25.5	–	–	–	73.4	–	–	–
Kettle M	Filter C	Pooled	No	27.4	20.3	39.7	55.3	72.2	131	133	130
Kettle N	Filter C	1	No	23.1	–	–	–	81.1	–	–	–
Kettle N	Filter C	2	No	23.0	–	–	–	78.9	–	–	–
Kettle N	Filter C	Pooled	No	23.1	23.6	42.5	59.0	80.0	129	130	131
Kettle O	Filter C	1	No	24.2	–	–	–	76.0	–	–	–
Kettle O	Filter C	2	No	20.8	–	–	–	78.3	–	–	–
Kettle O	Filter C	Pooled	No	22.5	90.9	39.4	62.5	77.2	147	150	126
Kettle P	Filter C	1	No	31.2	–	–	–	65.9	–	–	–
Kettle P	Filter C	2	No	31.3	–	–	–	64.8	–	–	–
Kettle P	Filter C	Pooled	No	31.3	39.9	44.5	50.4	65.4	121	140	132
Kettle Q	Filter C	1	No	57.3	–	–	–	92.1	–	–	–
Kettle Q	Filter C	2	No	51.1	–	–	–	93.7	–	–	–
Kettle Q	Filter C	Pooled	No	54.2	55.4	66.3	78.1	92.9	138	140	142
Kettle R	Filter C	1	No	50.6	–	–	–	62.1	–	–	–
Kettle R	Filter C	2	No	34.7	–	–	–	64.4	–	–	–
Kettle R	Filter C	Pooled	No	42.7	47.2	38.1	58.4	63.3	125	135	162
Kettle K	Water X	1	Yes	174	–	–	–	132	–	–	–

Table C.4 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle K	Water X	2	Yes	158	–	–	–	130	–	–	–
Kettle K	Water X	Pooled	Yes	166	146	137	127	131	122	117	108
Kettle K	Water X	1	No	177	–	–	–	128	–	–	–
Kettle K	Water X	2	No	161	–	–	–	130	–	–	–
Kettle K	Water X	Pooled	No	169	146	136	127	129	120	116	108
Kettle L	Water X	1	Yes	147	–	–	–	110	–	–	–
Kettle L	Water X	2	Yes	135	–	–	–	113	–	–	–
Kettle L	Water X	Pooled	Yes	141	125	124	110	112	108	111	111
Kettle L	Water X	1	No	158	–	–	–	120	–	–	–
Kettle L	Water X	2	No	140	–	–	–	118	–	–	–
Kettle L	Water X	Pooled	No	149	135	129	136	119	112	114	110
Kettle M	Water X	1	Yes	156	–	–	–	110	–	–	–
Kettle M	Water X	2	Yes	136	–	–	–	108	–	–	–
Kettle M	Water X	Pooled	Yes	146	143	125	162	109	105	98.6	102
Kettle M	Water X	1	No	148	–	–	–	122	–	–	–
Kettle M	Water X	2	No	141	–	–	–	120	–	–	–
Kettle M	Water X	Pooled	No	145	156	130	130	121	100	108	110
Kettle N	Water X	1	Yes	165	–	–	–	121	–	–	–
Kettle N	Water X	2	Yes	145	–	–	–	114	–	–	–
Kettle N	Water X	Pooled	Yes	155	138	129	118	118	103	98.4	97.5
Kettle N	Water X	1	No	157	–	–	–	130	–	–	–
Kettle N	Water X	2	No	144	–	–	–	122	–	–	–

Table C.4 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle N	Water X	Pooled	No	151	138	135	122	126	105	99.3	102
Kettle O	Water X	1	Yes	162	–	–	–	111	–	–	–
Kettle O	Water X	2	Yes	153	–	–	–	125	–	–	–
Kettle O	Water X	Pooled	Yes	158	213	140	125	118	112	107	104
Kettle O	Water X	1	No	162	–	–	–	132	–	–	–
Kettle O	Water X	2	No	160	–	–	–	131	–	–	–
Kettle O	Water X	Pooled	No	161	146	143	131	132	143	110	108
Kettle P	Water X	1	Yes	153	–	–	–	122	–	–	–
Kettle P	Water X	2	Yes	154	–	–	–	123	–	–	–
Kettle P	Water X	Pooled	Yes	154	146	136	126	123	113	106	106
Kettle P	Water X	1	No	168	–	–	–	131	–	–	–
Kettle P	Water X	2	No	155	–	–	–	123	–	–	–
Kettle P	Water X	Pooled	No	162	148	141	136	127	120	108	109
Kettle Q	Water X	1	Yes	156	–	–	–	127	–	–	–
Kettle Q	Water X	2	Yes	157	–	–	–	130	–	–	–
Kettle Q	Water X	Pooled	Yes	165	150	139	132	129	125	126	131
Kettle Q	Water X	1	No	167	–	–	–	130	–	–	–
Kettle Q	Water X	2	No	163	–	–	–	141	–	–	–
Kettle Q	Water X	Pooled	No	165	151	142	138	136	129	128	132
Kettle R	Water X	1	Yes	–	–	–	–	115	–	–	–
Kettle R	Water X	2	Yes	144	–	–	–	117	–	–	–
Kettle R	Water X	Pooled	Yes	144	132	126	190	116	119	119	118

Table C.4 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle R	Water X	1	No	–	–	–	–	125	–	–	–
Kettle R	Water X	2	No	137	–	–	–	131	–	–	–
Kettle R	Water X	Pooled	No	137	136	135	121	128	122	121	122

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2.

Table C.5 Calcium (mg/l Ca) – Boiled samples

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle K	Filter A	1	No	24.1	–	–	–	46.9	–	–	–
Kettle K	Filter A	2	No	21.3	–	–	–	47.2	–	–	–
Kettle K	Filter A	Pooled	No	22.7	34.2	31.0	42.3	47.1	61.2	67.3	65.0
Kettle L	Filter A	1	No	11.0	–	–	–	53.3	–	–	–
Kettle L	Filter A	2	No	9.6	–	–	–	53.5	–	–	–
Kettle L	Filter A	Pooled	No	10.3	26.6	35.2	45.6	53.4	66.3	61.3	57.8

Table C.5 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle M	Filter A	1	No	16.1	–	–	–	41.1	–	–	–
Kettle M	Filter A	2	No	14.9	–	–	–	39.5	–	–	–
Kettle M	Filter A	Pooled	No	15.5	23.4	31.5	37.3	40.3	56.6	60.7	66.2
Kettle N	Filter A	1	No	16.8	–	–	–	47.7	–	–	–
Kettle N	Filter A	2	No	15.2	–	–	–	47.7	–	–	–
Kettle N	Filter A	Pooled	No	16.0	24.4	26.4	36.0	47.7	59.0	62.6	59.5
Kettle O	Filter A	1	No	17.5	–	–	–	44.1	–	–	–
Kettle O	Filter A	2	No	16.0	–	–	–	42.8	–	–	–
Kettle O	Filter A	Pooled	No	16.8	26.5	25.2	35.5	43.5	61.0	63.0	64.2
Kettle P	Filter A	1	No	18.9	–	–	–	37.5	–	–	–
Kettle P	Filter A	2	No	17.3	–	–	–	36.9	–	–	–
Kettle P	Filter A	Pooled	No	18.1	23.1	26.3	34.4	37.2	58.8	66.5	63.7
Kettle Q	Filter A	1	No	27.2	–	–	–	36.5	–	–	–
Kettle Q	Filter A	2	No	23.2	–	–	–	36.1	–	–	–
Kettle Q	Filter A	Pooled	No	25.2	27.1	36.3	36.9	36.3	58.8	66.7	64.4
Kettle R	Filter A	1	No	22.8	–	–	–	41.5	–	–	–
Kettle R	Filter A	2	No	21.9	–	–	–	41.2	–	–	–
Kettle R	Filter A	Pooled	No	22.4	27.1	29.7	36.7	41.4	60.9	65.0	61.1
Kettle K	Filter B	1	No	23.4	–	–	–	54.7	–	–	–
Kettle K	Filter B	2	No	21.9	–	–	–	54.3	–	–	–
Kettle K	Filter B	Pooled	No	22.7	36.8	40.2	44.7	54.5	62.2	69.5	67.6
Kettle L	Filter B	1	No	22.9	–	–	–	49.2	–	–	–

Table C.5 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle L	Filter B	2	No	21.7	–	–	–	48.9	–	–	–
Kettle L	Filter B	Pooled	No	22.3	37.4	47.4	44.0	49.1	61.8	58.8	61.3
Kettle M	Filter B	1	No	23.8	–	–	–	46.5	–	–	–
Kettle M	Filter B	2	No	22.6	–	–	–	48.6	–	–	–
Kettle M	Filter B	Pooled	No	23.2	36.9	37.7	42.2	47.6	58.3	59.6	57.3
Kettle N	Filter B	1	No	24.7	–	–	–	52.8	–	–	–
Kettle N	Filter B	2	No	24.3	–	–	–	52.6	–	–	–
Kettle N	Filter B	Pooled	No	24.5	31.5	34.8	43.2	52.7	55.6	65.3	60.4
Kettle O	Filter B	1	No	20.2	–	–	–	51.6	–	–	–
Kettle O	Filter B	2	No	19.4	–	–	–	51.6	–	–	–
Kettle O	Filter B	Pooled	No	19.8	31.7	45.7	43.4	51.6	59.7	67.5	63.1
Kettle P	Filter B	1	No	15.0	–	–	–	45.1	–	–	–
Kettle P	Filter B	2	No	13.5	–	–	–	45.7	–	–	–
Kettle P	Filter B	Pooled	No	14.3	17.8	27.5	36.2	45.4	58.4	65.9	62.4
Kettle Q	Filter B	1	No	30.2	–	–	–	52.6	–	–	–
Kettle Q	Filter B	2	No	27.1	–	–	–	55.1	–	–	–
Kettle Q	Filter B	Pooled	No	28.7	34.9	36.4	44.5	53.9	61.2	69.4	66.0
Kettle R	Filter B	1	No	30.0	–	–	–	50.4	–	–	–
Kettle R	Filter B	2	No	24.2	–	–	–	49.5	–	–	–
Kettle R	Filter B	Pooled	No	27.1	28.9	34.1	40.9	50.0	58.6	68.5	66.0
Kettle K	Filter C	1	No	17.2	–	–	–	37.3	–	–	–
Kettle K	Filter C	2	No	13.7	–	–	–	.8.4	–	–	–

Table C.5 Continued

				Day							
		Litre	0.45 µm	1	2	3	4	5	12	19	26
Kettle K	Filter C	Pooled	No	15.5	21.1	22.3	34.4	22.9	56.1	64.9	66.3
Kettle L	Filter C	1	No	16.7	–	–	–	37.5	–	–	–
Kettle L	Filter C	2	No	15.3	–	–	–	37.4	–	–	–
Kettle L	Filter C	Pooled	No	16.0	19.0	22.4	38.2	37.5	58.8	60.6	60.7
Kettle M	Filter C	1	No	13.7	–	–	–	37.6	–	–	–
Kettle M	Filter C	2	No	11.8	–	–	–	37.5	–	–	–
Kettle M	Filter C	Pooled	No	12.8	14.1	23.2	32.0	37.6	57.5	60.8	62.6
Kettle N	Filter C	1	No	10.9	–	–	–	40.2	–	–	–
Kettle N	Filter C	2	No	9.2	–	–	–	40.0	–	–	–
Kettle N	Filter C	Pooled	No	10.1	14.4	25.4	33.1	40.1	57.2	60.7	60.6
Kettle O	Filter C	1	No	12.8	–	–	–	39.5	–	–	–
Kettle O	Filter C	2	No	10.0	–	–	–	39.7	–	–	–
Kettle O	Filter C	Pooled	No	11.4	23.6	23.9	35.2	39.6	64.7	65.9	61.6
Kettle P	Filter C	1	No	15.9	–	–	–	35.0	–	–	–
Kettle P	Filter C	2	No	13.8	–	–	–	34.8	–	–	–
Kettle P	Filter C	Pooled	No	14.9	22.1	26.0	29.7	34.9	57.2	63.8	62.2
Kettle Q	Filter C	1	No	27.0	–	–	–	45.8	–	–	–
Kettle Q	Filter C	2	No	23.8	–	–	–	47.3	–	–	–
Kettle Q	Filter C	Pooled	No	25.4	31.0	33.8	41.0	46.6	64.3	64.3	67.6
Kettle R	Filter C	1	No	24.4	–	–	–	35.8	–	–	–
Kettle R	Filter C	2	No	18.3	–	–	–	35.6	–	–	–
Kettle R	Filter C	Pooled	No	21.4	21.9	25.0	29.9	35.7	57.2	66.2	72.9

Table C.5 Continued

				Day							
		Litre	0.45 µm	1	2	3	4	5	12	19	26
Kettle K	Water X	1	Yes	77.0	–	–	–	60.8	–	–	–
Kettle K	Water X	2	Yes	70.0	–	–	–	61.2	–	–	–
Kettle K	Water X	Pooled	Yes	73.5	60.7	60.5	58.3	61.0	54.5	54.7	51.4
Kettle K	Water X	1	No	77.0	–	–	–	84.9	–	–	–
Kettle K	Water X	2	No	70.0	–	–	–	66.9	–	–	–
Kettle K	Water X	Pooled	No	73.5	62.3	62.4	60.6	75.9	57.8	57.3	52.3
Kettle L	Water X	1	Yes	63.7	–	–	–	52.6	–	–	–
Kettle L	Water X	2	Yes	58.0	–	–	–	53.0	–	–	–
Kettle L	Water X	Pooled	Yes	60.9	57.3	55.8	52.2	52.8	51.8	51.6	50.9
Kettle L	Water X	1	No	70.2	–	–	–	59.7	–		–
Kettle L	Water X	2	No	63.8	–	–	–	59.0	–		–
Kettle L	Water X	Pooled	No	67.0	61.6	60.8	54.2	59.4	55.6	67.9	66.2
Kettle M	Water X	1	Yes	64.0	–	–	–	53.1	–	–	–
Kettle M	Water X	2	Yes	60.2	–	–	–	52.1	–	–	–
Kettle M	Water X	Pooled	Yes	62.1	62.7	56.5	52.5	52.6	48.9	47.9	48.5
Kettle M	Water X	1	No	66.6	–	–	–	54.3	–	–	–
Kettle M	Water X	2	No	74.1	–	–	–	54.7	–	–	–
Kettle M	Water X	Pooled	No	70.4	70.8	67.4	56.2	54.5	51.3	53.0	54.6
Kettle N	Water X	1	Yes	64.7	–	–	–	55.1	–	–	–
Kettle N	Water X	2	Yes	61.8	–	–	–	54.9	–	–	–
Kettle N	Water X	Pooled	Yes	63.3	59.7	57.8	53.7	55.0	47.4	47.8	46.9
Kettle N	Water X	1	No	66.0	–	–	–	61.5	–	–	–

Table C.5 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle N	Water X	2	No	82.2	–	–	–	58.5	–	–	–
Kettle N	Water X	Pooled	No	74.1	59.1	60.4	57.8	60.0	50.3	49.3	55.6
Kettle O	Water X	1	Yes	69.0	–	–	–	59.2	–	–	–
Kettle O	Water X	2	Yes	65.4	–	–	–	57.9	–	–	–
Kettle O	Water X	Pooled	Yes	67.2	61.0	62.9	57.4	58.6	51.8	52.0	50.5
Kettle O	Water X	1	No	90.0	–	–	–	74.3	–	–	–
Kettle O	Water X	2	No	84.0	–	–	–	60.0	–	–	–
Kettle O	Water X	Pooled	No	87.0	66.7	64.1	60.7	67.2	55.0	54.6	53.0
Kettle P	Water X	1	Yes	62.3	–	–	–	56.6	–	–	–
Kettle P	Water X	2	Yes	64.1	–	–	–	57.2	–	–	–
Kettle P	Water X	Pooled	Yes	63.2	61.9	60.4	58.7	56.9	51.3	50.4	54.1
Kettle P	Water X	1	No	82.2	–	–	–	64.6	–	–	–
Kettle P	Water X	2	No	65.7	–	–	–	63.0	–	–	–
Kettle P	Water X	Pooled	No	74.0	61.7	62.5	60.8	63.8	53.7	52.6	50.3
Kettle Q	Water X	1	Yes	67.3	–	–	–	60.1	–	–	–
Kettle Q	Water X	2	Yes	65.1	–	–	–	60.5	–	–	–
Kettle Q	Water X	Pooled	Yes	66.2	62.8	62.3	59.4	60.3	55.8	57.1	58.3
Kettle Q	Water X	1	No	72.0	–	–	–	84.9	–	–	–
Kettle Q	Water X	2	No	86.0	–	–	–	79.9	–	–	–
Kettle Q	Water X	Pooled	No	79.0	66.1	64.9	63.9	82.4	59.9	59.6	60.1
Kettle R	Water X	1	Yes	88.3	–	–	–	55.4	–	–	–
Kettle R	Water X	2	Yes	62.0	–	–	–	55.6	–	–	–

Table C.5 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle R	Water X	Pooled	Yes	75.2	55.1	57.3	53.7	55.5	53.0	55.2	53.8
Kettle R	Water X	1	No	94.6	–	–	–	68.6	–	–	–
Kettle R	Water X	2	No	63.3	–	–	–	58.8	–	–	–
Kettle R	Water X	Pooled	No	79.0	60.7	61.5	67.8	63.7	62.7	62.2	61.8

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2.

Table C.6 Iron (μg/l Fe) – Boiled samples

		Litre	0.45 μm	Day 1	2	3	4	5
Kettle K	Filter A	1	No	<20	–	–	–	<20
Kettle K	Filter A	2	No	<20	–	–	–	<20
Kettle K	Filter A	Pooled	No	<20	30	<20	<20	<20
Kettle L	Filter A	1	No	<20	–	–	–	<20
Kettle L	Filter A	2	No	<20	–	–	–	<20
Kettle L	Filter A	Pooled	No	<20	<20	<20	<20	<20
Kettle M	Filter A	1	No	<20	–	–	–	<20
Kettle M	Filter A	2	No	<20	–	–	–	<20
Kettle M	Filter A	Pooled	No	<20	30	<20	<20	<20
Kettle N	Filter A	1	No	<20	–	–	–	<20
Kettle N	Filter A	2	No	<20	–	–	–	<20
Kettle N	Filter A	Pooled	No	<20	<20	<20	<20	<20
Kettle O	Filter A	1	No	<20	–	–	–	<20
Kettle O	Filter A	2	No	<20	–	–	–	<20
Kettle O	Filter A	Pooled	No	<20	30	<20	<20	<20
Kettle P	Filter A	1	No	<20	–	–	–	<20
Kettle P	Filter A	2	No	<20	–	–	–	<20
Kettle P	Filter A	Pooled	No	<20	30	40	<20	<20
Kettle Q	Filter A	1	No	<20	–	–	–	<20
Kettle Q	Filter A	2	No	<20	–	–	–	<20
Kettle Q	Filter A	Pooled	No	<20	30	30	<20	<20
Kettle R	Filter A	1	No	<20	–	–	–	<20
Kettle R	Filter A	2	No	<20	–	–	–	<20
Kettle R	Filter A	Pooled	No	<20	30	40	<20	<20
Kettle K	Filter B	1	No	40	–	–	–	<20
Kettle K	Filter B	2	No	40	–	–	–	<20
Kettle K	Filter B	Pooled	No	40	40	<20	<20	<20
Kettle L	Filter B	1	No	<20	–	–	–	<20
Kettle L	Filter B	2	No	<20	–	–	–	<20
Kettle L	Filter B	Pooled	No	<20	<20	<20	<20	<20
Kettle M	Filter B	1	No	<20	–	–	–	<20
Kettle M	Filter B	2	No	<20	–	–	–	<20
Kettle M	Filter B	Pooled	No	<20	<20	<20	<20	<20
Kettle N	Filter B	1	No	<20	–	–	–	<20
Kettle N	Filter B	2	No	<20	–	–	–	<20
Kettle N	Filter B	Pooled	No	<20	<20	<20	<20	<20
Kettle O	Filter B	1	No	<20	–	–	–	<20
Kettle O	Filter B	2	No	<20	–	–	–	<20
Kettle O	Filter B	Pooled	No	<20	<20	<20	<20	<20

Table C.6 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle P	Filter B	1	No	40	–	–	–	<20
Kettle P	Filter B	2	No	40	–	–	–	<20
Kettle P	Filter B	Pooled	No	40	30	<20	<20	<20
Kettle Q	Filter B	1	No	40	–	–	–	<20
Kettle Q	Filter B	2	No	40	–	–	–	<20
Kettle Q	Filter B	Pooled	No	40	<20	<20	<20	<20
Kettle R	Filter B	1	No	40	–	–	–	<20
Kettle R	Filter B	2	No	40	–	–	–	<20
Kettle R	Filter B	Pooled	No	40	<20	<20	<20	<20
Kettle K	Filter C	1	No	40	–	–	–	<20
Kettle K	Filter C	2	No	30	–	–	–	<20
Kettle K	Filter C	Pooled	No	35	30	<20	<20	<20
Kettle L	Filter C	1	No	<20	–	–	–	<20
Kettle L	Filter C	2	No	<20	–	–	–	<20
Kettle L	Filter C	Pooled	No	<20	<20	<20	<20	<20
Kettle M	Filter C	1	No	<20	–	–	–	<20
Kettle M	Filter C	2	No	<20	–	–	–	<20
Kettle M	Filter C	Pooled	No	<20	<20	<20	<20	<20
Kettle N	Filter C	1	No	<20	–	–	–	<20
Kettle N	Filter C	2	No	<20	–	–	–	<20
Kettle N	Filter C	Pooled	No	<20	30	<20	<20	<20
Kettle O	Filter C	1	No	<20	–	–	–	<20
Kettle O	Filter C	2	No	<20	–	–	–	<20
Kettle O	Filter C	Pooled	No	<20	30	<20	<20	<20
Kettle P	Filter C	1	No	<20	–	–	–	<20
Kettle P	Filter C	2	No	<20	–	–	–	<20
Kettle P	Filter C	Pooled	No	<20	30	30	<20	<20
Kettle Q	Filter C	1	No	<20	–	–	–	<20
Kettle Q	Filter C	2	No	<20	–	–	–	<20
Kettle Q	Filter C	Pooled	No	<20	30	30	<20	<20
Kettle R	Filter C	1	No	<20	–	–	–	<20
Kettle R	Filter C	2	No	<20	–	–	–	<20
Kettle R	Filter C	Pooled	No	<20	30	<20	<20	<20
Kettle K	Water X	1	Yes	<20	–	–	–	<20
Kettle K	Water X	2	Yes	<20	–	–	–	<20
Kettle K	Water X	Pooled	Yes	<20	<20	<20	<20	<20
Kettle K	Water X	1	No	70	–	–	–	<20
Kettle K	Water X	2	No	30	–	–	–	<20
Kettle K	Water X	Pooled	No	50	<20	<20	<20	<20
Kettle L	Water X	1	Yes	<20	–	–	–	<20

Table C.6 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle L	Water X	2	Yes	<20	–	–	–	<20
Kettle L	Water X	Pooled	Yes	<20	<20	<20	<20	<20
Kettle L	Water X	1	No	<20	–	–	–	<20
Kettle L	Water X	2	No	<20	–	–	–	<20
Kettle L	Water X	Pooled	No	<20	<20	<20	<20	<20
Kettle M	Water X	1	Yes	<20	–	–	–	<20
Kettle M	Water X	2	Yes	30	–	–	–	<20
Kettle M	Water X	Pooled	Yes	25	<20	<20	<20	<20
Kettle M	Water X	1	No	<20	–	–	–	<20
Kettle M	Water X	2	No	<20	–	–	–	<20
Kettle M	Water X	Pooled	No	<20	<20	<20	<20	<20
Kettle N	Water X	1	Yes	<20	–	–	–	<20
Kettle N	Water X	2	Yes	<20	–	–	–	<20
Kettle N	Water X	Pooled	Yes	<20	<20	<20	<20	<20
Kettle N	Water X	1	No	<20	–	–	–	<20
Kettle N	Water X	2	No	<20	–	–	–	<20
Kettle N	Water X	Pooled	No	<20	<20	<20	<20	<20
Kettle O	Water X	1	Yes	<20	–	–	–	<20
Kettle O	Water X	2	Yes	<20	–	–	–	<20
Kettle O	Water X	Pooled	Yes	<20	<20	<20	<20	<20
Kettle O	Water X	1	No	<20	–	–	–	<20
Kettle O	Water X	2	No	<20	–	–	–	<20
Kettle O	Water X	Pooled	No	<20	<20	<20	<20	<20
Kettle P	Water X	1	Yes	<20	–	–	–	<20
Kettle P	Water X	2	Yes	<20	–	–	–	<20
Kettle P	Water X	Pooled	Yes	<20	<20	<20	<20	<20
Kettle P	Water X	1	No	<20	–	–	–	<20
Kettle P	Water X	2	No	<20	–	–	–	<20
Kettle P	Water X	Pooled	No	<20	<20	<20	<20	<20
Kettle Q	Water X	1	Yes	<20	–	–	–	<20
Kettle Q	Water X	2	Yes	<20	–	–	–	<20
Kettle Q	Water X	Pooled	Yes	<20	<20	<20	<20	<20
Kettle Q	Water X	1	No	<20	–	–	–	<20
Kettle Q	Water X	2	No	<20	–	–	–	<20
Kettle Q	Water X	Pooled	No	<20	<20	<20	<20	<20
Kettle R	Water X	1	Yes	50	–	–	–	<20
Kettle R	Water X	2	Yes	<20	–	–	–	<20
Kettle R	Water X	Pooled	Yes	35	<20	<20	<20	<20
Kettle R	Water X	1	No	70	–	–	–	<20
Kettle R	Water X	2	No	<20	–	–	–	<20

Table C.6 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle R	Water X	Pooled	No	45	<20	<20	<20	<20
Feed	Water X		No	<20	30	30	30	<20
Feed	Water X		Yes	<20	<20	<20	<20	<20

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2.

Table C.7 Total chromium (µg/l Cr) – Boiled samples

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle K	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle K	Filter A	2	No	<0.3	–	–	–	<0.3
Kettle K	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle L	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle L	Filter A	2	No	<0.3	–	–	–	<0.3
Kettle L	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle M	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle M	Filter A	2	No	<0.3	–	–	–	<0.3
Kettle M	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle N	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle N	Filter A	2	No	<0.3	–	–	–	<0.3
Kettle N	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle O	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle O	Filter A	2	No	<0.3	–	–	–	<0.3
Kettle O	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle P	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle P	Filter A	2	No	<0.3	–	–	–	<0.3
Kettle P	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle Q	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle Q	Filter A	2	No	0.5	–	–	–	<0.3
Kettle Q	Filter A	Pooled	No	0.4	<0.3	<0.3	<0.3	<0.3
Kettle R	Filter A	1	No	<0.3	–	–	–	<0.3
Kettle R	Filter A	2	No	<0.3	–	–	–	<0.3

Table C.7 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle R	Filter A	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle K	Filter B	1	No	<0.3	–	–	–	<0.3
Kettle K	Filter B	2	No	0.4	–	–	–	<0.3
Kettle K	Filter B	Pooled	No	0.4	<0.3	<0.3	<0.3	<0.3
Kettle L	Filter B	1	No	0.6	–	–	–	<0.3
Kettle L	Filter B	2	No	0.5	–	–	–	<0.3
Kettle L	Filter B	Pooled	No	0.6	<0.3	<0.3	<0.3	<0.3
Kettle M	Filter B	1	No	<0.3	–	–	–	<0.3
Kettle M	Filter B	2	No	0.4	–	–	–	<0.3
Kettle M	Filter B	Pooled	No	0.4	<0.3	<0.3	<0.3	<0.3
Kettle N	Filter B	1	No	<0.3	–	–	–	<0.3
Kettle N	Filter B	2	No	<0.3	–	–	–	<0.3
Kettle N	Filter B	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle O	Filter B	1	No	0.5	–	–	–	<0.3
Kettle O	Filter B	2	No	0.4	–	–	–	<0.3
Kettle O	Filter B	Pooled	No	0.5	<0.3	<0.3	<0.3	<0.3
Kettle P	Filter B	1	No	0.4	–	–	–	<0.3
Kettle P	Filter B	2	No	<0.3	–	–	–	<0.3
Kettle P	Filter B	Pooled	No	0.4	<0.3	<0.3	<0.3	<0.3
Kettle Q	Filter B	1	No	<0.3	–	–	–	<0.3
Kettle Q	Filter B	2	No	0.6	–	–	–	<0.3
Kettle Q	Filter B	Pooled	No	0.5	<0.3	<0.3	<0.3	<0.3
Kettle R	Filter B	1	No	0.4	–	–	–	<0.3
Kettle R	Filter B	2	No	0.4	–	–	–	<0.3
Kettle R	Filter B	Pooled	No	0.4	<0.3	<0.3	<0.3	<0.3
Kettle K	Filter C	1	No	2.8	–	–	–	<0.3
Kettle K	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle K	Filter C	Pooled	No	1.6	<0.3	<0.3	<0.3	<0.3
Kettle L	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle L	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle L	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle M	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle M	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle M	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle N	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle N	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle N	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle O	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle O	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle O	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3

Table C.7 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle P	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle P	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle P	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle Q	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle Q	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle Q	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle R	Filter C	1	No	<0.3	–	–	–	<0.3
Kettle R	Filter C	2	No	<0.3	–	–	–	<0.3
Kettle R	Filter C	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle K	Water X	1	Yes	<0.3	–	–	–	<0.3
Kettle K	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle K	Water X	Pooled	Yes	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle K	Water X	1	No	0.7	–	–	–	<0.3
Kettle K	Water X	2	No	<0.3	–	–	–	<0.3
Kettle K	Water X	Pooled	No	0.5	<0.3	<0.3	<0.3	<0.3
Kettle L	Water X	1	Yes	0.5	–	–	–	<0.3
Kettle L	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle L	Water X	Pooled	Yes	0.4	<0.3	<0.3	<0.3	<0.3
Kettle L	Water X	1	No	<0.3	–	–	–	<0.3
Kettle L	Water X	2	No	<0.3	–	–	–	<0.3
Kettle L	Water X	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle M	Water X	1	Yes	0.4	–	–	–	<0.3
Kettle M	Water X	2	Yes	0.5	–	–	–	<0.3
Kettle M	Water X	Pooled	Yes	0.5	<0.3	<0.3	<0.3	<0.3
Kettle M	Water X	1	No	<0.3	–	–	–	<0.3
Kettle M	Water X	2	No	<0.3	–	–	–	<0.3
Kettle M	Water X	Pooled	No	<0.3	<0.3	<0.3	0.5	<0.3
Kettle N	Water X	1	Yes	<0.3	–	–	–	<0.3
Kettle N	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle N	Water X	Pooled	Yes	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle N	Water X	1	No	<0.3	–	–	–	<0.3
Kettle N	Water X	2	No	<0.3	–	–	–	<0.3
Kettle N	Water X	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle O	Water X	1	Yes	0.5	–	–	–	<0.3
Kettle O	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle O	Water X	Pooled	Yes	0.4	<0.3	<0.3	<0.3	<0.3
Kettle O	Water X	1	No	<0.3	–	–	–	<0.3
Kettle O	Water X	2	No	<0.3	–	–	–	<0.3
Kettle O	Water X	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle P	Water X	1	Yes	<0.3	–	–	–	<0.3

Table C.7 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle P	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle P	Water X	Pooled	Yes	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle P	Water X	1	No	<0.3	–	–	–	<0.3
Kettle P	Water X	2	No	<0.3	–	–	–	<0.3
Kettle P	Water X	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle Q	Water X	1	Yes	<0.3	–	–	–	<0.3
Kettle Q	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle Q	Water X	Pooled	Yes	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle Q	Water X	1	No	<0.3	–	–	–	<0.3
Kettle Q	Water X	2	No	<0.3	–	–	–	<0.3
Kettle Q	Water X	Pooled	No	<0.3	<0.3	<0.3	<0.3	<0.3
Kettle R	Water X	1	Yes	1.0	–	–	–	<0.3
Kettle R	Water X	2	Yes	<0.3	–	–	–	<0.3
Kettle R	Water X	Pooled	Yes	0.7	<0.3	<0.3	<0.3	<0.3
Kettle R	Water X	1	No	0.7	–	–	–	<0.3
Kettle R	Water X	2	No	<0.3	–	–	–	<0.3
Kettle R	Water X	Pooled	No	0.5	<0.3	<0.3	<0.3	<0.3
Feed	Water X		No	0.6	1.0	<0.3	<0.3	<0.3
Feed	Water X		Yes	0.5	0.6	<0.3	<0.3	<0.3

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2.

Table C.8 Chromium(VI) (µg/l Cr) – Boiled samples

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle K	Filter A	1	No	<0.06	–	–	–	<0.06
Kettle K	Filter A	2	No	<0.06	–	–	–	0.067
Kettle K	Filter A	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.064
Kettle L	Filter A	1	No	<0.06	–	–	–	<0.06
Kettle L	Filter A	2	No	<0.06	–	–	–	<0.06
Kettle L	Filter A	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle M	Filter A	1	No	<0.06	–	–	–	<0.06

Table C.8 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle M	Filter A	2	No	<0.06	–	–	–	<0.06
Kettle M	Filter A	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle N	Filter A	1	No	<0.06	–	–	–	0.063
Kettle N	Filter A	2	No	<0.06	–	–	–	0.074
Kettle N	Filter A	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.069
Kettle O	Filter A	1	No	<0.06	–	–	–	0.063
Kettle O	Filter A	2	No	0.080	–	–	–	0.084
Kettle O	Filter A	Pooled	No	0.070	<0.06	<0.06	<0.06	0.074
Kettle P	Filter A	1	No	<0.06	–	–	–	<0.06
Kettle P	Filter A	2	No	<0.06	–	–	–	<0.06
Kettle P	Filter A	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle Q	Filter A	1	No	<0.06	–	–	–	0.063
Kettle Q	Filter A	2	No	<0.06	–	–	–	0.063
Kettle Q	Filter A	Pooled	No	<0.06	<0.06	<0.06	0.058	0.063
Kettle R	Filter A	1	No	<0.06	–	–	–	0.067
Kettle R	Filter A	2	No	<0.06	–	–	–	0.067
Kettle R	Filter A	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.067
Kettle K	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle K	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle K	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle L	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle L	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle L	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle M	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle M	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle M	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle N	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle N	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle N	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle O	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle O	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle O	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle P	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle P	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle P	Filter B	Pooled	No	<0.06	<0.06	<0.06	0.068	<0.06
Kettle Q	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle Q	Filter B	2	No	<0.06	–	–	–	<0.06
Kettle Q	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle R	Filter B	1	No	<0.06	–	–	–	<0.06
Kettle R	Filter B	2	No	<0.06	–	–	–	<0.06

Table C.8 Continued

		Litre	0.45 µm	Day 1	2	3	4	5
Kettle R	Filter B	Pooled	No	<0.06	<0.06	<0.06	<0.06	<0.06
Kettle K	Filter C	1	No	0.204	–	–	–	<0.06
Kettle K	Filter C	2	No	<0.06	–	–	–	0.123
Kettle K	Filter C	Pooled	No	0.132	<0.06	<0.06	<0.06	0.092
Kettle L	Filter C	1	No	<0.06	–	–	–	0.075
Kettle L	Filter C	2	No	<0.06	–	–	–	0.068
Kettle L	Filter C	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.072
Kettle M	Filter C	1	No	<0.06	–	–	–	0.064
Kettle M	Filter C	2	No	<0.06	–	–	–	0.064
Kettle M	Filter C	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.064
Kettle N	Filter C	1	No	<0.06	–	–	–	0.064
Kettle N	Filter C	2	No	<0.06	–	–	–	0.068
Kettle N	Filter C	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.066
Kettle O	Filter C	1	No	<0.06	–	–	–	0.064
Kettle O	Filter C	2	No	<0.06	–	–	–	0.068
Kettle O	Filter C	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.066
Kettle P	Filter C	1	No	<0.06	–	–	–	0.063
Kettle P	Filter C	2	No	<0.06	–	–	–	0.084
Kettle P	Filter C	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.074
Kettle Q	Filter C	1	No	<0.06	–	–	–	0.077
Kettle Q	Filter C	2	No	<0.06	–	–	–	0.081
Kettle Q	Filter C	Pooled	No	<0.06	<0.06	<0.06	0.107	0.079
Kettle R	Filter C	1	No	<0.06	–	–	–	0.098
Kettle R	Filter C	2	No	<0.06	–	–	–	0.098
Kettle R	Filter C	Pooled	No	<0.06	<0.06	<0.06	0.062	0.098
Kettle K	Water X	1	Yes	<0.06	–	–	–	0.066
Kettle K	Water X	2	Yes	<0.06	–	–	–	0.073
Kettle K	Water X	Pooled	Yes	<0.06	<0.06	<0.06	0.064	0.070
Kettle K	Water X	1	No	<0.06	–	–	–	0.077
Kettle K	Water X	2	No	<0.06	–	–	–	<0.06
Kettle K	Water X	Pooled	No	<0.06	0.063	<0.06	0.061	0.069
Kettle L	Water X	1	Yes	<0.06	–	–	–	<0.06
Kettle L	Water X	2	Yes	<0.06	–	–	–	0.060
Kettle L	Water X	Pooled	Yes	<0.06	<0.06	<0.06	0.061	0.060
Kettle L	Water X	1	No	<0.06	–	–	–	<0.06
Kettle L	Water X	2	No	<0.06	–	–	–	0.070
Kettle L	Water X	Pooled	No	<0.06	0.068	<0.06	0.075	0.065
Kettle M	Water X	1	Yes	<0.06	–	–	–	0.063
Kettle M	Water X	2	Yes	<0.06	–	–	–	0.067
Kettle M	Water X	Pooled	Yes	<0.06	0.081	<0.06	0.078	0.065

Table C.8 Continued

		Litre	0.45 μm	Day 1	2	3	4	5
Kettle M	Water X	1	No	<0.06	–	–	–	0.060
Kettle M	Water X	2	No	<0.06	–	–	–	0.074
Kettle M	Water X	Pooled	No	<0.06	0.095	<0.06	0.098	0.067
Kettle N	Water X	1	Yes	<0.06	–	–	–	0.109
Kettle N	Water X	2	Yes	<0.06	–	–	–	0.070
Kettle N	Water X	Pooled	Yes	<0.06	0.077	<0.06	0.075	0.090
Kettle N	Water X	1	No	<0.06	–	–	–	0.070
Kettle N	Water X	2	No	<0.06	–	–	–	0.074
Kettle N	Water X	Pooled	No	<0.06	0.090	0.071	0.064	0.072
Kettle O	Water X	1	Yes	<0.06	–	–	–	0.066
Kettle O	Water X	2	Yes	<0.06	–	–	–	0.087
Kettle O	Water X	Pooled	Yes	<0.06	0.108	<0.06	0.072	0.077
Kettle O	Water X	1	No	<0.06	–	–	–	0.084
Kettle O	Water X	2	No	<0.06	–	–	–	0.088
Kettle O	Water X	Pooled	No	<0.06	<0.06	<0.06	<0.06	0.086
Kettle P	Water X	1	Yes	<0.06	–	–	–	<0.06
Kettle P	Water X	2	Yes	<0.06	–	–	–	0.073
Kettle P	Water X	Pooled	Yes	<0.06	0.068	<0.06	0.075	0.067
Kettle P	Water X	1	No	<0.06	–	–	–	0.063
Kettle P	Water X	2	No	<0.06	–	–	–	0.070
Kettle P	Water X	Pooled	No	<0.06	0.081	<0.06	<0.06	0.067
Kettle Q	Water X	1	Yes	<0.06	–	–	–	0.087
Kettle Q	Water X	2	Yes	<0.06	–	–	–	0.094
Kettle Q	Water X	Pooled	Yes	<0.06	0.081	<0.06	0.069	0.091
Kettle Q	Water X	1	No	<0.06	–	–	–	<0.06
Kettle Q	Water X	2	No	<0.06	–	–	–	<0.06
Kettle Q	Water X	Pooled	No	<0.06	0.077	<0.06	0.075	<0.06
Kettle R	Water X	1	Yes	<0.06	–	–	–	0.070
Kettle R	Water X	2	Yes	<0.06	–	–	–	0.080
Kettle R	Water X	Pooled	Yes	<0.06	0.063	<0.06	0.081	0.075
Kettle R	Water X	1	No	<0.06	–	–	–	0.074
Kettle R	Water X	2	No	<0.06	–	–	–	0.116
Kettle R	Water X	Pooled	No	<0.06	0.068	<0.06	0.061	0.095
Feed	Water X		No	<0.06	0.099	<0.06	0.081	0.326
Feed	Water X		Yes	<0.06	0.117	0.080	0.104	0.161

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2.

Table C.9 Nickel (µg/l Ni) – Boiled samples

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle K	Filter A	1	No	1730	–	–	–	277	–	–	–
Kettle K	Filter A	2	No	5170	–	–	–	176	–	–	–
Kettle K	Filter A	Pooled	No	3450	3070	2540	525	227	57.4	68.5	104
Kettle L	Filter A	1	No	3490	–	–	–	224	–	–	–
Kettle L	Filter A	2	No	6180	–	–	–	183	–	–	–
Kettle L	Filter A	Pooled	No	4835	4720	2000	511	204	54.2	59.7	83.3
Kettle M	Filter A	1	No	2420	–	–	–	450	–	–	–
Kettle M	Filter A	2	No	3230	–	–	–	472	–	–	–
Kettle M	Filter A	Pooled	No	2825	3320	1180	715	461	67.3	79.6	89.1
Kettle N	Filter A	1	No	3250	–	–	–	228	–	–	–
Kettle N	Filter A	2	No	3870	–	–	–	181	–	–	–
Kettle N	Filter A	Pooled	No	3560	3260	1490	335	205	42.6	54.3	61.6
Kettle O	Filter A	1	No	1460	–	–	–	288	–	–	–
Kettle O	Filter A	2	No	2170	–	–	–	247	–	–	–
Kettle O	Filter A	Pooled	No	1815	2540	1390	489	268	56.0	52.5	135
Kettle P	Filter A	1	No	2150	–	–	–	519	–	–	–
Kettle P	Filter A	2	No	5800	–	–	–	516	–	–	–
Kettle P	Filter A	Pooled	No	3975	3730	1800	797	518	42.7	37.5	41.1
Kettle Q	Filter A	1	No	1.15	–	–	–	0.67	–	–	–
Kettle Q	Filter A	2	No	0.83	–	–	–	0.69	–	–	–
Kettle Q	Filter A	Pooled	No	0.99	1.15	0.86	0.77	0.68	1.04	0.78	0.53

Table C.9 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle R	Filter A	1	No	1.60	–	–	–	0.70	–	–	–
Kettle R	Filter A	2	No	0.72	–	–	–	0.66	–	–	–
Kettle R	Filter A	Pooled	No	1.16	1.02	7.16	0.87	0.68	1.12	0.82	0.70
Kettle K	Filter B	1	No	1660	–	–	–	305	–	–	–
Kettle K	Filter B	2	No	2490	–	–	–	244	–	–	–
Kettle K	Filter B	Pooled	No	2075	2290	1350	723	275	58.6	75.5	66.4
Kettle L	Filter B	1	No	1470	–	–	–	113	–	–	–
Kettle L	Filter B	2	No	3070	–	–	–	78.2	–	–	–
Kettle L	Filter B	Pooled	No	2270	3130	481	169	95.6	29.3	25.5	45.7
Kettle M	Filter B	1	No	1270	–	–	–	193	–	–	–
Kettle M	Filter B	2	No	1430	–	–	–	219	–	–	–
Kettle M	Filter B	Pooled	No	1350	1080	679	344	206	62.9	91.3	358
Kettle N	Filter B	1	No	551	–	–	–	51.9	–	–	–
Kettle N	Filter B	2	No	789	–	–	–	65.2	–	–	–
Kettle N	Filter B	Pooled	No	670	693	296	95.8	58.6	47.9	33.5	61.6
Kettle O	Filter B	1	No	1160	–	–	–	142	–	–	–
Kettle O	Filter B	2	No	1570	–	–	–	138	–	–	–
Kettle O	Filter B	Pooled	No	1365	1800	485	308	140	42.5	38.0	55.8
Kettle P	Filter B	1	No	1200	–	–	–	462	–	–	–
Kettle P	Filter B	2	No	1860	–	–	–	359	–	–	–
Kettle P	Filter B	Pooled	No	1530	3350	1840	872	411	41.5	39.5	37.2
Kettle Q	Filter B	1	No	0.57	–	–	–	0.80	–	–	–

Table C.9 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle Q	Filter B	2	No	0.34	–	–	–	0.76	–	–	–
Kettle Q	Filter B	Pooled	No	0.46	0.83	0.57	0.60	0.78	0.92	0.79	0.44
Kettle R	Filter B	1	No	0.45	–	–	–	0.75	–	–	–
Kettle R	Filter B	2	No	0.24	–	–	–	0.71	–	–	–
Kettle R	Filter B	Pooled	No	0.35	0.84	0.70	0.62	0.73	0.86	0.77	0.58
Kettle K	Filter C	1	No	2370	–	–	–	1530	–	–	–
Kettle K	Filter C	2	No	4010	–	–	–	1570	–	–	–
Kettle K	Filter C	Pooled	No	3190	4010	4200	2360	1550	72.0	48.5	44.0
Kettle L	Filter C	1	No	1850	–	–	–	1330	–	–	–
Kettle L	Filter C	2	No	3480	–	–	–	1630	–	–	–
Kettle L	Filter C	Pooled	No	2665	5580	3490	1790	1480	64.5	51.2	66.3
Kettle M	Filter C	1	No	2260	–	–	–	498	–	–	–
Kettle M	Filter C	2	No	3240	–	–	–	489	–	–	–
Kettle M	Filter C	Pooled	No	2750	4830	2730	1300	494	57.1	378.0	83.4
Kettle N	Filter C	1	No	3020	–	–	–	310	–	–	–
Kettle N	Filter C	2	No	4570	–	–	–	375	–	–	–
Kettle N	Filter C	Pooled	No	3795	5210	2370	870	343	53.5	51.3	46.0
Kettle O	Filter C	1	No	2200	–	–	–	506	–	–	–
Kettle O	Filter C	2	No	4270	–	–	–	411	–	–	–
Kettle O	Filter C	Pooled	No	3235	3570	1880	797	459	80.6	66.4	69.4
Kettle P	Filter C	1	No	1990	–	–	–	756	–	–	–
Kettle P	Filter C	2	No	3120	–	–	–	638	–	–	–

Table C.9 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle P	Filter C	Pooled	No	2555	3720	1860	980	697	52.7	40.0	38.5
Kettle Q	Filter C	1	No	1.09	–	–	–	0.93	–	–	–
Kettle Q	Filter C	2	No	0.58	–	–	–	0.84	–	–	–
Kettle Q	Filter C	Pooled	No	0.84	0.86	0.78	1.06	0.89	1.07	0.73	0.74
Kettle R	Filter C	1	No	1.32	–	–	–	0.78	–	–	–
Kettle R	Filter C	2	No	1.26	–	–	–	0.81	–	–	–
Kettle R	Filter C	Pooled	No	1.29	1.70	0.90	0.76	0.80	0.97	0.77	0.74
Kettle K	Water X	1	Yes	762	–	–	–	242	–	–	–
Kettle K	Water X	2	Yes	723	–	–	–	140	–	–	–
Kettle K	Water X	Pooled	Yes	743	374	249	182	191	98.2	66.3	61.4
Kettle K	Water X	1	No	732	–	–	–	247	–	–	–
Kettle K	Water X	2	No	697	–	–	–	127	–	–	–
Kettle K	Water X	Pooled	No	715	378	250	185	187	98.5	66.8	62.1
Kettle L	Water X	1	Yes	1670	–	–	–	490	–	–	–
Kettle L	Water X	2	Yes	2330	–	–	–	187	–	–	–
Kettle L	Water X	Pooled	Yes	2000	1350	655	457	339	191	111	73.8
Kettle L	Water X	1	No	1560	–	–	–	473	–	–	–
Kettle L	Water X	2	No	2260	–	–	–	171	–	–	–
Kettle L	Water X	Pooled	No	1910	1370	651	462	322	191	111	73.4
Kettle M	Water X	1	Yes	2150	–	–	–	466	–	–	–
Kettle M	Water X	2	Yes	1850	–	–	–	171	–	–	–
Kettle M	Water X	Pooled	Yes	2000	577	467	353	319	169	88.9	57.8

Table C.9 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle M	Water X	1	No	1970	–	–	–	449	–	–	–
Kettle M	Water X	2	No	1790	–	–	–	158	–	–	–
Kettle M	Water X	Pooled	No	1880	581	470	355	304	170	89.3	57.5
Kettle N	Water X	1	Yes	2160	–	–	–	347	–	–	–
Kettle N	Water X	2	Yes	1860	–	–	–	218	–	–	–
Kettle N	Water X	Pooled	Yes	2010	690	386	297	283	105	85.4	72.1
Kettle N	Water X	1	No	2100	–	–	–	327	–	–	–
Kettle N	Water X	2	No	1880	–	–	–	202	–	–	–
Kettle N	Water X	Pooled	No	1990	693	384	300	265	105	85.3	72.3
Kettle O	Water X	1	Yes	2450	–	–	–	301	–	–	–
Kettle O	Water X	2	Yes	2560	–	–	–	166	–	–	–
Kettle O	Water X	Pooled	Yes	2505	825	370	275	234	108	66.2	46.5
Kettle O	Water X	1	No	2290	–	–	–	294	–	–	–
Kettle O	Water X	2	No	2650	–	–	–	151	–	–	–
Kettle O	Water X	Pooled	No	2470	827	373	277	223	108	66.3	46.2
Kettle P	Water X	1	Yes	2160	–	–	–	311	–	–	–
Kettle P	Water X	2	Yes	2380	–	–	–	211	–	–	–
Kettle P	Water X	Pooled	Yes	2270	797	436	273	261	122	85.7	68.3
Kettle P	Water X	1	No	2250	–	–	–	304	–	–	–
Kettle P	Water X	2	No	1950	–	–	–	201	–	–	–
Kettle P	Water X	Pooled	No	2100	801	436	272	253	119	85.7	70.9
Kettle Q	Water X	1	Yes	1.25	–	–	–	2.05	–	–	–

Table C.9 Continued

		Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Kettle Q	Water X	2	Yes	1.07	–	–	–	1.91	–	–	–
Kettle Q	Water X	Pooled	Yes	1.16	1.31	1.23	1.26	1.98	1.39	1.53	1.13
Kettle Q	Water X	1	No	1.14	–	–	–	2.44	–	–	–
Kettle Q	Water X	2	No	1.08	–	–	–	2.27	–	–	–
Kettle Q	Water X	Pooled	No	1.11	1.44	1.17	1.17	2.36	1.44	1.51	1.07
Kettle R	Water X	1	Yes	2.52	–	–	–	1.74	–	–	–
Kettle R	Water X	2	Yes	2.23	–	–	–	1.91	–	–	–
Kettle R	Water X	Pooled	Yes	2.38	1.59	1.28	1.17	1.83	1.86	1.47	1.39
Kettle R	Water X	1	No	2.09	–	–	–	1.84	–	–	–
Kettle R	Water X	2	No	1.63	–	–	–	1.74	–	–	–
Kettle R	Water X	Pooled	No	1.86	1.34	1.02	1.07	1.79	1.55	1.47	1.24
Feed	Water X		No	2.14	1.45	1.57	1.10	2.47	2.86	1.62	1.40
Feed	Water X		Yes	1.78	1.40	1.19	1.25	2.37	2.41	1.58	1.52

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2

Table C.10 Results for samples taken immediately after boiling (Kettle K)

Determinand	Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Alkalinity mg/l $CaCO_3$	1	Yes	198	–	–	–	147	–	–	–
	2	Yes	191	–	–	–	144	–	–	–
	Pooled	Yes	195	182	175	175	146	155	156	136
	1	No	198	–	–	–	167	–	–	–
	2	No	196	–	–	–	165	–	–	–
	Pooled	No	197	184	179	183	166	162	160	139
Calcium mg/l Ca	1	Yes	81	–	–	–	66.2	–	–	–
	2	Yes	83	–	–	–	66.2	–	–	–
	Pooled	Yes	82	77	75	70.9	66.2	66.8	69.2	62.8
	1	No	99	–	–	–	82.5	–	–	–
	2	No	101	–	–	–	86.0	–	–	–
	Pooled	No	100	93	91	91.5	84.3	78.4	73.9	64.7
Iron µg/l Fe	1	Yes	<20	–	–	–	<20	–	–	–
	2	Yes	<20	–	–	–	<20	–	–	–
	Pooled	Yes	<20	<20	<20	<20	<20	–	–	–
	1	No	70	–	–	–	<20	–	–	–
	2	No	30	–	–	–	<20	–	–	–
	Pooled	No	50	40	<20	<20	<20	–	–	–

Table C.10 Continued

Determinand	Litre	0.45 µm	Day 1	2	3	4	5	12	19	26
Chromium µg/l Cr	1	Yes	<0.3	–	–	–	<0.3	–	–	–
	2	Yes	<0.3	–	–	–	<0.3	–	–	–
	Pooled	Yes	<0.3	<0.3	<0.3	<0.3	<0.3	–	–	–
	1	No	0.40	–	–	–	<0.3	–	–	–
	2	No	0.40	–	–	–	<0.3	–	–	–
	Pooled	No	0	0	<0.3	<0.3	<0.3	–	–	–
Chromium(VI) µg/l Cr	1	Yes	<0.06	–	–	–	0.07	–	–	–
	2	Yes	<0.06	–	–	–	<0.06	–	–	–
	Pooled	Yes	<0.06	0.08	<0.06	0.08	0.07	–	–	–
	1	No	0.21	–	–	–	0.06	–	–	–
	2	No	0.07	–	–	–	0.08	–	–	–
	Pooled	No	0.14	0.08	<0.06	0.08	0.07	–	–	–
Nickel µg/l Ni	1	Yes	215	–	–	–	125	–	–	–
	2	Yes	67.8	–	–	–	36.8	–	–	–
	Pooled	Yes	141	95.8	95.6	83.3	80.9	61.7	44.5	48.0
	1	No	109	–	–	–	126	–	–	–
	2	No	49.2	–	–	–	25.3	–	–	–
	Pooled	No	79.1	102	98.4	83.0	75.7	61.8	44.6	48.0

NOTE: For sample days 1 and 5, Pooled result calculated as the mean of litres 1 and 2

Table C.11 Nickel leaching (µg/l Ni) in hard and soft water

Water	Kettle	Day 1	2	3	4
Hard	Kettle K	715	378	250	185
Soft	Kettle K	24.7	8.96	6.68	3.97
Hard	Kettle L	1910	1370	651	462
Soft	Kettle L	4.96	2.33	1.71	1.26
Hard	Kettle M	1880	581	470	355
Soft	Kettle M	3.76	1.87	1.58	1.10
Hard	Kettle N	1990	693	384	300
Soft	Kettle N	5.76	2.54	1.82	1.07
Hard	Kettle O	2470	827	373	277
Soft	Kettle O	7.88	2.89	2.25	1.39
Hard	Kettle P	2100	801	436	272
Soft	Kettle P	6.68	1.82	1.39	0.94
Hard	Kettle Q	1.11	1.44	1.17	1.17
Soft	Kettle Q	0.49	0.55	0.47	0.38
Hard	Kettle R	1.86	1.34	1.02	1.07
Soft	Kettle R	0.59	0.46	0.42	0.38

NOTE: Data for pooled samples, not 0.45 µm filtered

APPENDIX D – LITERATURE REVIEW – NICKEL LEACHING FROM ELECTRIC KETTLES

INTRODUCTION

Although nickel is not particularly toxic, it can cause contact dermatitis in some people. The allergic reaction can also occur *via* ingestion of foodstuffs containing nickel for those who are very sensitive. There is, therefore, some concern about the leaching of nickel from cookware. Because of the widespread use of kettles there has been interest in them as a possible significant source of nickel in the diet.

Stainless steel is the most common nickel-containing food contact material. It is used in a wide variety of utensils, as kitchen work surfaces and in kitchen appliances such as electric kettles. Stainless steel for contact with food is generally made up of around 8 to 10% nickel (Kuliogowski and Halperin, 1992). Although most nickel in contact with food is in the form of stainless steel, some utensils and kettle elements are nickel-plated. This review concentrates on leaching from electric kettle elements.

STUDIES OF NICKEL LEACHING

Most studies into nickel leaching have concentrated on stainless steel saucepans (Kuligowski and Halperin, 1992; Accominottis *et al.*, 1998; Christensen and Möller, 1978). Accominottis *et a.l* (1998) and Kuligowski and Halperin (1992) measured the concentration of nickel in acidic foodstuffs in a variety of saucepans. The main conclusions drawn were that more acidic foods caused greater nickel leaching in stainless steel pans. Although, not directly related to the main concern of this review (kettles) the findings of Flint and Packerisay (1997) seem relevant. The first boiling in stainless steel pans always contained greater amounts of nickel than subsequent boilings (water containing potatoes). They also found that variability between repetitions was quite high. It was concluded that the finishing of the pans was the probable cause of the variability. Electro-polished pans released the least nickel. It seems likely that a higher initial concentration of nickel leaching would occur with stainless steel or nickel-plated kettle elements.

Christensen and Möller (1978) compared the leaching of nickel from six stainless steel, two aluminium coated with PTFE and two aluminium saucepans using water with a range of pH values. Although these results are more relevant to leaching from kettles, with only water being used, the pH values tested were outside of the range allowable for drinking water in the UK (pH 5.5 to 9.5). Water (600 ml) was boiled in each pan until around 25 to 30 ml remained, this was then analysed for nickel. They found that the more acidic waters tested (pH 3.0, 3.2 and 3.5) caused appreciable levels of nickel leaching from the stainless steel saucepans (4 to 7 μg), but not from the other saucepan types.

Rasmussen (1983), quoted by Smart and Sherlock (1987) in their review of nickel in foods and the diet, found nickel release to be very high from the one electric kettle tested. The study looked at leaching of metals from a number of food contact materials. The electric kettle had water boiled in it three times for thirty minutes which produced water with up 36 mg/l nickel.

KETTLE LEACHING STUDIES

There appear to be only a few studies related to kettles, one undertaken in Denmark and another by the Nickel Development Institute (NiDI). The Danish work by Berg *et al* (2000) (published paper, main report by Pederson, 1995). studied the release of nickel, chromium and lead from electric kettles and coffee machines and was carried out for a magazine similar to 'Which?'. Kettles were tested under conditions meant to represent regular household use. Twenty-six kettles sold on the Danish market were tested initially.

The six leachates per kettle were produced by boiling 500 ml of synthetic water (deionised water with 50 mg/l sodium chloride and 50 mg/l calcium carbonate), stabilised at pH 6.6) until the kettle automatically switched off. After cooling, 100 ml was acid preserved and sent for analysis by graphite furnace atomic absorption spectrometry. Descaling was carried out after 3 extractions.

The highest levels of nickel leaching occurred in kettles with nickel-plated or chromium-plated elements. Chromium-plated copper elements varied in their release of nickel. Two models by the same manufacturer leached high levels (154 μg/l and 110 μg/l), whilst the remaining five kettles showed low or no nickel leaching. The nickel was considered to have come from a layer of nickel that is often present under chromium-plating. The difference in leaching from such elements was thought to indicate differences in the manufacturing processes.

Most of the kettles with nickel-plated copper elements showed high nickel release. Two kettles from one manufacturer leached low levels prior to descaling (19 μg/l and 13 μg/l) and higher levels after (66 μg/l and 44). One of the kettles with a stainless element also leached nickel at around 30 μg/l. This was thought to be due to nickel being a component of stainless steel, with differences in manufacture being responsible for the lack of leaching from the other four kettles with stainless steel elements. Descaling of one gold-plated element led to nickel leaching, however this was found to be from a nickel-plated disc by the handle. The remaining elements with stainless steel, gold-plating or PTFE coated, gave very low or no nickel release.

The pattern shown by the study was that nickel leaching decreased during consecutive extractions. Descaling led to an immediate increase in nickel concentrations in those kettles leaching it, followed by the same scale of decrease shown prior to descaling. The study considered leaching of 50 μg/l nickel as the level of concern for human health issues. Ten of the kettles tested exceeded this level during testing. The manufacturers of these kettles agreed to make changes to their kettles to try to reduce nickel leaching.

The second part of the study involved looking at ten kettles two years later. Two of the ten, which had elements made up of nickel-plated copper and copper coated with a nickel-chromium alloy, failed the 50 µg/l level.

The NiDI work was undertaken after seeing the results of the Danish study and concentrated on looking at the two types of elements seen to leach nickel at significant levels. One part of the study involved testing two kettles with nickel-plated elements and one with a chromium-plated element. The nickel-plated kettles (NK) were boiled 413 times with 0.5 litres of fresh water per boiling. Samples were taken on specific boilings one minute after the kettles had automatically switched off. The chromium-plated kettle (CK) was subjected to a different routine with some water being reboiled. Descaling was performed after 305 boilings.

For all three kettles the initial release of nickel was high in the first boiling (63.7 µg/l and 130 µg/l for NK and 296 µg/l for CK). By the end of day one (after 8 boilings) the levels had dropped by 90-96% for all the kettles. Where kettles were left overnight either empty or with water the general pattern was that there was an increase in nickel leaching for the first boiling. This pattern was followed even up to 305 boilings (just before the descaling). For example one of the NK kettles was shown to leach 6.2 µg/l on the last boil of day one, and then 49.2 µg/l on the first boil of the following day after being left empty overnight. The same kettle leached <5 µg/l at the end of the day coinciding with 300 boilings. After being left empty overnight the first boiling of the day contained 31.4 µg/l nickel.

At intervals, water was left overnight in the CK kettle then analysed. High levels were found in the water left overnight. After 18 boils 100 ml of water was taken for analysis (<5 µg/l nickel), with the remaining 400 ml being left in the kettle overnight (212 µg/l nickel). This pattern continued when the same sampling was undertaken at 81 boilings (<5 µg/l in 100 ml, 124 µg/l after overnight in kettle).

The nickel concentrations did gradually drop over time up to descaling, even allowing for the increases seen after empty or water-filled kettles were left overnight. Prior to the descaling all three kettles were leaching <5 µg/l nickel. The first boiling in the NK kettles after descaling contained 60.4 and 62.6 µg/l whilst the CK kettle leached 33 µg/l nickel.

The levels of nickel after descaling until the last of the 413 boilings fluctuated but tended to increase for the chromium-plated kettle. For the last 12 boilings the average nickel concentration in the leachates was 340 µg/l. It appears that descaling may have damaged the chromium-plating allowing nickel leaching from the nickel-plated layer underneath. It is possible that the last few boilings had higher concentrations as more of the damaged plating eroded off.

For the two kettles with nickel-plated elements the values were higher after descaling, averaging about 40 µg/l nickel in the leachates. By the 400th boiling levels had dropped to around 8 µg/l nickel. However, both kettles leached very high levels of nickel when water from the 411th boiling was left overnight before analysis (1880 and 492 µg/l).

The second investigation involved testing kettles with four different element types: chromium-plated, nickel diffused; 316 stainless steel, alloy 800 and nickel-plated. All but the nickel-plated elements were tested with both hard and soft water for 71 boilings. The nickel-plated element was only tested in soft water.

Much lower levels of leaching were recorded in this section of the study. Values for all types of element in hard and soft water were generally <5 μg/l. The main exception to this was the nickel-plated element in soft water. The first leachate contained 304 μg/l nickel, dropping off to 24.3 μg/l by the eighth boiling.

The 800 alloy leached 52 μg/l nickel in the first boiling, dropped to 7 μg/l after the second boiling and remained at below 5 μg/l for the rest of the hard water test. The nickel-diffused element leached the most nickel over time out the kettles tested in hard water. An initial concentration of 16 μg/l was recorded with levels then dropping and averaging out at around 7 μg/l.

As with the previous test, occasionally water was left in the kettles overnight and then analysed. As with the last test higher levels of nickel were recorded after overnight leaching in both hard and soft water, typically rising from <5 μg/l to 17 μg/l in hard water and from <5 μg/l to 20 μg/l in soft water (excluding the nickel-plated element).

As with the previous test descaling was carried out (after 52 boilings). In soft water the chromium-plated element showed increased leaching, but only after water was left in the kettle overnight (38 μg/l). The nickel-diffused element had increased leaching in soft water, but only to levels similar to those found when water was left in the kettle overnight (around 15 μg/l). With soft water the nickel-plated element leached 165 μg/l nickel in the first boil after descaling. It then dropped to 40, 32 and then 9 μg/l for the following boilings. After being left in the kettle overnight 251 μg/l nickel was found in the soft water leachate of the descaled kettle.

Nickel was determined by graphite furnace atomic absorption spectroscopy for both parts of the study. Repeatability and reproducibility were both tested and found to be satisfactory.

A third smaller study by Helmer (1998) looked at the release of nickel from eight pre-used kettles and one new kettle. Leachates contained >50 μg/l in one case, >20 μg/l in two cases and between 10 and 20 μg/l in two more of the kettles. Again, descaling led to an increase in nickel leaching at up to a factor of 50 (maximum concentration found 640 μg/l). The new kettle took 120 boils of water to get nickel to fall below the limit of detection (5 μg/l). After descaling, five boilings were needed to get nickel levels below 20 μg/l.

CONCLUSIONS

Nickel leaching from kettles seems to be most predominant from elements that are nickel-plated, followed by chromium-plated elements. The quantities released from such elements in new kettles and after descaling are at levels that may affect those people who are sensitive to nickel. Levels do decrease during kettle use due to the scaling of the elements and after any unreacted nickel is removed. Electric kettles with elements made of stainless steel and gold coated or PTFE coated elements do not seem to release quantities of nickel of any significance.