hydrophila isolates possess human virulence factors.

3. There is little overall similarity between diarrheal and water isolates. Water isolates that can infect humans are rare.
4. There are many species of *Aeromonas*. Based on isolates from cases of gastroenteritis, *A. hydrophila* is the only one associated with human disease. Even within the species *Hydrophila*, only a small percentage of isolates produce sufficient virulence factors to cause disease. Accordingly, laboratory tests for *Aeromonas* must not only be specific for the species but also the virulence factors.
5. *Aeromonas*, including *A. hydrophila*, are of low virulence. Animal studies show it requires large numbers of bacteria inoculated intraperitoneally to cause disease. Human feeding studies with ingestion of 10^8 cells have not produced disease.
6. No *Aeromonas* medium that has acceptable sensitivity, specificity, and reproducibility for the detection of *A. hydrophila* has been developed or used extensively for drinking water. There has not been widespread use or testing of media for this bacteria from drinking water.
7. *Aeromonas* isolates exhibit no exceptional resistance to chlorine disinfection at concentrations and exposure times typically found in public water systems.

Based on these observations, there is insufficient evidence that *A. hydrophila* can be considered an opportunistic pathogen when present in drinking water, and it would be inappropriate to consider monitoring or regulating this organism at this time.

4. Significance of HPC populations in drinking water

As mentioned previously, the number of HPC bacteria in drinking water varies widely. It depends on the quality of the source water, the types and efficacy of treatment, the type and concentration of disinfection residuals, the age and the condition of the storage and distribution system, the concentration of dissolved organics in the treated drinking water, the ambient temperature of the raw and finished water, the elapsed time between the water treatment plant and sampling locations, and, of course, the HPC method and time and temperature of incubation. These are just some examples of variables that have a profound effect on the enumeration of HPC bacteria. With all these of variables, it is obvious that the range of HPC populations in drinking water is considerable, i.e., <0.02 to 10^4 cfu/ml or higher.

While there is a lack of health-based justification for setting an upper HPC limit in drinking water, a number of countries have established mandatory limits for HPC bacteria in drinking water. As would be expected, different countries use a variety of terms to describe their respective bacterial count method, specify different analytical procedures (media, temperature, time) that can be used, and establish different maximum acceptable counts, which can range from 20 to 1000 cfu/ml. Some have argued that lower HPC bacterial populations in drinking water are more desirable than higher populations, but there is no epidemiological evidence that higher HPC populations have any public health significance. Typically, public water systems with conventional treatment are able to limit HPC bacterial populations to below 100 cfu/ml in the distribution system, although many systems experience increased HPC populations (500–1000 cfu/ml) during the summer months. Bottled water that has no disinfectant residual may have much higher HPC populations. While a maximum HPC population of 500 cfu/ml in drinking water is often cited as a health-based standard, this perception is fallacious and not based on fact. As reviewed below, there is no health-based substantiation for HPC regulations.

4.1. Origin of basis for establishing maximum HPC populations

The commonly used "level of concern", 500 cfu/ml, originated from studies that examined the effect of HPC populations on analytical recovery of total coliforms. It was never a health-based action level.

Possibly the first evidence that high HPC populations may interfere with the detection of coliforms by the multiple-tube-fermentation method (MTF) or the membrane-filtration method (MF) was suggested by McCabe et al. (1970). In reviewing the bacteriological results from a 1969 survey of 969 public water systems in the US, the authors stated: "While bacteria enumerated by plate count do not usually have a direct health significance, heavy growths of bacteria and other microorganisms do indicate the potential for contamination. Also, research findings (Geldreich, 1972) suggest that high plate counts inhibit the growth of coliform bacteria on laboratory media, thereby obscuring their presence". They further examined the question of interference specifically and reported that the 1969 survey data found the frequency of detecting total and fecal coliforms by the membrane-filtration method increased as the SPC levels increased to 500 cfu/ml, but decreased in frequency when SPC levels exceeded 1000 cfu/ml.

To further examine this interference phenomenon, Geldreich et al. (1978) collected 613 samples from 32 dead-end water main flushing sites in the Cincinnati, OH, distribution system. This study found 76 samples contained coliforms by the MTF procedure, but only 19 by the MF procedure. Data analysis demonstrated a correlation between excess SPC densities and desensitization of the MF method when SPC bacteria exceeded 500 cfu/ml. Other researchers (Clark, 1980; Herson and Victoreen, 1980; Means and Olson, 1981; Seidler et al., 1981; Burlingame et al., 1984; Franzblau et al., 1984) have also reported method desensitization or coliform antagonism by HPC bacteria clustering in the 500–1000 cfu/ml range. These investigations demonstrated that high SPC (HPC) densities can substantially interfere with both the MTF method and especially the MF method, but that this phenomenon may not occur consistently.

One of the co-authors of the 1978 report is also a co-author here. From the original analytical data demonstrating interferences by HPC on the recovery of coliforms, to 25 years later, the following have been demonstrated:

1. There is no EPA, FDA, or WHO health-based HPC regulation.
2. HPC concentrations are mentioned only twice in EPA regulations: first, as a cause of false-negative coliform tests in which lactose-based media (i.e., MTF and MF) are employed and second, as a surrogate for chlorine residuals in distribution systems.
3. Suppression of coliform recovery only occurs with lactose-based media formulations. Defined Substrate Technology methods (e.g., Colilert®, Colisure®) do not suffer from HPC suppression.

4.2. Significance and impact of HPC bacteria on coliform detection methodology

The ramifications of HPC populations greater than 500 cfu/ml in drinking water are significant because they desensitize membrane-based coliform methods that contain lactose. Given that routine analysis of drinking water for coliforms and *Escherichia coli* is the most common and the most important determination as to the microbiological safety of drinking water, desensitization by HPC bacteria may have grave public health consequences. For this reason, it is imperative that HPC analysis be performed in parallel with each MF coliform/*E.coli* determination. This quality assurance approach ensures that coliform/*E. coli* data, especially negative results, accurately reflect the true microbiological quality of drinking water.

In the late 1980s, the development of the Defined Substrate Technology (Edberg et al., 1988) for the simultaneous enumeration of coliforms and *E.coli* provided a method that was not subject to HPC interferences, resulting in greater confidence that negative coliform/*E.coli* drinking water samples correctly reflect their microbiological quality.

5. Uses of heterotrophic plate count measurements

While there is no validated clinical evidence that the consumption of drinking water containing high levels of HPC bacteria poses increased health risks, HPC measurements do have value as a tool to ensure drinking water quality. The purpose of water treatment is to provide a safe water supply through the use of unit processes that reduce turbidity, and chemical, and microbiological contaminants to desired levels. Beyond the water quality gains as a result of treatment, there remains the challenge of maintaining water quality during storage and distribution prior to reaching consumers.

According to Reasoner (1990), HPC is a useful tool for

1. monitoring the efficiency of the water treatment process, including disinfection;
2. obtaining supplemental information on HPC levels that may interfere with coliform detection

in water samples collected for regulatory compliance monitoring;
3. assessing changes in finished-water quality during distribution and storage and distribution system cleanliness;
4. assessing microbial growth on materials used in the construction of potable water treatment and distribution systems;
5. measuring bacterial regrowth or after growth potential in treated drinking water;
6. monitoring bacterial population changes following treatment modifications such as a change in the type of disinfectant used.

6. Summary

1. While the literature documents the universal occurrence of HPC bacteria or autochthonous flora in soil, food, air, and all types of water, there is insufficient clinical and epidemiological evidence to conclude that HPC bacteria in drinking water pose a health risk. For this reason, it is not possible to establish health-based standards for HPC bacteria in drinking water.
2. The various methods used to enumerate HPC bacteria differ significantly in the number and genera detected, and HPC data from different methods are not necessarily comparable.
3. HPC populations greater that 500–1000 cfu/ml in drinking water can interfere with coliform/*E. coli* analysis by lactose-based methods, which include the membrane-filtration method.
4. *Klebsiella*, *Pseudomonas*, and *Aeromonas* cannot be considered opportunistic pathogens when found in drinking water, since there is no clinical or epidemiological evidence to support this designation.
5. HPC determinations can be a useful tool to the monitor efficacy of drinking water treatment processes and undesirable changes in bacterial water quality during storage and distribution, but not because of health-risk reasons.

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International Journal of Food Microbiology 92 (2004) 297–306

INTERNATIONAL JOURNAL OF Food Microbiology

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Heterotrophic plate count monitoring of treated drinking water in the UK: a useful operational tool☆

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Abstract

The count of general or heterotrophic bacterial populations in treated drinking water in the UK has been undertaken since the 1880s. Counts of heterotrophic bacteria at 22 and 37 °C are used widely as part of an overall assessment of treated drinking water quality. There were no legislated standards for water quality in the UK until adoption of the first EU Directive in 1989. The UK has, however, never stipulated numerical standards or guidelines for heterotrophic bacteria, although their enumeration has long been part of the assessment of 'wholesome' water, on which advice regarding microbiological quality was given in a series of documents known as 'Report 71'. The current regulations stipulate only that there should be 'no abnormal change' in numbers normally associated with a given supply. This paper reviews the historical context regarding the enumeration, and interpretation of results, of heterotrophic bacteria from treated drinking water, and information regarding current practices by UK water suppliers. The appropriateness of using heterotrophic bacteria counts as an operational tool or as a health parameter is briefly discussed in the light of the UK experience.

Keywords: Heterotrophic bacteria; Plate counts; Drinking water; UK standards

1. The use of heterotrophic plate counts in the UK (1885–2002)

In the summer of 1884, Percy Faraday Frankland visited the International Health Exhibition at South Kensington in London, and saw a demonstration of the technique for the cultivation of bacteria on solid nutrient gelatine medium that Robert Koch had been developing over the previous 5 years. A lengthy description of the method was also published in the *Lancet* (Hamlin, 1990). Frankland, who was a chemist by training and had an interest in the quality of water being supplied to London, appreciated that the technique could be applied to culturing and counting bacteria from untreated and treated water, and together with his wife, Grace, adapted the method. One millilitre of water was added to a molten mixture of gelatine and filtered meat broth and incubated at 18–22 °C (basically at room temperature) for a few days, counting colonies as they developed (Frankland and Frankland, 1894). At the beginning of 1885, Frankland started testing various waters supplied to London and, in the

☆ Presented at the NSF International/World Health Organisation Symposium on HPC Bacteria in Drinking Water, April 22–24, 2002, Geneva, Switzerland.

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0168-1605/$ - see front matter © 2003 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijfoodmicro.2003.08.006

process, inaugurated the first monthly systematic bacteriological examination of the supplies (Garner, 1948). The results of this testing were soon to be published by the then official 'Water Examiner' Colonel Francis Bolton. In mid-1885, Frankland also applied the technique to testing water before and after sand filtration, employed by some London water companies, recording reductions in numbers of bacteria of greater than 88%, and to testing the effectiveness of different filter materials (Frankland and Frankland, 1894). With this work, the counting of general bacterial populations (subsequently termed plate counts, then colony counts, and now heterotrophic plate counts (HPC)) in drinking water became firmly established as an important parameter for the assessment of water quality.

The use of plate counts became widely used and an incubation temperature of 18–22 °C became the norm with daily examination of plates for up to 5 days (Horrocks, 1901). Additional counts of bacteria after incubating a second set of plates for 40–48 h at 36–38 °C were recommended in 1904 (Royal Institute of Public Health, 1904), as these were considered more likely to represent those that could grow in the human body and, therefore, could be indicative of faecal contamination, although it was recognised that many other naturally occurring bacteria were also capable of growing at this temperature (Savage, 1906). During this time, counts at 18–22 or 20–22 °C were typically conducted using nutrient gelatine plates, and those at 37 °C using nutrient agar plates (Royal Institute of Public Health, 1904; Savage, 1906). Formal guidance on the bacteriological examination of water supplies and the interpretation of results was first published by the UK Ministry of Health in 1934 (Anon., 1934) as what was to become universally known as 'Report 71'. The recommended method involved dispensing of 1 ml aliquots of water, mixing with nutrient agar and incubation of one set of plates at 20–22 °C for 3 days and another set at 37 °C for 2 days, which, apart from a change of medium, has continued to today and is widely used throughout the world. The number of bacteria enumerated at 20–22 °C was said to give 'some indication of (1) the amount of food substance available for bacterial nutrition and (2) the amount of soil, dust and other extraneous material that had gained access to the water' whilst the count at 37 °C 'affords more information as to dangerous pollution' as 'the organisms developing at this temperature are chiefly those of soil, sewage, or intestinal origin, and their number, therefore, may be used as an index of the degree of purity of the water' (Anon., 1934). The Report also stated that the colony count of a single sample had comparatively little significance and that 'it is difficult to state limits which, if exceeded, involve unfavourable comment on the hygienic quality of the water'. The ratio of the count at 22 °C to that at 37 °C was said to be helpful in explaining sudden fluctuations, with high ratios being associated with bacteria of clean soil or water saprophyte origin and, therefore, of 'small significance' (Anon., 1934). This approach was reaffirmed in the second edition of 'Report 71', published 5 years later (Anon., 1939).

Experience gained over the next 17 years, however, led to a change of emphasis in the third edition (Anon., 1956; Society for Water Treatment and Examination, 1956) which stated that 'although plate counts at 22 °C and 37 °C reflect by an increase in the numbers, particularly at the higher temperature, the access of faecal pollution, they are not now usually employed for this purpose'. Their principal use was now one of a more general detection of 'any form of contamination', maintaining their role as indicators and not a health parameter in their own right. The Report presented a review of the agar plate count (written by E. Windle Taylor, then Director of Water Examination of the Metropolitan Water Board, London) which discussed the wide variability of numbers of bacteria from differing water types and sources and technical aspects of the method, concluding that 'high plate counts at either temperature, even if confirmed, do not necessarily indicate that a water is a danger to health'. They were, however, 'undesirable since the presence of large numbers of bacteria in water may cause food spoilage'. The key value of plate counts was their use in assessing the efficacy of water treatment processes, providing an 'estimate of the general hygienic quality of a water' (particularly with regard to food production) and that 'a rising plate count may give the earliest sign of pollution' (e.g. in wells) (Anon., 1956). This interpretation of the value of plate counts was reiterated in the fourth and fifth editions of 'Report 71' (Anon., 1969, 1982) which also stated that 'colony counts are not essential for assessing the safety of domestic water supplies'. The fourth edition also introduced yeast extract agar (YEA) as the medium of choice for the enumeration of colony counts, and confirmed an incubation time of only 24 h for counts at 37 °C, introduced in the 1956 third edition. The 1982 fifth edition also noted that 'organisms which grow best at 37 °C usually grow less readily in water and are more likely to have gained access from external sources' and that 'a sudden increase......would call for immediate investigation since it might be an early sign of more specific or serious pollution' (Anon., 1982). All reference to potentially indicating faecal contamination had been dropped.

Significant strides in the understanding of microbial behaviour, particularly with regard to heterotrophic bacterial populations, in water supplies during the 1980s and 1990s were reflected in the sixth edition of 'Report 71' published in 1994 (Standing Committee of Analysts, 1994). The three key areas where plate counts were of value, outlined in the 1956 third edition, remained, but multiplication of bacteria within distribution systems due to available nutrients (assimilable organic carbon) in the water or fixtures and fittings, and the growth of biofilms and their potential role in taste and odour problems were also recognised (interestingly a relationship between available nutrients and bacterial growth had been alluded to in the 1934 and 1939 editions of 'Report 71', but not since). The Report stated that 'in practice, changes in the pattern of colony counts of samples from a given water supply are usually more significant than the actual numerical count of any particular sample' and that 'the counts themselves have little direct health significance'. The Report recognised that some potentially opportunistic pathogens (e.g. *Pseudomonas aeruginosa* and *Aeromonas* sp.) may be part of the colony count population, and 'their appearance in large numbers in water indicates that conditions in the distribution system have become suitable for growth as opposed to survival of these organisms'. However, it concluded that without evidence of faecal contamination 'elevated colony counts should not be viewed with concern in terms of the health of the population as a whole'. Regular enumeration of colony counts from a distribution system did, however, provide useful data with which to assess any long-term trends in the general microbiological quality of drinking water.

This interpretation of the use of colony counts is retained in the seventh edition of the guidance (Standing Committee of Analysts, 2002a,b) prepared with regard to the new UK legislation (Anon., 2000) arising from the 1998 EU Directive (European Union, 1998). The guidance re-emphasises that 'it is not the absolute numbers of colony count bacteria enumerated from a supply that are of importance, but whether there are significant changes or long-term trends in those numbers'. Although the requirement to enumerate colony counts at 37 °C is no longer stipulated in the EU Directive, it has been retained in the UK legislation, and is still considered to be of some value 'in that it can provide an early indication of a significant deterioration in quality before coliform bacteria or other indicator bacteria are detected (for example, due to ingress into a distribution system)' (Standing Committee of Analysts, 2002a). Coliform bacteria are also no longer regarded as indicators of faecal contamination, but are of use as indicators of general microbial quality. This acknowledges that some coliform bacteria may be part of the natural bacterial flora in water and proliferate in biofilms. Coliforms are also considered useful for monitoring treatment processes and assessing the disinfection of new or repaired mains. This edition also re-introduced the option of incubating 37 °C plates for up to 48 h (Standing Committee of Analysts, 2002b), as had been the norm prior to 1956, and is also in agreement with the ISO standard ISO 6222:1999 (International Organisation for Standardization, 1999) stipulated by the 1998 EU Directive (European Union, 1998) as the method to be used. The lower 22 °C incubation range in the ISO standard is 22 ± 2 °C, which is a wider range than the 20–22 °C historically used in the UK and recommended by the UK guidance (Standing Committee of Analysts, 2002b).

The use of counts of heterotrophic bacteria has, therefore, a long history in the UK. The count at 22 °C has been used as a general indicator of water quality since 1885. The count at 37 °C was originally introduced with the belief that it could indicate potential faecal contamination, but this was soon disregarded, although it is still used for operational management in the UK, despite being dropped in the EU Directive.

2. Current use of heterotrophic plate counts in the UK

There are 35 public suppliers of water in the UK (Table 1), all of whom participated in a survey regarding the monitoring of HPC populations. The suppliers were asked for information regarding their HPC monitoring under the UK regulations and for nonregulated operational purposes (e.g. customer complaint and allied investigations, new mains and rehabilitation work acceptance).

2.1. Use of data from regulatory monitoring

The UK regulations (Anon., 2000) stipulate frequencies for analysis of plate counts from treatment works final waters, service reservoirs and water supply zones. These are as follows:

(a) Water treatment works—depending upon the size of works (in terms of volume supplied) these range from daily (large works) to weekly (small works),
(b) Service reservoirs—weekly,
(c) Water supply zones—depending upon the population served; these range from twice a week to monthly.

Reduced frequencies of analyses can be applied to water treatment works and water supply zones depending upon previous results.

The principal use of the data gathered from regulatory monitoring is to monitor trends or deterioration (in terms of rising counts) in quality. Many suppliers targeted trend monitoring with data from service reservoirs. Other uses of the data included:

(a) chlorine management,
(b) microbial populations modelling,
(c) treatment works performance assessment,
(d) assessment for planned maintenance of infrastructure (e.g. cleaning of service reservoirs), and
(e) secondary indicators of quality following isolation of coliforms or other primary indicators.

Many suppliers reviewed plate count data for a supply area whenever an unusual result was recorded. Most suppliers also had regular review periods, typically monthly, half yearly or annually, some undertaking reviews on both a regular basis and by an unusual result. Most suppliers undertake these reviews on an informal basis, but several have a formal program, some linked in with their Quality Assurance procedures (e.g. ISO 9002, International Organisation for Standardization, 1994).

2.2. Use of plate counts in operational monitoring

All bar two suppliers undertake plate count testing for various areas of operational monitoring (Table 2). Undertaking plate counts as part of a suite of analyses when responding to claims of ill health is the most widespread use, with most suppliers doing counts at both 37 and 22 °C, but a few only at 37 °C. The rationale is that plate counts may indicate a significant event within the distribution system, and not that HPC bacteria may be related to the ill health. Plate counts are also widely used when investigating complaints of off-tastes or odours, as changes in HPC populations may indicate proliferation of biofilms, which can be associated with microbially mediated generation of some organoleptic compounds (Standing Committee of Analysts, 1998). Operational plate counts are also commonly used as part of acceptance criteria for new mains prior to being put into supply, and in assessing water quality following mains rehabilitation work.

2.3. What is an 'abnormal change' in plate counts?

When the UK adopted the first European Directive on drinking water (European Union, 1980), the guideline values for plate counts (10/ml at 37 °C and 100/ml at 22 °C) were not formally included. Instead, the regulations stated that there should be 'no significant increase over that normally observed' (Anon., 1989a). Guidance from the regulators

Table 1
Number of public water suppliers in UK by legislative region

England	24
Wales	2
Scotland	3
Northern Ireland	1
Channel Isles	3
Isle of Man	1
Isles of Scilly	1
Total	35

Table 2
Use of plate counts for operational monitoring by 33 UK suppliers

Operational activity	Number of suppliers conducting plate counts at	
	37 °C	22 °C
Acceptance of new mains	23	21
Testing after rehabilitation work	23	20
Taste and odour investigations	26	25
Health complaint investigations	33	31
Biofilm investigations	14	15
Following repair of mains	8	5
Other investigations	9	8
Raw water monitoring	4	1

(Anon., 1989b) stated that 'continuous review is needed of colony counts' and further investigation should be taken if 'there is a sudden and unexpected increase in a colony count, particularly the 37 °C count, compared with that normally found' or 'there is a significant trend of increasing colony counts in the supply over a period of a few years'. Both the current EU Directive (European Union, 1998) and UK regulations (Anon., 2000) do not set numerical standards or guideline values for the colony counts, which are defined as indicator parameters, but state that there should be 'no abnormal change'. This is in keeping with the approach that colony counts are an operational tool for the management of water quality in distribution systems. It does, however, beg the question 'what is an abnormal change?'. There is, currently, no official guidance on this in the UK (or Europe) and, consequently, there are several approaches that have been adopted by the water suppliers (Table 3).

Many suppliers employ simple numerical values for an indication of an abnormal change in counts from regulatory samples, some based on the guideline values of the first EU Directive (European Union, 1980), whilst some have adopted higher values (Table 3). These values generally serve as triggers to review previous data and make an assessment of any significance of the increase. Several factors appertain to the use of these numerical values, such as type of source (pristine groundwater sourced supplies generally have lower values allocated than lowland river sourced supplies), seasonal variation and local knowledge of water quality behaviour in the supply area. In practice, since counts of heterotrophic bacteria in UK public water supplies are generally low, counts exceeding these limits would represent a marked rise in bacterial populations. Several suppliers, however, have established arbitrary levels of increase ranging from 0.5 to >2 log increases over previous results (Table 3). This has the advantage that it automatically takes into account the natural rise and fall in heterotrophic bacterial populations that occur during the seasons. A few suppliers have adopted a statistical approach (several others indicated that they were also investigating a statistical approach), based upon a comparison to mean counts. The time-base of the data for which mean counts are calculated can vary, depending upon the seasonal variation in the counts and the frequency of analysis, with some covering the previous few weeks and others a period of year or more. Generally, those that are derived for groundwater sourced supplies can be calculated from annual or more data as the counts tend to be more stable in the less biologically active water. When applied to more nutrient-rich surface water derived (and thus more variable) supplies, shorter data periods would tend to be used.

Table 3
Definitions of 'abnormal change' and operational limits for plate counts used by UK suppliers

Type of definition	37 °C	22 °C
Numerical limits for regulatory samples (cfu/ml)	>10, >20, >50, >100, >200, >300, >500	>50, >100, >300, >500
Numerical change in counts for regulatory samples	>0.5 log, >1 log, >2 log, >2.3 log	
Statistical change in counts for regulatory samples	(a) >3 standard deviation from previous six results	
	(b) 20 times 3-year mean	
	(c) >1.5 times 12-month rolling mean	
	(d) >98 percentile of rolling annual mean (22 °C)	
Numerical limits for operational samples (cfu/ml)	>10, >50, >100, >300, >500, >1000	>50, >100, >300, >500, >1000

2.4. Limits for plate counts for operational samples

Many UK suppliers have also established working limits for samples taken for operational reasons, whilst others have no limits, but rely on previous knowledge of the distribution system (basically a local risk assessment approach). For health complaint and similar samples, the 'abnormal change' criteria described above tend to be used. For other samples (e.g. new mains acceptance, repaired mains testing), arbitrary values have been adopted, some in formal procedures, often at a higher level than those applied to regulatory samples (Table 3).

3. Heterotrophic plate count bacteria in UK public water supplies

Counts of heterotrophic bacterial populations in UK water supplies are, thus, used as secondary indicators of general water quality. The counts obtained at 22 °C are taken to be representative of the bacterial dynamics within distribution systems, with increases indicating growth of biofilm or similar events. Sudden changes in the count at 37 °C are initially taken to indicate potential nonspecific intrusion into the distribution system, although rises are also associated with growth in river derived supplies during seasons when the water temperature rises. Typically, counts in UK public water supplies are low and elevated counts at either incubation temperature uncommon. For example, the data from regulatory monitoring for Severn Trent Water (the second largest supplier in the UK, supplying 7.4 million people) for the year 2000 shows that, out of 44174 samples from service reservoirs and customer taps, 95.4% of counts at 37 °C did not exceed 10/ml (the 1980 EU guideline value) and only 0.3% of samples had counts of 100 or more (Table 4). The higher counts were associated with periods of warm water temperature for some surface water derived supplies. Sixty-seven percent of Severn Trent Water's supplies are sourced from surface waters. For counts at 22 °C, 98.1% did not exceed 100/ml (the 1980 EU guideline value) (Table 4), with higher counts being primarily associated with some service reservoirs during periods of higher water temperature and low volume turnover, during which proliferation of biofilms and associated heterotrophic bacteria is enhanced.

Identification of bacteria enumerated in plate counts is not routinely undertaken in the UK and published information is limited. Anecdotal information from suppliers, when identifications have been undertaken, indicates that the same bacteria are encountered as those that have been reported from USA and European supplies (e.g. LeChevalier et al., 1980; Gambassini et al., 1990; Rusin et al., 1997). Typically, species of *Pseudomonas* and related genera (e.g. *Burkholderia* and *Sphingomonas*), *Flavobacterium*, *Acinetobacter*, *Chromobacterium* and *Bacillus* are cited as occurring. A study of a supply sourced from a eutrophic reservoir in the east of England (Gibbs and Hayes, 1989) identified five species from the *Pseudomonas* group, and strains of *Aeromonas*, *Alcaligenes* and *Bacillus*. It is not surprising that these same groups of bacteria are being recorded from distribution systems, as these represent those bacteria that grow well on standard media and are amenable to identification by the commonly used commercial miniaturised identification systems (e.g. the API 20NE or BBL Crystal E/NF systems). In an investigation in 1997 of two

Table 4
Levels of plate counts from regulatory monitoring of water in supply for Severn Trent Water during 2000

		Percent of results			
		= 0	= 1 – 10	= 11 – 100	= > 100
Service reservoirs	37 °C	81.5 %	14.5 %	3.7 %	0.3 %
n = 31,278	22 °C	67.2 %	22.3 %	8.1 %	2.4 %
Customer taps	37 °C	71.9 %	22.0 %	5.8 %	0.3 %
n = 12,896	22 °C	69.1 %	24.3 %	5.9 %	0.7 %
Total	37 °C	78.7 %	16.7 %	4.3 %	0.3 %
n = 44,174	22 °C	67.8 %	22.9 %	7.4 %	1.9 %

Shaded boxes are counts within the 1980 EU Directive guidelines (European Union, 1980).

Table 5
Species of heterotrophic bacteria identified from two surface water derived supplies in the Severn Trent Water region

Treatment works	Service reservoirs	Distribution system
Acinetobacter lwoffi	*Acinetobacter lwoffi*	*Agrobacterium sp.*
Aeromonas hydrophila	*Bacillus licheniformis*	*Bacillus brevis*
Bacillus brevis	*Bacillus subtilis*	*Bacillus licheniformis*
Bacillus licheniformis	*Flavimonas oryzihabitans*	*Burkholderia cepacia*
Bacillus subtilis	*Flavobacterium odoratum*[a]	*Corynebacterium* sp.
Corynebacterium sp.	*Flavobacterium* sp.[a]	*Flavobacterium indologenes*
Flavimonas oryzihabitans	*Xanthomonas maltophilia*	*Flavobacterium* sp.
Flavobacterium sp.		*Pseudomonas fluorescens*[a]
Pseudomonas sp.		*Pseudomonas* sp.[a]
		Vibrio sp.
		Xanthomonas sp.[a]

[a] Identification confirmed by ribotyping.

surface water derived supply areas by Severn Trent Water, isolates were identified by conventional biochemical testing and by ribotyping (Table 5). Again, species of *Bacillus*, *Flavobacterium*, *Pseudomonas* and *Pseudomonas*-related genera are the principal strains identified, with a greater range of identifiable species being recorded from samples taken from the distribution system customer taps compared to those from service reservoirs.

A more recent study conducted for the UK regulators (Drinking Water Inspectorate, 1998; Surman et al., 1998) attempted to characterise over 1000 isolates from 18 drinking water systems in England and Wales. Samples were taken from taps prior to flushing and disinfection of the tap (i.e. representing the standing water in the tap and immediate pipework) and after flushing and disinfection of the tap (i.e. representing water from the distribution network). As would be expected, counts from pre-flush samples were consistently higher than those from post-flush samples. Of 1127 isolates, 902 were Gram-stained, of which 376 (41.6%) were Gram-negative bacilli and 442 (49.0%) were Gram-positive cocci. One hundred and thirty-seven isolates of Gram-negative bacilli were identified using either API 20NE or BBL Crystal E/NF systems (Table 6). The identification of some isolates as *Listonella damsela* or *Shigella* sp. highlights the caution that needs to be taken with the identification of environmental bacteria with such systems. A much greater range of species, however, was identified from the pre-flush tap samples (26 species) than from the post-flush samples (17 species), probably reflecting the impact of external contamination and growth of natural and contaminating bacteria

Table 6
Tentative identification of plate count isolates from pre-flush and post-flush tap water samples from 18 supplies in England and Wales (modified from Drinking Water Inspectorate, 1998)

Identification	Frequency of identification		
	Pre-flush	Post-flush	Total
Acinetobacter lwoffii	7	1	8
Aeromonas salmonicida	3	4	7
Agrobacterium tumefaciens	1	0	1
Agrobacterium radiobacter	1	0	1
Chromobacterium violaceum	0	1	1
Chryseomonas luteola	0	1	1
Flavobacterium breve	3	0	3
Flavobacterium gleum	1	0	1
Flavobacterium indologenes	4	3	7
Flavobacterium meningosepticum	2	0	2
Flavobacterium odoratum	1	0	1
Listonella damsella[a]	29	17	46
Listonella sp.	0	1	1
Moraxella phenylpyruvica	1	0	1
Moraxella sp.	1	2	3
Neisseria cinerea	2	0	2
Ochrobactrum anthropi	3	0	3
Pasteurella sp.	1	3	4
Pseudomonas fluorescens	1	0	1
Pseudomonas putida	2	0	2
Pseudomonas stutzeri	3	2	5
Pseudomonas vesicularis	6	1	7
Shewanella putrefaciens	1	0	1
Shigella sp.[b]	0	1	1
Shingobacterium multivorum	6	1	7
Sphingomonas paucimobilis	1	1	2
Vibrio metschnikovii	0	1	1
Vibrio parahaemolyticus[c]	1	0	1
Weeksella virosa	4	4	8
Weeksella zoohelcum	3	2	5
Xanthomonas maltophilia	3	0	3
Total isolates identified	91	46	137

[a] As *Listonella damsella* is a marine bacterium, this identification is probably incorrect.
[b] Considering the nature of the supplies, this identification is suspect. The isolate died before the identity could be confirmed.
[c] *Vibrio parahaemolyticus* is a pathogenic marine bacterium associated with seafoods. If the identity is correct, the most likely source is contamination of the tap during food preparation.

in the standing water. In this study, isolates were also tested for potential virulence (cytotoxins and enterotoxins, adhesive and invasive factors, and haemolysins). Of 585 isolates tested for at least one virulence marker, 127 (21.7%) showed some toxin or haemolytic activity (Drinking Water Inspectorate, 1998). Ninety-five (16%) isolates exhibited a haemolysin, 21 (4.5% of 469 tested) were verotoxic and 4 (2.5% of 151 tested) were cytotoxic. Twelve isolates (2.6% of 469 tested) were invasive into Hep-2 cells. Very few isolates demonstrated more than one virulence factor. These results are in accordance with those of Edberg et al. (1997) who also reported a low incidence of cytotoxicity and virulence characteristics for HPC bacteria isolated on blood agar. These virulence markers were not associated with any particular species or phenotypic group of bacteria or recognised enteropathogenic species. It was concluded that if any of these bacteria could produce disease they would need to be present in drinking water in high numbers and that the frequency of isolation of heterotrophic species with the capability to cause gastroenteritis symptoms is too low to be of significant concern to health authorities or water companies (Drinking Water Inspectorate, 1998; Surman et al., 1998), concurring with the conclusions of Edberg et al. (1997).

4. Heterotrophic plate counts: a useful operational tool

From the preceding discussion, it can be seen that in the UK the use of plate counts for assessing water quality has a long history. From an operational perspective, these counts are useful for assessing trends in changes of water quality and some distribution management issues (e.g. biofilm development, stagnation and reduced chlorine levels). Populations of heterotrophic bacteria in treated water supplies are extremely heterogeneous, and population profiles will be dependent upon a number of factors including the nature of the source water, residence time in the system and disinfectant used. General heterotrophic bacteria populations are not considered to be of significant health concern (Drinking Water Inspectorate, 1998; Standing Committee of Analysts, 2002a), even though certain members may be opportunistic or potential pathogens. If it were considered that these bacteria merit investigation or control, then specific attention would be paid to them. The number of heterotrophic bacteria with putative virulence characteristics that have been isolated from treated water is very low, and does not represent a significant risk to public health (Edberg et al., 1997; Surman et al., 1998). The number of heterotrophic bacteria counted from UK drinking water is typically very low (a significant majority being <10/ml and very few being >100/ml), although occasional counts up to 10^3/ml can be encountered. These are markedly lower than counts of aerobic bacteria permitted in ready-to-eat foods where aerobic colony counts up to 10^7 cfu/g can be considered to be acceptable (Table 7) (PHLS Advisory Committee for Food and Dairy Products, 2000). In the UK, it is estimated that the average consumption of drinking water is 1.138 l/day (Drinking Water Inspectorate, 1996). The survey indicated that, on average, 81.5% of tap water consumed is drunk as tea, coffee or other hot drink. Assuming that consumption can, on average, be ascribed pro-rata, this gives a mean consumption of unboiled tap water

Table 7
Guidelines for aerobic colony count (30 °C/48 h) for various ready-to-eat foods (PHLS Advisory Committee for Food and Dairy Products, 2000)

Food category	Example foods	Count (cfu/g)		
		Satisfactory	Acceptable	Unsatisfactory
1	Pork pies, sausage roll, raw pickled fish, mousse	$<10^3$	10^3–$<10^4$	$\geq 10^4$
2	Ice cream, pizza, cakes and pastries (without dairy cream), mayonnaise, cooked vegetables	$<10^4$	10^4–$<10^5$	$>10^5$
3	Sliced beef and poultry, seafood meals, cakes and pastries (with dairy cream), dried fruit, coleslaw	$<10^5$	10^5–$<10^6$	$\geq 10^6$
4	Sliced ham, smoked fish, prepared mixed salads, sandwiches and filled rolls	$<10^6$	10^6–$<10^7$	$\geq 10^7$

of 18.5% or 210 ml. This is similar to the median value of 153 ml reported from the Netherlands (Teunis et al., 1997). Thus the contribution to ingestion of HPC bacteria from drinking water, even with exceptionally high counts (ca. 10^3/ml), is minimal compared to that potentially contributed from foods and other environmental sources. In this regard, setting of a numerical standard for general heterotrophic bacteria counts in public water supplies would not enhance public health protection.

In conclusion, the use of plate counts in the UK is seen as a useful tool in the management of the treatment and distribution of drinking water, but in themselves are not to be taken as indicators of direct health risk. Should specific members of this group of bacteria become of increased significance, if transmitted via the water supply, then specific standards or codes of practice for their control would be appropriate, rather than a general limitation of total heterotrophic bacteria numbers.

Acknowledgements

The author is very grateful to all the UK public water suppliers for participating in the HPC practices survey, and to David Drury (Drinking Water Inspectorate) and Alan Godfree (United Utilities Water) for useful discussions and comments on the manuscript. This paper is published with the permission of Severn Trent Water, but the views expressed are those of the author and are not necessarily those of Severn Trent Water, nor those of the suppliers who participated in the survey of UK practices.

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厚生労働科学研究費補助金（健康安全・危機管理対策総合研究事業）
Ⅱ．分担研究報告書

２．貯水槽水道における水の滞留の長期化や不適切な管理による水質悪化とその対策に関する研究（貯水槽水道の管理に関する自治体アンケート調査の結果について）

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研究要旨
調査は、東京都福祉保健局のご協力をいただき、東京都特別区所管の保健所２３か所、東京都福祉保健局所管の６保健所（うち、１保健所の４出張所）、市所管保健所２の合計３４の保健所の担当者を対象に貯水槽の水の滞留による水質悪化の問題に対する行政サイドの意識及び対応状況について、アンケート調査を行ったものである。

A　研究目的

保健所の担当者を対象に貯水槽の水の滞留による水質悪化の問題に対する行政サイドの意識及び対応状況について把握することを目的とする。

B　研究方法

東京都特別区所管の保健所２３か所、東京都福祉保健局所管の６保健所（うち、１保健所の４出張所）、市所管保健所２の合計３４の保健所の担当者を対象に貯水槽の水の滞留による水質悪化の問題に対する行政サイドの意識及び対応状況について、アンケート調査を行った。

（倫理面への配慮）特になし

C・D　研究結果・考察

１　アンケート実施時期

平成２３年１１月～１２月

２　実施方法

別紙アンケート表を東京都監視センターから、対象保健所に送付していただき、とりまとめを行っていただいたものである。

３　結果

（１）回答を得たのは、３４保健所中２６保健所で、回答率は、７６．５％であった。

（２）問い１は、「貯水槽の水の滞留による水質悪化の問題について実態を調査し、把握しているか」についてである。

①　この結果は、「調査し、把握している」が３５％（９保健所）で、「調査していない」が６２％（１６保健所）、回答なしが４％（１保健所）であった。新しい問題であるにもかかわらず、ある程度の期間が問題意識を持って対応していることが分かり、興味深い。

②　「調査している」と回答したところは、いずれも一斉検査時、

立ち入り検査時に「水の使用量調査」、「回転数」の把握を行っている。

③ 「調査していない」「回答なし」と回答したところでも、「ある程度は行っている」、「回転数の低い場合は指導している」、「苦情相談のあった場合は調査している」、「異常があれば調査している」等の自由記載があり、かなりの保健所で問題意識を持っていることがうかがえた。

（３） 問い２は、「何らかの指導をしているか」どうかの問いである。

① この結果は、「始めている」が５４％（１４保健所）、「始めていない」が４２％（１１保健所）「回答なし」が４％（１保健所）であった。半数を超える保健所が問題意識を持ち、何らかの指導を行っているとの結果となった。問い１の「実態を調査し、把握している」より大きな割合となっているが、全体の調査、把握に先行して、必要に応じ、個別に対応を行っていることが読み取れる。

② 「始めている」の回答した機関では、「適正な回転数になるよう要領の見直し」、「水位を下げての使用」、「水位制御装置の設置」、「必要に応じ、給水停止、清掃、水質検査の実施」、「有効容量を減少させる対策」、「直結給水化」等の指導が行われている。

③ 「始めていない」、「回答なし」の機関でも、個別的には、「適切な管理の指導」、「水位の調整」、「直結給水への移行」等の指導が行われている。

（４） 問い３では、「滞留による水質悪化に係る認識」、「どのように対処しようとしているのか」について尋ねている。

① その結果、水の滞留は、「残留塩素の減少につながり、問題がある」とする意見がある半面、「残留塩素があれば、とりあえずは問題ない」とする意見もある。又、「問題は認識しているが、効果的に対処する手段を見いだせていない」、「職員数の少なさに比べ、貯水槽の数が多い」との声もある。

E　結論

（１） 全体的に、行政サイドでの問題意識は高く、個別には、可能な限りの指導が行われていると評価できる。

（２） しかし、当面は、全体的に対処するのはむずかしいとの認識が多く、効果的な対処方法が見いだせていないのが現状と考えられる。

（３） 従って、適切で、簡易な指導方法が提起されれば、自治体での統一的な対応が行われる可能性が高い。

貯水槽水道の管理に関する自治体アンケートについて

特別区所管保健所　　23	回答16/23	69.6%
東京都福祉保健局所管保健所 ６保健所(内１保健所：4出張所)	回答　8/9	88.9%
市所管保健所　　　2	回答　2/2	100%
合計	26/34	76.5%

(問１)貯水槽(容量に関わらず)の水の滞留による水質悪化の問題について、保健所として実態を調査し、把握していますか。		
1　調査して、把握している	9(34.6%)	特別区所管保健所2、福祉保健局所管保健所6、市所管保健所1
2　調査していない	16(61.5%)	特別区所管保健所14、福祉保健局所管保健所1、市所管保健所1
回答なし	1(3.8%)	福祉保健局所管保健所1

1の回答について	特別区所管	特定建築物等の一斉検査時、貯水槽水道等の苦情対応等の際に貯水槽の回転数、給水末端栓での遊離残留塩素濃度の測定等 ※貯水槽を持つ施設の極々一部での実施ではあるが・・・
	特別区所管	建築物衛生法に基づく立入検査時、水の使用量の調査及び残留塩素の測定を行っている。また、専用水道施設については、毎月水の使用量及び残留塩素の測定結果について報告を受けている。簡易専用水道については登録検査機関の通報制度を継続している。小規模給水施設に関して、希望する施設に対する立入調査時に、残留塩素の測定を行っている。
	局所管	特定建築物では、立入検査時に残留塩素濃度を測定するとともに、貯水槽の水の回転数を毎回調査している。その他、簡易専用水道、特定小規模貯水槽水道等の立入検査時に、残留塩素濃度を測定し、残留塩素濃度が基準値を下回る場合等は、原因追求の中で、貯水槽内の水の回転数等を調査している。＊問2に同じ。
	局所管	特定建築物のみが対象となるが、使用水量を把握して、受水槽の回数を算出している。同時に残留塩素を測定し、簡易的ではあるが水質の状態を把握している。
	局所管	・水道法、都貯水槽条例に基づき、立入検査・調査を実施 ・貯水槽の外観・構造検査、貯水槽内部点検、設備管理状況 ・末端給水栓の簡易水質検査(臭気、味、色、濁度、色度、残留塩素) ・帳簿書類確認(清掃、定期点検、水質検査、外観検査、残留塩素測定)
	局所管	滞留水を目的としての体系だった調査は行っていないが、通常の立入検査や定期報告等により、概ねの状況は把握している。
	局所管	・水道法、東京都条例に基づく立入検査・立入調査を定期的に実施。 ・上記検査(調査)時に給水末端における残留塩素濃度測定等を実施。 ・上記検査(調査)時に貯水槽清掃記録、水質検査結果等を確認。
	局所管	ビル管や専用水道等の通常の立入検査時に把握
	市所管	特定建築物について、立入検査時に1日当たり使用水量から受水槽回転数を把握している。専用水道について、水道月報の月間使用水量から受水槽回転数を把握している。また、旅館・興行場等の環境衛生営業施設については、施設監視指導時に、残留塩素濃度等を確認し、濃度が著しく低い場合には原因究明し、滞留によるものの場合は指導を行っている。簡易専用水道については、水道法第32条の2の登録機関より、塩素未検出施設の通報があった場合に調査を実施している。また、貯水槽水道利用者からの水質悪化等の相談を受けた際にも調査を実施している。
2の回答について	特別区所管	積極的な調査は行っていないが苦情相談等で保健所に調査の要請があった場合は調査を行っている。調査内容は残留塩素の確認、使用水量及び受水槽の回転数の調査、末端での水の状況等である。
	特別区所管	相談等により個別事例については把握している。
	特別区所管	特定建築物の貯水槽については特定建築物立ち入り時に検査・指導を実施しており、実態を把握している。
	局所管	各施設の衛生管理については、各法令や都条例に基づき、立入検査(特定建築物、専用水道)の実施や報告書の提出(簡易専用水道、小規模貯水槽水道等)により、ある程度把握しています。ただし『滞留による水質悪化』という点に関しては、貯水槽の規模等により対応が異なります。立入検査を行う施設については、設備検査で実際に貯水槽の状況を確認するので、残留塩素濃度や回転数(滞留の有無)の確認も行い、回転数が低い場合には指導も行います。その他の施設については、貯水槽の回転数、残留塩素の状況は一切不明です。また水質悪化に関連する調査は特に行っていません。＊問2も同じ。
	市所管	個々の施設について、立入検査、苦情相談などで残留塩素低下等の異常があれば、当該施設の状況を調査する。
回答なしについて	局所管	統一的な調査は行っていないが、個別の立入検査等において、残留塩素濃度や貯水槽の回転数等を確認している。

(問2)この問題に関し、何らかの指導を始めておられますか。		
1　始めている	14(53.8%)	特別区所管保健所7、福祉保健局所管保健所6、市所管保健所1
2　始めていない	11(42.3%)	特別区所管保健所9、福祉保健局所管保健所1、市所管保健所1
回答なし	1(3.8%)	福祉保健局所管保健所1

1の回答について	特別区所管	貯水槽の回転数が適正な回転数になるよう容量の見直し等
	特別区所管	水の使用量低下により、残留塩素が低下している施設については、適切な容量への貯水槽の更新、水位を下げての使用、水位制御装置の設置、水をしばらく流してからの飲用開始、直結化等の助言を行っている。
	特別区所管	貯水槽水位の調整及び直結給水化を指導している。
	特別区所管	施設から貯水槽の水の停滞が原因と思われる相談時には『有効容量を減少させる対策を施す』等、助言・指導を行っている。また、検査機関からの通報に対して現場確認を行い、必要に応じた指導を行っている。
	特別区所管	区報やホームページで案内し、貯水槽経由の家庭の水を保健所窓口に持参してもらい、残留塩素、色度、濁度について簡易測定をし、結果に応じた指導、助言をしている。
	特別区所管	・新築物件について「目黒区建築物の衛生的環境確保に関する指導要綱」により設計時において貯水槽容量の適正化を指導及び直結化の推奨 ・既設のものについては貯水槽の水位を下げる(有効容量の適正化)等の対策により水の回転数をあげるよう指導。また、貯水槽を設けない
	特別区所管	特定建築物の立入検査の際に、滞留水による水質悪化について説明し、適切な管理を行うよう、注意指導している。
	局所管	残留塩素が基準値ぎりぎりの場合は、有効容量を減らす等の指導を行っている。
	局所管	・使用人数に対する一日の使用量を確認し、滞留による末端残留塩素の低下があれば、貯水容量を少なくするなどの指導助言を行っている。 ・学校などで未使用期間(夏休み等)がある場合には、使用直前の清掃実施などを助言している。
	局所管	簡易専用水道等の調査時に滞留水等、問題が認められた場合、個別に原因調査及び改善に向けた指導を行っている。
	局所管	・水の滞留による水質悪化の問題が生じていることが確認された場合は、状況に応じ、給水停止、貯水槽清掃、水質検査の実施等について施設所有者・管理者に指導・助言を行う。 ・根本的解決として貯水槽有効容量の変更や増圧直結等への切り替え等について助言を行う場合もある。
	局所管	問1で問題が明らかな場合、その都度指導
	市所管	特定建築物と専用水道については、施設設計時に図面の審査を行うので、その際に受水槽等が適正な容量等、適切な構造となるよう指導を行っている。また、立入検査等で、受水槽回転数の著しい低下や死水構造等が発見された場合は、改善指導を行っている。
2の回答について	特別区所管	全体的な指導は行っていないが、問1にあったような相談事例においては、受水槽の水位の調整など、水の停滞対策を指導している。
	特別区所管	相談等により個別事例について指導している。
回答なしについて	局所管	・相談があれば、直結給水方式への変更等を助言。 ・小規模貯水槽水道の衛生管理の普及啓発において、都水道局の直結給水関係リーフレットも使用している。

（問3）滞留による水質悪化について、どのような御認識をお持ちかお答えください。
また、今後、この問題にどのように対処しようとしておられるかについて、お答えください。

	特別区所管	貯水槽水の滞留が原因で残留塩素濃度が0．1ppmを下回る事例は少ないが、その場合、水位の調節あるいは直結水栓への切り替えや増圧ポンプにすることを助言している。小規模貯水槽にあっては、登録機関による検査の義務付けはないが、所有者、管理者（以下、所有者等）が設備の維持管理を含めた貯水槽全般の衛生管理の責任を負っている。従って、当所では所有者等に対し、貯水槽の衛生管理について啓発を続けている。
	特別区所管	認識：遊離残留塩素濃度の消失 対処：建物の使用水量による貯水槽容量の見直し等を指導
	特別区所管	依頼書にあったように、水の使用が減る理由として飲用しないことや節水があるが、そのほかにテナントの退出による使用水量の減や水道直結水の残留塩素の低濃度化から、末端で残留塩素が検出されないケースが生じていて、問題と考えている。
	特別区所管	貯水槽水道から直結給水及び増圧直結方式への転換が水槽の清掃を含めた衛生管理が容易であると考える。
	特別区所管	改築した学校で顕著化している。トイレ・散水は雨水、飲料は直結ウォウタークーラー使用。受水槽経由は、特別教室と教室内の流し、トイレの手洗いのみになっている。受水槽経由水の使用方法から、単位時間あたりの使用量に対応できる容量と、一日当たりの使用量に適した容量の乖離が出てきている。単純に回転数の低下であれば、ボールタップ等の調整での対応ができるが、時間あたりの給水能力と衛生確保の回転数の確保は不明。
	特別区所管	法に基づく貯水槽水道については、立入検査等により、指導しているため、問題は少ないといえる。しかしながら、小規模給水施設については、定期的な現況調査や、立入調査の実施とパネル展示等による維持管理の普及啓発を行っているが、設置数も多く、指導・助言が行き届かない場合が多々ある。今後も立入調査や普及啓発を実施していきたい。
	特別区所管	過去は貯水槽の水質について調査・指導を行ったことがありましたが、現在、水質悪化の報告が無い状態ですので、特に問題としてとらえておりません。
	特別区所管	貯水槽設置当初と比較して、利用者数の減少や節水意識向上の影響から使用量が減少している。既存の施設に対しても、状況に応じて給水設備の直結化を指導していく。
	特別区所管	増圧給水等タンクを持たない施設が増加し、滞留による水質悪化事例も減少すると思われる。今後は、災害対策用タンクなどの非日常的な管理についての指導が求められると考えられる
	特別区所管	最近は、飲料水を別途購入したり、節水型のトイレ、シャワーといった設備も普及してきたことにより、水道水の使用量が減少してきていることは認識しています。また、使用量の減少による受水槽の滞留問題も懸念してはおります。しかし、今後の対策については、現在のところ未検討です。
	特別区所管	貯水槽での水の滞留による問題は、残留塩素の減少・不検出であり、この問題はしばしば発生している。実際の現場では、単に貯水槽の回転数のみでは判断できず、水の残留塩素の頻繁なモニタリグが重要である。「停滞による水質悪化」が、「残留塩素の減少・不検出」を意味するものであるならば、ビル管理立入り検査や専用水道報告、簡易専用水道法定検査にともなう通報等で機会を捉えて指導を行っている。
	特別区所管	問題は認識しているが、効果的に対処する手段を見いだせていない。
	特別区所管	貯水槽内の残留塩素が消失してしまえば、藻の発生や何らかの過程にて混入する細菌による汚染等に対応できないと考えられる。しかしながら、防火や防災等を理由に有効容量の減少に踏み切れない施設もあった。本問題に対しては今後とも衛生の観点から適切に指導してまいりたい。
	特別区所管	貯水槽水の滞留による水質悪化があることをまず広く区民に普及啓発していき、水が滞留しない工夫についてアドバイスをしていきたい。
	特別区所管	新築物件については直結化や貯水槽の低容量化が浸透してきたようである。既存の貯水槽には、古い地下式の過大なものや居住者構成・テナント減少等により水の使用量が減少したもの等、改善を要するものがあるが、高額な経費を理由に対策をとらないことが多い。貯水槽水道の維持管理の重要性を設置者・管理者に認識してもらい、適切な維持管理や改善をしてもらうことが重要である。今後も貯水槽水道設備の維持管理に必要な知識の普及とともに貯水槽を設けない給水方式への転換に関する普及啓発を推進していく。（具体的には「問2の答」のとおり）
	特別区所管	容量の過大な水槽や、滞留を生じやすい構造の水槽については改善するよう指導していきたい。

	局所管	滞留があったとしても、末端での残留塩素が確保されていれば、とりあえずは問題ないと考えています。また滞留の確認より、毎日毎月の貯水槽の点検を適正に行っていれば、そうそう大きな事故につながるような状況は起こらないと考えています。点検の不備に加えて、滞留、残塩も出ないような場合は、やはり指導の必要はありますが、管理者の意識や技術力の度合いのほうが重要だと思います。専用水道（専用水道では水道技術管理者の選任が義務付けられている）のような施設はともかく、ご年配の方がマンション貯水槽の管理をなさっているようなところでは『回転数』や『残留塩素』などの説明をしても、ほとんど話が通じません。『水道の衛生』に対する設置者・管理者の意識や技術を高めるほうが先決なのではないでしょうか。 **その他** 保健所としては、今のところ簡易専用水道や小規模貯水槽水道等の『滞留による水質悪化』の調査は考えていません。理由としては、まず職員数の少なさに比べ貯水槽の数が多いこと。もちろん住民の方から苦情等の相談があれば、状況確認、場合によっては改善の指導等は行っていますが、管内全施設についての調査を行うのは物理的に難しいです。加えて管内の事故例では、設備の管理不備（例えば、マンホールのふたが外れていた、防虫網が破れたままになっていた等）などが汚染の主な理由で、貯水槽水の滞留ために残留塩素が低下し、事故につながった例も記憶になく『滞留による水質悪化』を意識したことは、あまりなかったのが正直なところです。またマンション等の場合、セキュリティや個人情報の関係で、簡単に連絡を取ることや、中に入れてもらうことが難しく、手間や時間がかかり、あまり効率的に作業が行えません。また報告書の提出により、回転数等や残留塩素の状況を求める方法も考えられますが、上述のように専門の管理者が常にいるわけではありませんので、管理状況についての正確な情報を把握し報告してもらう事も難しいのではと思います。あまり積極的な意見ではなく、申しわけありませんが、今後、なんらかの調査等を行うということであれば、ご協力させていただきます。
	局所管	可能であれば、直結給水方式に変更するのが望ましい。又、事務所等では使用水量のうちトイレ洗浄等の雑用系での使用が多くを占めるので、飲用系統と雑用系統の給設備を分けるのが望ましい。建築設計に現在の水使用量の実態を反映できるようにするべき。ただ、震災時などの水確保の問題を考慮することも必要と思う。
	局所管	節水器具の普及や、飲用水はペットボトル水を使用する人の増加等で、HASSの単位給水量が実態に合わなくなっている。 東京都でも一人当たりの使用水量調査を行っているが、HASSの改訂が必要。
	局所管	過去に比べ使用水量が減少し、さらに水道局が残留塩素の低減化を推進している現状において、給水末端で残留塩素濃度を確保するのが困難な状況にある施設が現に存在するため、今後は増加傾向と思われる。このため、受水槽を設計する段階で過大な容量を防ぐことや、予算に余裕があれば増圧直結方式に変更するよう助言することが必要と思われる。
	局所管	・滞留による水質悪化は、日常管理や定期点検で早期発見につなげることができる。貯水槽設備管理者の衛生意識が必要である。 ・貯水槽での滞留のみが原因であれば、増圧直結給水方式への変更などが有効であるが、地域的や施設的な配管耐圧の問題、災害時の防災拠　点の場合の貯水槽撤去が出来ない場合などもある。
	局所管	特殊な場合を別にして、基本的には使用水量に見合った貯水槽容量となっていることが大事。そのため、各施設における使用水量の把握や日常管理の徹底が重要になる。殊に島では利用者の変動が大きい旅館等での対応が難しい。残留塩素の確保が困難な場合は水位調整の可能な設備や塩素注入設備の導入が望ましいものと思うが、なかなか対応できていない。こうした施設では貯水槽水を直接飲用に使用しないことを徹底することもひとつの方策か。
	局所管	・貯水槽容量の大小に係らず滞留が起これば水質悪化は起こりうる。という認識。 ・リスクのある施設については日常の管理（給水末端における残留塩素濃度の測定等）による水質の確認、水質異常の早期探知が大切と感じています。
	局所管	設計水量に比べて、実際の使用水量が少ないことや、水道水の残留塩素濃度が低く抑えられている（おいしい水作戦等）ため、過大な貯水槽で、残留塩素確保等衛生問題が生じていると考えられる。そこで、今後も使用者・設置者からの苦情相談に個別に対応していく。
	市所管	建設省告示第1597号以前の消防用水槽と共用の時代と比較して、劇的に改善されている。現在問題となっているのは、オフィスビル等の事業用建築物と認識している。オフィスビル等では、中水道の普及によるトイレ洗浄水の分離、ペット飲料やミネラルウォーターベンダーの普及により飲料水としての利用とそれに係る茶器の洗浄などの頻度が低下していることも原因と考えている。また、テナントビルや投資用マンション等で空室が増加していること、自社ビルであっても組織再編等により空フロア等が生じていることなどにより、使用水量が低下している場合もみられている。特定建築物の建築確認申請時など、設計者に対し社屋建替等で過去の実績があるときは実績に基づく容量計算をすること、テナントビル等であっても計算上最小の容量を採用すること等を指導している。また、学校、興行場など施設の使用状況や行事等により使用量が著しく増減する施設に対して電極棒による電磁弁制御等で水位の切替が容易に行える構造とすることなどについても助言している。また、専用水道では水道法により水道施設設計確認を行うため、施設設置者に対して、適切な構造設備となるよう指導している。
	市所管	東京都水道局が実施した「クリーンアップ貯水槽事業」では、水質異常のあった施設がほとんどなかったことから、新たな取組みの予定はない。これまでどおり、簡易専用水道検査機関や水道事業体と連携し、貯水槽の適正管理を進める。