TGN1 - MEDICAL SURVEILLANCE OF PERSONNEL

Introduction

To maintain safe water supplies, water undertakers must continue to be vigilant and take appropriate steps to minimise ways in which water supplies could become contaminated.

Following the outbreak of typhoid fever in Croydon in 1937, where the source of infection was identified as a typhoid-carrying operative working in a groundwater well, it is now a requirement that all personnel who carry out work in, on or around treated and partially treated drinking water (herein referred to as "restricted operations") be registered on an approved hygiene scheme and hold a valid water hygiene training card.

Good Practice

1. The training and assessment process for obtaining a water hygiene card requires personnel to declare whether they have ever suffered from any infection that may pose a risk to human health and that may be transmitted through water supplies. These infections include (but are not limited to) the enteric fevers typhoid and paratyphoid, hepatitis A and E, dysentery and verocytotoxin producing *E. coli* (VTEC). The assessment also requires personnel to declare whether they have a history of enteric fever, persistent diarrhoea, vomiting, jaundice or prolonged, unexplained fever.

2. Any personnel who declare such illness or history of illness should be referred for further specialised medical advice.

3. Known carriers of waterborne diseases must not be allowed to work on restricted operations.

4. It is the card holder's responsibility to report any vomiting, diarrhoea or fever (greater than 72 hours), jaundice or any other illness that may have a bearing on their suitability to work on restricted operations to their line manager immediately. All such personnel should be suspended from carrying out work on restricted operations until cleared to do so.

5. Personnel who have been off sick should be assessed to verify that they are fit to continue their restricted operations duties.

6. Line managers who receive any such reports should seek advice from their company medical advisor.

7. Clearance to return to work on restricted operations should depend on the approval of the medical advisor. All such actions should be appropriately documented.

8. Water undertakers should have procedures in place to ensure that all personnel carrying out restricted operations (including their contractors) comply with the requirements of the approved hygiene scheme.

TGN2 - DISTRIBUTION SYSTEM (NEW MAINS AND SERVICES)

Introduction

Designers, constructors, and operators of water networks should be alert to all the possible opportunities for contamination to enter supplies, and take all reasonable precautions to minimise the risk. They should equally avoid circumstances where water in the mains can deteriorate through stagnation or long contact with particular materials e.g. cement mortar pipe lining. The design and specification of the network can itself significantly reduce most of these risks.

Where distribution networks are designed and installed by self-lay organisations (SLO) water undertakers should ensure that these activities are carried out in accordance with the Code of Practice for the self-laying of water mains and services and relevant British Standards. SLOs should be members of the Water Industry Registration Scheme operated by Lloyds on behalf of Water UK and the Water Industry.

Good Practice

In developing their own policies or operating procedures, companies and SLOs should consider the following points:

1. As far as practicable, new mains should be designed to ensure adequate turnover. In particular, crossovers, "push-pull" mains or other intermittently used pipes should be avoided where possible, or at least be provided with appropriate washout facilities.

2. Networks should be designed to include all the features required for their subsequent commissioning (including sampling).

3. An assessment of the ground conditions in which the new main is to be laid should be carried out in order to identify any risks to water quality either during the laying or from permeation through the main following commissioning. For example, use of metal or barrier pipes should be used in brown-field sites where there is a risk of hydrocarbon contamination.

4. Chambers for hydrants and air valves should be sited in readily accessible locations, away from risk of spillage or surface water, and constructed as self-draining.

5. Laying new mains and services requires personnel to hold registration under an approved hygiene scheme and carry a valid water hygiene training card. Ideally, relevant personnel should have current certification to at least NVQ level 2 in Network Construction Operations.

6. Pipes and fittings should be transported and carefully stored on site, off the ground, to avoid entry of dirt or vermin. All pipes should be supplied with close-fitting end caps where feasible and these should remain in place until the pipe is laid. All pipes and fittings (and in particular plastic types) should be kept clear of fuel oils, and any materials so contaminated should be discarded.

7. All fittings and pipe ends should be free of any visible contamination and sprayed with a solution of 1000mg/l free available chlorine as they are laid.

8. Care should be taken to prevent water, subsoil or other material entering a pipeline under

construction. It should not be assumed that such material will be flushed out on commissioning. Additional cleaning measures (e.g.: swabbing) and inspection techniques (e.g.: CCTV) should be considered prior to commissioning on larger diameter mains.

9. Swabs may be useful for clearing a new main of any dirt or debris that has entered and the use of a chlorinated swab may be appropriate if any form of contamination is suspected. However, a chlorinated swab is only an intermediate measure and is not a substitute for disinfection.

10. After installation and before use, water mains should be flushed until visibly clear. They should be disinfected by charging with water containing sufficient free chlorine to ensure that a concentration of at least 20mg/L has been maintained throughout the entire pipe length over a period of standing for at least 16 hours. The time is important to ensure adequate dispersion and contact of the chlorine with the water and the entire internal surface of the main and fittings. The main should then be flushed and left charged for a minimum of 16 hours, and sampled at appropriate points, including the downstream end. The number and location of samples required should be sufficient to ensure the suitability for supply of the entire length of main.

11. Alternative disinfection methods can be considered that are equivalent to 20mg/L for 16 hours (for example, spraying the full internal length with a solution containing 1000 mg/L chlorine).

12. Chlorinated water should be discharged appropriately, including dechlorination where necessary (for example when discharging to surface water). Ref: TGN 14.

13. Samples from new mains should, as a minimum be checked for residual chlorine, taste & odour, coliform bacteria, *E. Coli*, and appearance / turbidity. Consideration should be given to including other parameters as appropriate.

14. Documentary evidence should be provided of satisfactory water quality results before the main is connected (by the water undertaker or its service partners) to the live network.

15. If the main is not brought into service within 14 days of a satisfactory sample having been taken, the main should be flushed with mains water and re-sampled. If contamination is suspected, the main should be re-chlorinated and sampling carried out as in 10 & 12 above.

16. All new service connections should be pressure tested and flushed with mains water before use. Service pipes above 50mm diameter require disinfection, although water quality samples will not normally be required. If the disinfected service pipe is not commissioned and brought into supply within 30 days of completing disinfection, the disinfection process should be repeated prior to commissioning if it is considered that deterioration of water quality may have occurred within this period.

TGN3 - DISTRIBUTION SYSTEM (REPAIRING MAINS)

Introduction

A burst or damaged main and the process of its repair are potential opportunities for contamination to enter the distribution system. A risk assessment should be carried out immediately prior to all repair activity; this should be dynamic and respond to any new developments during the repair process. Precautions are necessary to prevent contamination and minimise the risk to public health when responding to these circumstances and during subsequent repair work.

Good Practice

1. Repair activities on all water mains are restricted operations. All personnel undertaking repairs must be registered under an approved hygiene scheme and carry a valid water hygiene training card.

2. The risk of contamination is greatest when the main is depressurised, whether from the burst or damage itself, or during subsequent isolation for repair when contaminated water or other material can enter the main directly or from backflow through service pipe connections.

3. An on-site assessment should be performed in each case to establish whether there is a risk of contamination and if so its nature and severity. The risk assessment should take account of the possibility that the surrounding soil may be contaminated with chemical or biological materials (for example, petrol or sewage).

4. Where the main is leaking, but still under pressure, for example from a crack around the circumference of the main, a simple repair can be effected with a collar. The excavation should be drained below pipe level (at least 150mm below the invert of the pipe), and the water should remain under a positive, but if necessary reduced, pressure while the repair is made.

5. Where possible, the excavation should be made and pumped so that the water is below pipe level prior to the main being depressurised. For more serious bursts (where there is risk of flooding to properties, danger to the public or significant loss of downstream pressure) the main should be isolated as soon as possible at the nearest downstream valve first. Under these circumstances it is likely that a cut-out repair or pipe length replacement will be necessary.

6. Where the main has to be replaced or cut out for repair, the excavation should extend to a sump well to at least 150mm below the invert of the pipe. The water level should be kept below the bottom of the pipe throughout the repair process, when necessary by suitable pumping.

7. Fittings and pipes should be inspected prior to installation to ensure they are clean and free of defect. Replacement pipes and pieces of pipes together with all fittings and cut ends should be spray disinfected with a fresh solution of 1000mg/L of free available chlorine ensuring that all surfaces are covered.

8. After completing any repair on a depressurised main, including installations of new sections or components, the main should be flushed at the nearest downstream hydrant to remove any debris and excess chlorine. Where practicable, flushing should ideally

achieve three volume changes. Due consideration must be given to the potential for contamination of watercourses. Sufficient neutralising agent (e.g.: sodium thiosulphate) should be added to de-chlorinate the water where this is necessary.

9. Measurement of the downstream chlorine residual should be carried out in order to determine whether sufficient flushing of the repaired section has been completed and the residual has returned to background concentration.

10. Where depressurisation occurs during the repair, the precautions necessary prior to return-to-service should be documented. Where the repair requires a cut-out, but the risk assessment indicates no reason to suspect contamination and the appearance and smell of the water is satisfactory, a sample should be taken for chlorine residual, taste and odour properties, physicochemical and bacteriological analysis from the nearest available downstream hydrant or property. The main may be returned to service pending the results. In the event of a failing sample, the main should be re-sampled and additional samples taken in the adjacent distribution system. Further actions proportionate to the circumstances should be considered to protect public health including disinfection or the issuing of protective advice as necessary.

11. If it is known or suspected that groundwater or other material has entered the pipe, on completion of the repair the main should be flushed (and where necessary swabbed), disinfected and sampled. Dependant on the nature and extent of the contamination, the main may be returned to service prior to receipt of analytical results. Where the risk assessment suggests significant contamination may have occurred (e.g.: from sewerage) the main should remain out of service until results are known, or if it is critical to restore the supply immediately after repair precautionary advice (such as Boil Water Advice or Do Not Drink Advice) should be issued.

12. Where the on-site risk assessment has determined the necessity for disinfection of the isolated section of main this should be carried out with a minimum of 50mg/L of free available chlorine for 30 minutes (or equivalent method). Levels should be checked during this period to ensure that the concentration of chlorine is maintained throughout the process.

13. During this time all service connections should be closed. If this is not possible, steps should be taken to protect any customers who may be affected. After disinfection the main should be flushed as in 8 above.

14. Where “Thermopipe” is used as a repair material it should be treated as an epoxy or polyurethane spray lining. Disinfection by steam is not acceptable. For further information refer to the codes of practice for In-situ Lining of Water Mains.

15. Repairs requiring more than 3 pipe lengths or more than approximately 20 metres long should be disinfected as new mains.

16. The table below is designed to provide a summary of the operational requirements for various types of mains repair and circumstances.

Job	Risk Assess	Hand Spray Disinfect	Flush	Charge & Disinfect	Sample	Water Quality clearance required
Repair on pressurised main	√	√				
Repair on depressurised main (e.g.: cut-out repair or piece-up).	√	√	√		√	
Repair on depressurised main - risk of contamination*	√	√	√	√	√	√

*Note: This includes possible foul contamination for example due to the proximity of a damaged sewer.

TGN4 - DISTRIBUTION SYSTEM (RENOVATED MAINS)

Introduction

Due its intrusive nature, the process of mains renovation represents a potential opportunity for contamination to enter the system and therefore specific precautions are needed during such work to minimise these risks. However, this planned activity also usually requires the disruption of supplies to consumers, which in itself has potential public health implications. This work should therefore be carried out in such a manner as to minimise the period during which consumers are without water, whilst at the same time minimising risk to water quality during the process. Water undertakers should therefore continue to be vigilant and recognise all possible ways in which contamination could enter water supplies.

The spray lining of pipes with an approved polymer is a frequently used method for renovating pipes. Compliance with Information and Guidance Note (IGN 4-02-02): Code of practice for the *in-situ* resin lining of water mains and the associated Water Industry Standard (WIS 4-02-01): Operational Requirements: *In-situ* resin lining of water mains is a mandatory requirement for *in situ* lining. These documents are controlled and administered on behalf of the water industry by Water UK. This TGN also provides guidance on the hygienic use of coiled polyethylene pipes and liners.

Good Practice

In developing their own policies or operating procedures, companies and contractors should consider the following points:

General

1. Mains renovation is a restricted operation and as such all personnel involved should be medically assessed and be must be registered under an approved hygiene scheme and carry a valid water hygiene training card.

2. All fittings and pipe cut ends should be spray disinfected with a solution containing at least 1000mg/L of free available chlorine ensuring that all surfaces are coated. The pipe should be capped until connected.

3. Where pipes are being installed using a heat reversion process the heat generated can be considered to bring about *in situ* disinfection. However, all fittings and pipe cut ends should be spray disinfected with a solution containing at least 1000mg/L of free available chlorine.

4. All pipes and fittings should be stored, transported, installed and connected in ways which minimise the risk of contamination (e.g.: from groundwater or other materials) from entering them.

5. In cases where the newly installed or lined pipe may have become contaminated, the need for further disinfection and/or precautionary boil advice notices should be assessed in accordance with company practice. An individual risk assessment should be carried out on each such occasion to determine whether measures are required to protect public health and what these should be. Companies should have appropriate procedures to deal with instances of contamination when they occur to ensure that at no time are customers' water supplies at risk. Typically, these procedures should include isolation of properties from the contamination, communication with customers, communication with the appropriate regulatory bodies, methods of removing the contamination, methods for the

disinfection of all apparatus and an appropriate sampling regime.

6. Companies and their contractors should have appropriate procedures and method statements for the specific rehabilitation technique employed.

Spray Lining

1. Lining of mains with polyurethane (PU) should be carried out in accordance with the aforementioned WIS and IGN.

2. Lining work should be carried out with approved materials which should be applied in accordance with the manufacturer's instructions for use. It should only be applied by accredited contractors in accordance with specified conditions of approval.

3. Spray lined mains should be disinfected by either one of the following methods:
   a) disinfection by "fill and stand" – a free chlorine concentration of 50mg/L for a minimum of 30 minutes should be used. A significant reduction in chlorine concentration using this method over the contact period may indicate a dirty or otherwise contaminated pipe: or
   b) spray disinfection – a specially designed chlorine spray-lining unit designed to completely wet the entire internal surface of a relined main with 1000 mg/l should be used. The main should be left for a minimum of one hour before flushing.

The main may be returned to service following recharging and checks on residual chlorine concentration.

4. A sample should be taken following the return to service of each renovated section of main.

Coiled Polyethylene Pipes or Liners

1. Where coiled polyethylene pipes or liners are to be installed within an existing main, either close or loose fitting within the existing pipe or by insertion through pipe-bursting or created by directional drilling, one of the following disinfection procedures should be followed:
   a) pre-disinfected with free chlorine levels of 20mg/L for 16 hours (or equivalent), flushed and then recharged with mains water for a further 16 hours before sampling at appropriate points and written approval obtained before being brought into service. A significant reduction in chlorine concentration using this method over the contact period may indicate a dirty or otherwise contaminated pipe; or
   b) disinfection for a minimum of 50mg/L of free available chlorine for 30 minutes followed by flushing and sampling prior to being returned to service. A significant reduction in chlorine concentration using this method over the contact period may indicate a dirty or otherwise contaminated pipe; or
   c) use of factory sealed and pre-disinfected pipes (supplied with a manufacturers expiry date) with the seal remaining intact until the pipe is ready to be installed; or
   d) treated as a new main installation and disinfected accordingly (see Technical Guidance Note 2)

2. The risk of contamination during the installation of pre-disinfected coiled pipe (e.g.: loss of sealed cap through "pulling" main) should be assessed. Where the pipe is suspected to have become contaminated during installation, further cleaning and disinfection methods should be considered.

3. Factory-sealed coiled pipe should be installed within 6 months of the disinfection/sterilisation date. Where the 6 month period has been exceeded, the pipe should be re-chlorinated.

4. Where a pre-chlorinated coiled pipe has been cut or there is any doubt about the disinfection status of the pipe, or it is suspected that contamination has occurred, then the coil should be re-chlorinated.

TGN5 - DISTRIBUTION SYSTEM (ABANDONED MAINS AND CHANGED FUNCTION MAINS)

Introduction

Mains and connections which are no longer in service represent a significant risk to water quality if they are not fully decommissioned. Mains whose function is changed from carrying potable water to partially-treated or raw water also represent a potential risk to water quality if procedures for their correct identification and labelling on company GIS records are not accurately and promptly updated.

An abandoned main is a main that has been permanently decommissioned and is not required for further use.
A decommissioned main is a main that has been taken out of service either on a temporary but prolonged basis or pending abandonment.

Good Practice

Abandoned Mains

1. As soon as practicable after a main has been taken out of service for abandonment, all live connections should be physically separated from any abandoned pipework remaining *in situ*. A closed valve is not sufficient. Valves between live and abandoned mains should be removed where possible, but as a minimum they should be fitted with a blanking plate (and thrust block where necessary), buried in the closed position and the surface box removed.

2. Where abandonment of mains creates a potential for poor turnover the need for a washout facility should be considered at the end of the live main.

3. Valves and hydrants on abandoned mains should be buried and the surface box removed.

4. Abandoned or decommissioned fire-hydrants should have their marker plate removed and the Fire and Rescue Service notified.

5. Where a main is in service but a hydrant is no longer required, the hydrant (and any branch pipe) should be removed as close to the main as practicable or alternatively converted to a washout.

6. Abandoned service pipes have the potential to introduce contamination into live water mains due to backflow. They should be isolated by closing or removing the ferrule. A closed stop-tap is not a satisfactory long-term solution.

7. The details of all abandoned assets should be recorded promptly in company records and/or GIS.

8. Decommissioned mains should be clearly identified in company records and/or GIS. Procedures for their effective re-commissioning should be in place to prevent the inadvertent introduction of a decommissioned main without an appropriate risk assessment.

9. The abandonment of asbestos cement pipes requires additional consideration and should follow the Environment Agency protocol developed by the water industry with Defra and the Scottish Government. Records of the condition should be made available to anyone

proposing to work on the pipe and the disposal of any pipe must be treated as “hazardous Waste”.

Changed function mains

1. Mains whose function is changed from carrying potable water to non-potable water (i.e.: partially-treated, blended or raw water mains) should be clearly identified on company records and/or GIS.

2. Any services connected to such mains should be identified and transferred to a potable main prior to such change in function.

TGN6 - TEMPORARY (OVERLAND) MAINS AND SERVICES

Introduction

As part of a planned work activity, for example where water mains are being renovated or in an emergency situation, there may be a need to install a temporary overland supply. The use of temporary mains presents additional risks to the integrity of the water supply. Therefore, generally, the use of temporary mains should be only for short periods and where there is no other satisfactory means of supply. Water undertakers should have safeguards in place to satisfy themselves that risks from the use of temporary mains are adequately controlled.

Good practice

1. The installation, testing and connection of a temporary main is considered a restricted operation. All staff carrying out such work should be registered under the National Water Hygiene Scheme administered by Energy and Utility Skills and carry the card that provides evidence of registration and should be suitably trained to participate in that activity.

2. The size of the overland supply pipe should be appropriate for the number of customers to be supplied and modelling techniques may be used for this purpose.

3. If the temporary main is laid as part of a pre-planned activity, it should be disinfected, sampled and satisfactory results obtained before being commissioned.

4. Alternatively, prechlorinated lengths of polyethylene pipe may be used to maintain supplies providing they have been sampled and approved for use.

5. If electrofusion joints are used then the main should be treated as if the coil has not been disinfected and further disinfection carried out and samples taken to demonstrate it is suitable to put into use.

6. Temporary service connections (<50mm) do not normally require sampling provided appropriate flushing and/or disinfection has been carried out.

7. All joints and fittings should be disinfected with a fresh solution of 1000mg/L of free available chlorine.

8. Consideration should be given to ensuring that the main and services are suitably protected from physical damage. For example where crossing driveways, footpaths and roads, appropriate measures may include the use of sandbags, ramps and shallow buried sections.

9. The potential for contamination by oil, petrol or solvents should be assessed as these may quickly penetrate plastic pipes. If crossing contaminated land then suitably protected/barrier pipe should be used.

10. Suitable points should be installed to enable the temporary main(s) to be flushed (and if necessary sampled) prior to use.

11. Where temporary mains are required to be used for extended periods, regular checks should be carried out to confirm the integrity of the arrangements.

12. The main should then be connected, flushed and chlorine residuals checked to match normal distribution levels. Further clarity, taste and odour checks should be carried out at the downstream flushing point.

13. After connection, samples should be taken from downstream points for bacteriological indicator parameters. Scientific staff should risk assess an appropriate sampling regime required for the particular installation.

14. Chlorinated water should be discharged appropriately, including dechlorination where necessary (for example when discharging to surface water). Ref: TGN 14.

15. When in use the overland main should be regularly inspected to confirm its integrity and samples should be taken at a frequency determined by risk assessment.

16. In warm weather, consideration should be given to regular flushing to minimise the effects of rises in water temperature.

17. For certain operations, such as mains relining or online replacement, it may be necessary to redeploy bypass mains as the work proceeds. Should this be the case, pipe lengths should be securely capped on disassembly and fittings cleaned. Upon reassembly, and providing that a period of no more than 14 days has elapsed between the two operations, an assessment of the cleanliness of the pipes should be carried out and recorded. Bypass mains assessed as uncontaminated by the move should be disinfected with a 50 mg/l chlorine solution for a period of 30 minutes, flushed and sampled prior to being put into service. Bypass mains that have been out of service for longer than 14 days or where contamination may have occurred should be disinfected in accordance with a company's new mains procedure. In use monitoring procedure should be as detailed above

TGN7 - CATCHMENT PROTECTION

Introduction

Application of a multiple-barrier approach to water treatment recognises that the failure of one barrier might be compensated by the effective operation of the remaining barriers. This approach reduces the likelihood of contaminants passing through the entire treatment system and/or being present in sufficient concentrations to pose a potential risk to the health of consumers.

By minimising contamination of the source water through application of effective and appropriate catchment management measures, the challenge to treatment processes, and degree of treatment required can be reduced with a beneficial effect on water quality risk and operational costs. This follows the principle of "prevention is better than cure".

The Water Framework Directive (2000/60/EC) (WFD) came in to force in 2003. The primary objectives of the WFD directly concerned with catchment management are:

- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances and;
- ensure progressive reduction of groundwater pollution

Further, the introduction of the WFD brought about the need for increased analytical monitoring and a requirement to report raw water data to the DWI. This is enshrined in the Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations. These Regulations require water undertakers to carry out "source to tap" risk assessments of all the hazards in the catchment and where necessary to implement a sampling regime to monitor their potential impact on water supplies.

This TGN presents examples of potential hazards in the catchment and suggests strategies to help reduce or mitigate these. It does not provide comprehensive guidance on risk assessment methodology, nor does it identify all potential risks to surface and ground waters.

The following Good Practice guidance is provided:

Good Practice

In developing their own policies, codes of practice and operating procedures for the management of catchments, companies should consider the following points:-

1. It is important to understand the influence of the characteristics of a catchment on water quality and how this may vary temporally and spatially. Such changes may influence the requirements for treatment, its efficiency, efficacy and ultimately the potential of the final treated water to pose a potential risk to human health.

2. Where a number of water sources are available, there may be flexibility in the selection of water for treatment and supply. For example, it may be possible to avoid taking water from rivers and streams when water quality is poor (e.g., following heavy rainfall or a known contamination event) in order to reduce risk and prevent potential problems in subsequent treatment processes.

3. In addition to maintaining continuous availability of water for treatment, retention in raw water reservoirs can reduce the number of faecal microorganisms through settling and die-off either by senescence or predation and solar inactivation. If well designed, such

structures will also “peak lop” or buffer any fluctuations in raw water quality providing more consistent water for treatment.

4. Raw water quality may be influenced by both natural and human factors. Important natural factors include wildlife, climate, topography, geology and vegetation. Human factors include accidental or deliberate point source pollution, diffuse source pollution and the influence of animal husbandry practices. These factors can present significant microbiological and chemical hazards continuously or during a pollution event. Examples of risks and control measures are provided below (11-13).

5. It is recognised that not all catchments (in part or entirety) are owned by the water undertaker. Whilst catchment ownership clearly allows for more direct management of any potential hazards, third party ownership should not impede a responsible and prudent approach to catchment risk management.

6. Scenarios that could lead to water pollution should be identified and managed (either directly or via stakeholder management). Despite economic drivers and the need for increased development in catchments, introducing good practice in containment of hazards is often possible without substantially restricting activities or increasing cost.

7. Collaboration between stakeholders is a powerful tool to reduce pollution without reducing beneficial development. Where catchment management is beyond the direct control of the water undertaker, the planning and implementation of mitigation measures will require coordination with other agencies. These may include:
   - Land owners and their agents,
   - Local planning authorities,
   - The Environment Agency (and equivalents in Scotland and Northern Ireland),
   - Natural England (and equivalent in Wales, Scotland and Northern Ireland),
   - Highway authorities,
   - Agricultural umbrella organisations (e.g.: NFU)
   - Industrial and trade organisations

8. The multi-agency approach to the management of certain pesticides (e.g.: metaldehyde) is a good example of indirect catchment management.

9. Groundwater from deep and confined aquifers is usually of good microbiological quality, chemically stable and less easily influenced by direct contamination. However, shallow or unconfined aquifers can be subject to the same contamination risks as surface water as well as by gradual permeation of pollutants. The contamination of groundwater is at its greatest where the hazard occurs close to or within Source Protection Zone 1 as defined by the Environment Agency (a theoretical boundary where the transmission from surface to aquifer may be less than 50 days).

10. The disposal of all wastes produced on groundwater sites (e.g.: sewage) should be managed to prevent pollution of the source.

11. Specific control measures for the protection of the well / borehole head from contamination (e.g.: from local flooding) should be in place. Assessment of the physical integrity of the borehole casing and headworks structures should be carried out periodically.

12. Hazards and hazardous events that may have a deleterious impact on catchments, abstraction systems and raw water storage reservoirs include:
    - Municipal and industrial wastewater discharges;
    - Septic tanks and cess pits;
    - Chemical use in catchment areas (e.g., use of fertilizers and agricultural pesticides);
    - Major chemical spills (including relationship to public roads and transport routes), both accidental and deliberate;
    - Land use (e.g., agriculture, forestry, mining, waste disposal, industrial area) and changes thereof;
    - Active or closed mining or waste disposal sites / contaminated sites / hazardous wastes;
    - Human access (e.g., recreational activity);
    - Number, type and concentration of wildlife and livestock;
    - Inadequate buffer zones and vegetation, soil erosion and failure of sediment traps;
    - Storm water flows and discharges;
    - Geology (naturally occurring chemicals);
    - Unconfined and shallow aquifer (including groundwater under direct influence of surface water) especially those within a flood plain
    - Proliferation of algal and cyanobacterial blooms within, or stratification of, the raw water storage

13. Effective resource and source protection management measures may include the development and implementation of a catchment management plan. This is a useful method of identifying and recording control measures to protect raw water sources. This should consider:
    - The impact of climatic and seasonal variations (e.g.: heavy rainfall events, droughts, flooding).
    - Procedures to identify planning applications that may pose risks to source water quality.
    - Promotion and awareness in the community of the impact of human activity on water quality.

14. Control measures for effective protection of source water, catchments, raw water storage and abstractions systems include:
    - Implementation of a catchment management plan;
    - Control of wastewater effluents;
    - Regular inspections of catchments;
    - Appropriate location, security measures, and protection of intake;
    - Designated and restricted access to catchments, or areas of a catchment and where appropriate prevention of unauthorized access;
    - Management of human activities (including commercial and domestic developments) within catchment boundaries;
    - Management of animal husbandry practices and livestock populations within catchments and, where appropriate restricted access by animals;
    - Registration of chemicals used in catchments and, specific protective requirements (e.g.: containment) for chemical industry or fuel storage;
    - Control of storm water flows and where appropriate runoff interception;

- Use of available water storage during and after periods of heavy rainfall;
- Appropriate choice of off-take depth from reservoirs;
- Proper well construction, including casing, sealing and wellhead security.

TGN8 - WATER TREATMENT - DISINFECTION

Introduction

All drinking water must be disinfected prior to supply. 'Disinfection' is defined under the Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations as "*a process of water treatment to remove, or render harmless to human health every pathogenic micro-organism and pathogenic parasite that would otherwise be present in the water; and 'disinfected' shall be construed accordingly".*

This definition makes it clear that all microbiological hazards that may be present in the catchment (either intermittently or continuously) should be understood, taking into account their likely impact on the source water and variations brought about by environmental conditions. The treatment process(es) should be designed and operated to ensure the effective removal or inactivation of these organisms. Further, disinfection should be seen (where necessary) as a *series* of treatment processes whose *cumulative* effect results in a final water that is safe and pathogen free. It is important to recognise therefore, that the disinfection of many source waters does not merely refer to chlorination.

Water treatment processes should be matched and optimised to the quality characteristics of the water source(s) and they should be capable of producing adequately disinfected water for all the expected variations of raw water quality.

The Regulations do not specify the type of treatment process(es) required to achieve safe drinking water however, they do require water to have been pre-treated (where necessary) to ensure that it is adequately prepared for the final stage of disinfection (e.g.: chlorination or ultraviolet irradiation). Further, they specifically require that any of its properties (e.g.: pH) or substances (e.g.: ammonia) that are known to adversely affect disinfection have been modified accordingly and that water entering the final stage of disinfection has a turbidity of less than 1 Nephelometric turbidity unit (NTU).

The Regulations also require water undertakers and combined licensees to 'verify the effectiveness of disinfection'. Companies must be able to demonstrate how the disinfection process is designed for the microbiological challenges in the raw water and that the process(es) are operating within the design criteria. On its own, the absence of 'indicator bacteria' is insufficient evidence to show that water has been disinfected.

Finally, the Regulations require Companies to keep disinfection by-products "as low as possible" *without* compromising the effectiveness of disinfection.

Companies should have a written Disinfection Policy (supported by appropriate peer-reviewed scientific literature) to demonstrate that their disinfection processes (both removal and/or inactivation) are appropriately designed and operated to meet the microbiological and quality challenges present in the source water. The Drinking Water Inspectorate expects that such Disinfection Policies are approved by an appropriate Director of the company.

In addition to a company's Disinfection Policy, each water treatment works should have specific procedures that document how disinfection is achieved and ensure that the policy is effectively implemented. Such procedures should identify and document the critical control points for disinfection at each site.

Water treatment requires expert supervision and well-trained staff to ensure public health is not put at risk and that water quality standards are maintained. Operatives should have attained qualifications in

water treatment in accordance with the national Competent Operator Scheme (administered by EU Skills Ltd).

This TGN describes a range of good practice for ensuring water is adequately disinfected.

Good Practice

Physical Removal Processes

1. A risk assessment of the microbiological hazards likely to be present within the raw water should be carried out for each WTW.

2. Raw water monitoring for microbiological parameters should be carried out to assist the verification of the capability of the disinfection process. Processes should be in place to ensure that any significant changes in microbiological quality detected by such monitoring are acted upon.

3. Effectively managed solid/liquid separation processes may be necessary to remove pathogens which are resistant to chemical inactivation or ultraviolet irradiation.

4. Treatment processes should be operated within their process design criteria to achieve optimum performance. Specific and documented risk assessments should be carried out where processes are required to be operated outside of their 'design envelope'.

5. Many of the recommendations from the three expert group reports[1] on *Cryptosporidium* are still valid and Companies should satisfy themselves that their disinfection processes remain consistent with this guidance.

6. Coagulation, flocculation and clarification processes should be optimised with respect to turbidity and/or organic carbon removal and residual coagulant concentration. Coagulants, and where required, coagulant and/or flocculant aids should be used that are appropriate for the raw water quality and treatment process. Regular checks should be carried out to confirm process performance and optimisation.

7. Sand filters should be optimised in respect of turbidity removal. Filtration rates should be kept constant as far as practicable and maximum filtration rates, maximum filter flows and maximum rates of change should be determined. Backwashing should be optimised to prevent particle breakthrough.

8. Routine media depth checks should be made and recorded and be supported by procedures for media replacement and top-up.

9. Slow sand filters should have an appropriate cleaning regime, and should not be brought back into service without an adequate ripening period.

10. Turbidity should be monitored on-line at the critical stages in the water treatment process with appropriate alarms and shutdown systems as necessary.

11. The requirement for monitoring for Cryptosporidium should be determined by risk assessment.

12. Where granular activated carbon (GAC) is used, appropriate consideration should be

given to

- how the growth, accumulation and subsequent release of micro-organisms (and animalcules) from the media into the water stream may impact disinfection and
- the potential impact of returning adsorbers to service that may have become anoxic (and hence contain reducing compounds) during their outage.

13. Where membrane filtration processes are used as a primary disinfection barrier, appropriate monitoring of the integrity of the membranes should be in place. The performance characteristics of such membranes for removing organisms of a particular size should be documented and verifiable.

14. General water hygiene practices should be in place to prevent inadvertent contamination. Restricted operations areas should be identified and appropriate methods to prevent vermin access to such partially and fully treated water should be in place.

Chlorination Processes

1. Raw and partially treated water monitoring should be used to establish the likely microbiological challenge from those organisms intended to be inactivated by chlorination or UV) processes.

2. Where chlorination is used, the Ct required should achieve the required degree of inactivation under all operating ranges and conditions.

3. The hydraulic performance of tanks used for chlorination should be determined (for example by the use of tracer tests). Such tanks should preferably be designed and operated to achieve optimum “plug flow” conditions.

4. On-line chlorine residual monitoring (for free and/or total chlorine) should be carried out at critical control points to provide an on-going verification that Ct targets are being achieved. The requirement for multiple instrument monitoring (i.e.: dual or triple validation) should be assessed.

5. Alarms should be set to minimise the risk of inadequately disinfected water being supplied. Process loop times (i.e.: “dead-bands”) should be minimised.

6. Where practicable, automatic shut-down mechanisms should be installed to prevent inadequately disinfected water being supplied. Where such “failsafe” mechanisms are not practicable, companies should satisfy themselves that operator response times provide a sufficient margin of safety.

7. Consideration should be given to the need for on-line monitoring of pH, especially where this is liable to fluctuate sufficiently to affect the chlorination process.

8. Final water chlorine residuals should be set to balance the need to maintain a residual disinfectant concentration within the supply network with the potential for customer complaints and disinfection by-product formation.

9. Disinfection by-product control – reference should be made to the associated guidance document for the aforementioned Regulations e.g. “Guidance on implementing the Water Supply (Water Quality) Regulations in England and Wales ” .

Other Chemical Inactivation Processes

1. Ozone is not often used in the United Kingdom as a primary disinfectant due to a variety of factors including, control and monitoring issues, cost, health and safety and lack of a stable and persistent residual in treated water.

2. Despite these factors, numerous recent scientific studies on the efficacy of ozone as a disinfectant have shown it to be a powerful oxidant and effective against a wide-range of micro-organisms. Note, that for many organisms, these doses are higher than those required for pesticide removal.

3. Therefore, where ozone is used as a primary disinfectant (or is relied upon as part of the overall disinfection process), companies should have in place process validation, verification and control strategies similar to those applied for chlorination.

4. This approach should be used for any other disinfectant process deployed (e.g.: chlorine dioxide, chloramination, peroxide)

Ultraviolet (UV) Irradiation

1. In 2010, the Drinking Water Inspectorate issued 'Guidance on the use of Ultraviolet (UV) irradiation for the disinfection of public water supplies'. This document was reviewed and reissued in 2016. Companies who use, or wish to use, UV for this purpose should consult this detailed document.

TGN9 - TREATED WATER STORAGE

Introduction

Distribution systems often include treated water storage structures in the form of Service Reservoirs (SR) and Water Towers (WT) to balance variation in demand and provide storage. These strategic points in the network are often appropriate locations for the provision of secondary chlorination, or other chemical adjustment to the water.

Weekly monitoring of SRs and WTs, when in supply, for bacteriological indicators and chlorine residual is a requirement of Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations, hereinafter "the Regulations".

These structures are usually the last storage unit for potable water before it is distributed to consumers and are at additional risk as they are not pressurised and are a potential point for water quality deterioration, e.g. ingress, water age, malicious damage.

Appropriate design and operation of such structures are important factors for ensuring water quality is maintained.

Routine inspection and maintenance strategies are required to identify risks and necessary control measures to ensure that water quality does not deteriorate as it passes through these assets.

Contact tanks, clear water tanks, pump suction tanks and break pressure tanks are not classed as "service reservoirs" under the Regulations, however many of the following principles of Good Practice apply to all such treated water retaining structures and companies should ensure that appropriate operation and maintenance practices are applied.

Treated water storage tanks should be classified as restricted areas and all personnel involved in their inspection, cleaning and maintenance must hold valid a National Water Hygiene card (see Principles of Water Supply Hygiene Technical Guidance Note 1).

Good Practice

In developing their own policies, codes of practice or operating procedures for the management of treated water storage structures, companies should consider the following points:-

Security and Structural Integrity Issues

1. Structures should be designed:
    i. to prevent contamination through external ingress,
    ii. and managed to ensure that there is adequate turnover,
    iii. to allow access for cleaning,
    iv. to achieve a balance of hydraulic flow between compartments
    v. Structures must be designed, operated and maintained in accordance with the Reservoir Act 1975 and the Security and Emergency Measures (Water and Sewerage Undertakers) Direction 1998.

2. Facilities should be available to isolate the structure from service to allow continuation of supply e.g. bypass facilities, multiple compartments.

3. Overflow arrangements should be secured, designed and maintained to prevent introduction of contaminants and vermin (e.g. flap valves need to be maintained to

prevent sticking in the open position).

4. All materials used for construction, maintenance and repair (including membranes, sealants and associated apparatus which are likely to come into contact with treated potable water) must be approved under Regulation 31 of The Water Supply (Water Quality) Regulations 2016.

5. Access hatches should comply with the Water UK security specifications and be:
    i. kept to a minimum,
    ii. designed with concealed hinges,
    iii. designed to include devices to prevent contaminant ingress,
    iv. fitted with a watertight seal between the lid and supporting frame,
    v. self-venting,
    vi. installed with intruder alarms installed where necessary,
    vii. regularly inspected.

6. Vents screens should be constructed of corrosion resistant mesh designed and maintained to prevent access of insects and small mammals.

7. Redundant access hatches should be securely and permanently sealed.

8. Where secondary (booster) chlorination is considered necessary to maintain chlorine residual in the distribution system, dosing facilities should be flow proportional. Disinfection by-product risk should also be assessed.

9. Services including telemetry cables and sample pipes that may be a route for contamination should, as a minimum, be sealed with an appropriate elastomeric sealant to a depth that will prevent inadvertent raking out. Installing glanded entry plates inside reservoirs and tanks should be considered for all small bore entries such as cables and small bore pipes (e.g.:. sample lines).

10. Where structures are emptied to supply to enable inspection , care should be taken to prevent the mobilisation of any sediment entering the distribution system.

11. Prior to return to supply, arrangements must be made to ensure adequate disinfection and satisfactory water quality monitoring results are obtained.

12. On-site valves should be clearly marked with details recorded in site manuals and asset records.

Hydraulic Performance Issues

1. The retention time and hydraulic performance of treated water storage tanks can have a significant impact on water quality. Structures should be designed and operated to minimise the detrimental effects of water ageing. The following factors should be considered:
    i. Inlet and outlet pipes should be located, as far as is practicable, to minimise the creation of "dead spots" within tanks;
    ii. Common inlet/outlet pipes ("push/pull" systems) should be avoided as far as is practicable.
    iii. The operation of multiple-celled tanks should be optimised to prevent deterioration in one or more such tanks from hydraulic imbalances.

iv. Turbulent inflow improves mixing and prevents stratification leading to particle deposition.

Inspection, Maintenance and Cleaning Issues

The following Good Practice is provided in addition to any requirements that may be necessary under the Reservoirs Act 1975 and the Security and Emergency Measures (Water and Sewerage Undertakers) Direction 1998.

1. External and internal inspection of structures should be carried out at a frequency determined by individual risk assessment. Internal inspection should be carried out at a frequency not be greater than every 10 years.

2. Internal inspections should identify aspects which may impact on water quality, including a survey of internal surfaces and joints, a leakage drop test and roof integrity test. Remedial work should be carried out prior to return to supply.

3. Structures should be cleaned, disinfected and satisfactory sample results obtained prior to return to supply.

4. Sampling should routinely include analysis for bacteriological, physical and aesthetic parameters. Other parameters should be considered where additional contamination risks may have occurred during refurbishment and/or cleaning activities.

5. Where a structure is being filled or left standing during the return to service period, it must be configured such that flow out to the distribution system is prevented.

Sampling Issues

1. Sampling facilities should be installed to enable compliance with the water quality monitoring requirements of the Regulations.

2. Particular consideration should be given to achieving representative samples from multi-compartment structures and those with more than one outlet main.

TGN10 - EVENT AND INCIDENT MANAGEMENT

Introduction

Water undertakers should ensure that they have management procedures in place for the handling of events and incidents that have or have the potential to affect drinking water quality. The processes for responding to events and incidents have developed considerably through the capture of experience over the last 10 years. Management procedures should be established within a water safety plan framework and should not be restricted to those situations that may have a direct effect on human health. In general the term 'incident' is used for more serious events either because of the nature of water quality risk or its extent, for example the number of customers affected. In the context of this document, these are all referred to as 'events'. Differentiation should be made between microbiological contamination such as the detection of *E. coli* and chemical events such as a contamination due to hydrocarbons because there are distinctive factors to an effective response. The potential for malicious contamination should also be considered.

These procedures should be underpinned by a thorough understanding of supply systems and, wherever practical, by established and tested water resource contingency plans.

The Drinking Water Inspectorate has provided guidance on the type of event that they expect to be notified. By their nature all events and incidents are different to some degree or other. The following Good Practice is provided as guidance on general principles for the more common types of occurrence.

Good Practice

1. The building of relationships with health and local authorities through liaison meetings and regular contact is essential for effective communication during an event.

2. Up to date contact lists with health professionals and other stakeholder organisations must be maintained and should include arrangements for out of hours contact where appropriate.

3. Water undertakers should ensure that these key stakeholders have an understanding of the main public health risks identified from their Drinking Water Safety Plans and the control measures that are in place.

4. As part of liaison with Local Authorities and Health Protection Units it is advisable to establish the trigger values (or other escalation criteria) for certain chemical and microbiological monitoring parameters, customer contacts and other intelligence that would lead to declaration of an event/incident and notification being made. These could take the form of a value for a parameter, for example a particular pesticide, the presence of Cryptosporidium, or number of customer contacts for discoloured water received in a 24 hour period.

5. Water undertakers should have procedures in place detailing the investigative steps and actions required following exceedences of PCVs; these should include the sampling requirements in terms of locations and minimum numbers of samples, analysis required and reporting timescales for results.

6. Incident Management / Outbreak Control Plans, developed and agreed in consultation with local health authorities and environmental health professionals, should be in place and should be exercised periodically.

7. When circumstances require that precautionary advice is given to customers placing restrictions on water usage (unless this advice is to a single property according to a pre-established procedure) these must be issued after consultation with the relevant health and local authorities. The criteria for withdrawing any restrictions to water use must also be identified and agreed early in the event management process.

8. In general, precautionary advice can involve the following restrictions to water use:
    a. Boil Water for Drinking
    b. Do Not Drink Water
    c. Do Not Use Water.

9. All such advice to customers must be issued by the water undertaker who remains responsible for its implications and management throughout the incident. There should be clear criteria agreed at the outset when issuing such advice to customers regarding the lifting of such notices.

10. To ensure that all potentially affected customers are notified as quickly as practicable of any restrictions to water use, the following or equivalent arrangements should be available:
    a. Use of pre-prepared warning cards for each restriction, and where necessary standard letters for customers affected. Arrangements should be in place for rapid delivery of any warning cards and/or letters (e.g. walk plans for areas, arrangements with external contractors/Royal Mail). Delivery of warning cards should be capable of being achieved within 36 hours of the decision being taken to issue.
    b. Use of local media; press statements can be pre-prepared for each of the above restrictions, and locations affected added at the time of the event. Media announcements should be made where the delivery of warning notices cannot be achieved within the same working day. The issuing of joint press statements with other stakeholders should be considered and where Incident Management or Outbreak Control Teams are convened is strongly advised.
    c. Development of Question & Answer sheets for each of the above scenarios and ensuring that these are quickly made available to company call centres, scientific and operational teams.
    d. Use of company websites to display information relating to the event / incident.
    e. For smaller incidents, door-to-door notification, or use of loud-hailers on vans may be used in advance of the arrival of a warning card/letter.
    f. Consideration should be given where appropriate to provision of advisory information in languages other than English and in Braille.

11. In practice reliance should not be placed on any single method and consideration should be given to using a combination of the above to ensure that all customers are informed.

12. Lists of ‘vulnerable’ customers should be maintained and special care and attention provided to these during events. Customers receiving renal dialysis should be prioritised and local dialysis centres contacted. Liaison with local health authorities should establish what assistance would be necessary to ensure these customers are appropriately provided for.

13. Customers who are immuno-compromised are routinely advised to boil water for drinking and precautionary advice or provision of alternative supplies during a potential incident does not alter this position.

14. Special consideration should also be given to businesses, such as food manufacturers, in the affected area for whom water quality might be critical.

15. Liaison arrangements should also be in place with other organisations such as the Environment Agency, British Soft Drinks Association, European Point of Use Drinking Water Association and Chilled Food Association, along with neighbouring water companies with bulk import or export agreements. In some cases it may be appropriate to consider liaison with the Food Standards Agency. Reference should be made to the Water UK protocols agreed with some of these organisations for use in emergency situations.

16. Consideration should be given to the nature and extent of publicity at an early stage. In a multi-agency incident it is very important to ensure that press statements are made by joint agreement with health and local authorities (or other appropriate agency) to ensure that a consistent and reliable message is communicated.

17. The following general principles apply to the resolution of events
    - Have the criteria agreed at the outset for the withdrawal of advice notices to customers been satisfied? These decisions should be informed from an appropriate monitoring programme and should involve wider understanding of the system to define the extent of the event.
    - Every effort should be made to find the root cause and this should be verified after remedial action has been implemented.
    - Where no root-cause can be identified, or where a cause is only tentatively identified, it may be prudent to carry out further investigation and monitoring to obtain additional information and confidence.
    - Information from the event should be used to update the Drinking Water Safety Plan taking account of hazardous events and control measures identified.

Microbiological events

1. Following detection of microbiological contamination in treated water and following suspected ingress of surface water, soil or sewage, customers should, as a minimum, be advised to boil water for drinking. For events where sewage ingress is implicated, and the sewage may contain industrial waste including chemicals, a risk assessment should be performed before deciding what precautionary advice is appropriate. The decision to issue this precautionary advice should be taken following consultation with the health and local authorities. The good practice outlined above in terms of customer notification should be followed.

2. Where practicable and without compromising public health, prior to any remedial chlorination, samples should be taken from the affected area, along with upstream areas for comparison. Following such chlorination, and the return of chlorine residuals to normal concentrations, a sample survey should be undertaken in the affected area (along with upstream locations) to confirm the effectiveness of the chlorination. These samples should be analysed for coliforms and *E. coli*. Depending on the nature of the contamination consideration should be given to sampling for other parameters such as Cryptosporidium.

3. Where appropriate, the concentration of chlorine in the area affected should be increased for example by controlled dosing of sodium hypochlorite. In some circumstances, such as in order to disinfect a discrete section of the distribution system, the use of, for example, 50 mgCl/l (free residual) held for 30 minutes standing may be necessary. If possible the stop-taps at boundary boxes should be isolated prior to disinfection of the main, otherwise customers in areas where high-level chlorination is being undertaken should be warned and an appropriate restriction to water use imposed (usually "Do Not Use"). At the end of the chlorination period, the distribution system should be flushed until the chlorine concentration has returned to normal levels. Any discharges of highly chlorinated water must be neutralised and strictly controlled to prevent environmental damage.

4. In other circumstances, such as where low levels of coliform bacteria (in the absence of other faecal indicators) are detected, increasing the chlorine concentration, for example to between 0.5 and 2 mg/l for a longer period of time, may be more appropriate. This could involve increasing the concentration of free chlorine leaving the water treatment works or storage point to or boosting the chlorine in a part of the distribution system using portable chlorination equipment. A typical application time for such booster chlorination to be effective could be 12-24 hours, and where deemed necessary, the distribution system should then be flushed until the chlorine residuals are normal for the area.

5. For the quality of the water to be considered satisfactory after such an event a second set of samples should be taken from locations defining the extent of the contamination as well as the original locations at a time after the first set taking into account the turnover of the system but usually not less than 12 hours later, and should be negative for indicator bacteria after analysis for the parameters identified above.

6. The advice to boil water for drinking may be withdrawn in consultation with health and local authorities provided that the criteria agreed at the beginning of the event have been satisfied.

Non-microbiological events

1. The actions to be taken during an event involving chemical parameters depend very much on the parameter involved.

2. Events affecting the aesthetic quality, appearance, taste and odour, of the water are generally first identified from customer contacts. Appropriate procedures should be in place to alert operations, customer services and water quality management departments.

3. For events involving aesthetic parameters, provided that there is no risk to human health no restrictions to water use may be necessary, although it may be advisable to give advice to the customer service department on responding to such issues. In the case of iron and manganese related events, flushing or air-scouring of the distribution system, if deemed appropriate, may be sufficient to alleviate the problem. The nature and extent of the problem should be identified through undertaking sample surveys in the affected and wider area. Whenever practicable contemporaneous samples should be taken during the event and must be taken afterwards to verify the effectiveness of any remedial action.

4. For events involving chemical parameters posing a potential risk to public health, such as hydrocarbons, restrictions to water use may be required dependant on the concentrations

of the parameter involved. Toxicity data should be used to inform the process of making such a decision and the nature of any restriction or advice to customers being considered should be discussed with the health and local authorities prior to implementation. The remedial action required will also be dependent on the parameters involved; it is good practice to have procedures in place to detail actions required for a variety of chemical events.

5. Depending on the nature of the contamination and the risk assessment, a single set of samples may be sufficient to demonstrate that levels are within acceptable limits. However in general, for the quality of the water to be considered satisfactory after a chemical contamination event, a number of sets of samples, taken from locations defining the extent of the contamination, at least 12 hours apart, taking the turnover of the system into account, should demonstrate that results are within acceptable limits.

6. Advice to customers about restricting the use of the water may be withdrawn in consultation with the health and local authorities provided that the criteria agreed at the beginning of the event have been satisfied.

TGN11 - STORAGE AND USE OF BOTTLED WATER

Introduction

From time to time a water company may need to provide alternative supplies in the form of bottled water. They may also be distributed as part of a company's provision of alternative supplies under the Security and Emergency Measures Direction 2006 issued by Defra, of 10 litres per person per day or 20 litres per person per day in incidents lasting more than 5 days.

Good practice

Prior to supply

1. Bottled water provided to customers by a water company is classified as drinking water and therefore must be in compliance with drinking water quality standards at the point of consumption. Bottled water manufacturers are required to provide information on water quality at the point of bottling. Water companies must therefore ensure therefore that they are satisfied that the bottled water that they provide to consumers meets the appropriate standards at the relevant point of compliance.

2. Bottled water must, by law, be sold in sealed tamper-evident containers. Bottled water must comply with the microbiological standards in the Natural Mineral Water, Spring Water and Bottled Drinking Water Regulations 2007, SI 2785 up to the point of sale (during its marketing).Note: the exception is TVC which is only applicable within 12 hours of bottling (maintained at 4 +/- 1 C)

3. When a delivery of bottled water is made to the water supplier, the manufacturer should issue a quality test certificate. The certificate should include the results of all microbiological testing, particularly *E.coli* and coliform bacteria and colony counts at 22ºC and 37ºC measured within the period 12 hours following bottling with the water being maintained at 4ºC (+/-1 ºC).

Storage

1. Water is labelled with "Best Before" durability labelling, rather than 'Use By'. If the bottles of water are stored correctly the water will not deteriorate and there is no requirement for regular testing during storage. If stored for an unusually long period, the water should be checked, but primarily to test for any deterioration in the integrity of the packaging. The storage conditions should be supervised to ensure that they are satisfactory but, provided that this is the case, it is not necessary to routinely analyse the water.

2. Bottled water must be stored in conditions suitable for food products as recommended by the supplier. A cool, dust-free environment, away from direct sunlight and potential sources of contamination, such as strong smelling chemicals or diesel fumes. Under no circumstances should the product be stored outside and / or exposed to sunlight.

3. The shelf life of the product kept in suitable conditions is as advised by the manufacturer and is usually a maximum of 2 years. Stocks should have a clearly displayed "Best before date" and should be rotated in appropriate order to ensure that the oldest stock is used first. Any stock identified as being out of date must not be issued and should be disposed of.

4. If there are any concerns that the quality of a batch of bottled water has deteriorated then

a quarantine and testing procedure should be in place to ensure it is not deployed to customers until sample results have confirmed conformity or otherwise.

Use of Bottled Water

1. A record should be kept of when strategic quantities bottled water are deployed. This should detail the date, quantity issued and batch number. In some cases the record may need to include where the water was used e.g. sub-depot or to whom the bottled water was issued e.g. distribution inspector.

2. The record should be completed for all strategic issues – including any water that is returned or discarded (including the reason why).

3. Guidance to the Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations contains further details of the monitoring requirements necessary for bottled water supplied to customers. This specifically requires bottled water that has been deployed and left outside of the water undertakers control (but not on consumers premises) to be sampled at the point of deployment (for example where a pallet of bottled water is delivered to the corner of a street or car park).

Audits

1. Each store of bottled water should be subject to a regular (at least annual) audit, by water quality staff.

2. As part of the audit, a review of the results from routine sampling should be carried out and where necessary additional samples should be taken.

3. The findings of the audit should be discussed and agreed with relevant personnel and management and any improvements documented in changed procedures.

4. Audits of bottled water producers should also be carried out to enable the water undertaker to satisfy itself of the quality procedures throughout the entire production process.

Product recall

1. Should a bottled water supplier instigate recall of a batch of bottled water, the water undertaker should be notified immediately in order to prevent issue of substandard or contaminated product to its customers.

2. Procedures should be in place for communication during and outside normal working hours.

3. The bottled water supplier should provide full details of the reasons for the recall together with details of the batch recalled, including the location of all relevant deliveries made to the water undertaker.

4. The appropriate batch should be quarantined for return to the supplier or discarded.

Please see the position paper on bottled water regulation at Water UK website - www.water.org.uk/regulations-use-bottled-water-water-companies

TGN12 - TANKERS, STATIC TANKS AND BOWSERS

Introduction

When normal supply arrangements are disrupted, either as a result of a planned shutdown of the distribution network or following an operational emergency, water undertakers may provide alternative supplies to customers. This includes the use of tankers, static tanks, bowsers or bottled water. The distribution of bottled water is not covered by this TGN. Under the Security and Emergency Measures Direction 2006 issued by Defra, undertakers are required to supply a minimum of 10 litres per person per day if mains supplies are unavailable or 20 litres per person per day in incidents lasting more than 5 days.

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The requirements for sampling tankers, static tanks and bowsers is covered under Regulation 6 of the Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations ("the Regulations"), with further information given in the guidance to these Regulations issued by the Drinking Water Inspectorate in 2016.

Good practice

General

1. Water undertakers should have procedures in place to ensure the smooth deployment of alternative supplies across their supply area.

2. Undertakers should consider the need to have a pre-planned list of appropriate locations to place static tanks and bowsers, taking into account accessibility for consumers, risk of vandalism and contamination, and suitability for filling and re-filling by tanker.

3. Where undertakers employ the use of third party vehicles and equipment, additional protection is needed to ensure these are likely to be available when needed. Undertakers should consider having plans in place to contact alternative providers. The Water UK mutual aid scheme has been set up so that undertakers can request additional equipment from other undertakers for temporary use during an emergency.

4. The plans should be regularly tested and updated where necessary.

Personnel

1. All personnel involved in the deployment and use of tankers, static tanks and bowsers should hold a National Water Hygiene Card (see TGN No.1). The only exception is tanker drivers provided they do not have contact with the equipment to be deployed including associated fittings such as hoses.

Equipment and vehicles

1. All clothing and personal protective equipment should be clean and kept suitable for use on restricted operations (e.g. separate from other equipment).

2. Road tankers, tanks and bowsers should be approved in accordance with Regulation 31 (or its equivalent in previous Regulations) for either permanent or emergency use.

3. Vehicles, equipment and fittings used in water supply operations must not be used for any other purpose and kept clean internally and externally.

4. Petrochemicals, oils and chemicals and any fuel-driven equipment should be kept separate from pipework and fittings during transport.

5. Pipework and fittings should be kept above the vehicle floor and pipes should be end-capped. Small fittings should be kept in their original protective wrappings or in clean polythene bags.

6. Used/soiled equipment should be thoroughly cleaned and disinfected before being returned to use.

7. Each vehicle should carry hand washing facilities, preferably soap and water, but waterless hand cleaner and paper towel may be used.

8. In an emergency, tankers normally used for the transport of food-grade liquids can be used, but should be subject to additional washing, disinfection and flushing depending on the previous use. In any case, all materials in contact with potable water should meet the requirements of Regulation 31 (or its equivalent in previous Regulations).

9. Tankers and bowsers may be kept in a "ready condition" provided there is a suitable regime of turnover and sampling or periodic disinfection and sampling, and that the appropriate records are maintained.

10. If not stored in a state of readiness, tankers, static tanks and bowsers should be left drained and stored in area where the risk of external contamination is minimised.

11. Tankers, static tanks and bowsers should be able to be locked to prevent unauthorised access, and be marked with a unique number for reference and audit.

Filling

1. All tankers, static tanks and bowsers should be completely empty before filling.

2. All equipment (hoses, hydrants and standpipes) used for filling must be kept specifically for that purpose, stored appropriately and cleaned and disinfected before use. The filling point should also be flushed and where necessary disinfected before use. Acceptable disinfection methods include the use of steam-cleaning equipment (supported by an appropriate method statement) and chlorine solutions.

3. Appropriate arrangements and methods should be in place to ensure suitable disposal of any chlorinated water.

4. Water undertakers should consider nominating designated filling points that can guarantee a rapid filling rate.

5. At these sites the filling point should be subject to regular flushing to minimise any risk of deterioration in water quality.

Deployment

1. Before delivery of static tanks and bowsers, undertakers should ensure that they are in a safe and secure position. They should be placed in accordance with legislation with regard to signing, lighting and guarding.

2. All tanks and bowsers should be checked for the expected chlorine residual at the point of use.

3. Access and filling points should be locked and secured to prevent contamination.

4. Static tanks and bowsers should be clearly signed with “boil before use” notices. This is due to the risk of contamination from the vessel used by the consumer to carry water to the point of use.

5. The position of the equipment should be recorded and a re-filling and sampling plan put in place.

6. Where re-filling operations take place they should be arranged to ensure an air gap between the delivery hose and the water in the tank to prevent back-syphoning. If this is impractical then a double check valve should be fitted in the re-filling device.

7. The Water Supply (Water Quality) Regulations 2016 require a sample to be taken for bacteriological and physico-chemical parameters from each deployed bowser or static tank that has been in continuous deployment for 48 hours. Where a bowser or static tank is in continuous use for longer than 96 hours, full chemical and bacteriological analysis should be undertaken.

TGN13 - PREPARATION OF CHLORINE SOLUTIONS

Introduction

Chlorine is an effective disinfectant for most bacterial and viral pathogens. The effectiveness of prepared chlorine solutions for use in water hygiene procedures is dependent upon the concentration of the active form of chlorine (e.g.: hypochlorous acid where hypochlorite salts are used) which is influenced by age of product and storage conditions.

Good Practice

In developing their own policies or operating procedures for the preparation of chlorine solutions, the following points should be considered:-

1. Only materials which are approved under Regulation 31 of the Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations should be used.

2. The most commonly used (and approved) chlorine compounds are:-
   - i) Hypochlorite solutions with an available chlorine content of approximately 10-15% (w/v)
   - ii) Calcium hypochlorite tablets with an available chlorine content of approximately 33-35% (w/w)
   - iii) "Instachlor" tablets – isocyanurate

3. Appropriate health and safety procedures must be employed when using concentrated chlorine-based solutions, powders and tablets.

4. Chlorine-based solutions and tablets should not be used after the stated "expiry date". Procedures should be in place to ensure that diluted chlorine solutions (for use for example in spray chlorination techniques) are also used within a stated time to ensure their effectiveness. Procedures should be in place to ensure effective stock rotation.

5. Chlorine-based solutions must only be stored in dedicated and clearly marked containers. Storage sites must have sufficient bunding to prevent accidental spills affecting a wider area. Containers previously used for the storage of any other products must not be used.

6. "Ready-reckoner" tables are useful for operational field staff in the preparation of chlorine-based solutions. The table below shows the amount (ml) of 10% (w/v) sodium hypochlorite solution required to make specific volumes of chlorine solution at various strengths (i.e.: 5L of sodium hypochlorite in 100L of water will produce a solution strength of 5mg/L free available chlorine).

Desired chlorine concentration strength (mg/l or ppm)	**Solution volume (L)**				
	10	**100**	**500**	**1,000**	**5,000**
0.5	Not	0.5	2.5	5	25
1	Not	1	5	10	50
5	0.5	5	25	50	250

10	1	10	50	100	500
20	2	20	100	200	1.000
50	5	50	250	500	2,500
1,000	100	1,000	5,000	10,000	50,000

TGN14 - DISPOSAL OF CHLORINE SOLUTIONS & CHLORINATED WATER

Introduction

Chorine is toxic to aquatic flora and fauna. Care should be taken when disposing of water containing chlorine, particularly strong solutions used for the disinfection of water mains and fittings. Chlorine may also inactivate the biological process necessary for effective sewage treatment.

Good Practice

1. Chlorine solutions and chlorinated water should not be discharged to water courses, without prior consent from the Environment Agency. Care should also be taken to ensure that surface and land drains do not discharge to water courses.

2. Chlorine solutions and chlorinated water may be discharged to foul drainage systems. A risk assessment should be carried out prior to doing so in order to confirm that the receiving sewage treatment works will not be adversely affected.

3. It may be necessary to dechlorinate water prior to disposal. Dechlorination can be achieved using a number of different chemical compounds, the most commonly used of which are sodium thiosulphate and sodium bisulphite.

4. Only materials which are approved under Regulation 31 of the Water Supply (Water Quality) Regulations 2016 and their equivalents in the devolved administrations should be used for the dechlorination of water that will be subsequently used for supply.

5. Dechlorination solutions, powders and tablets should not be used after the stated “expiry date”.

6. Chlorine-based solutions must only be stored in dedicated and clearly marked containers. Containers previously used for the storage of petroleum products must not be used (see TGN13)

7. The following information if provided as a guide to the relative concentration of sodium thiosulphate and sodium bisulphite solutions required to neutralise a specific chlorine solution. Advice from technical and scientific staff should be sought in order to calculate the required amount of dechlorination chemical in other circumstances.
   - 1ml of l.8% (w/v) solution of sodium thiosulphate will neutralise 1L of water containing 5mg/L (ppm) of free available chlorine.
   - 10g of sodium thiosulphate (w/w) crystals will neutralise 1,000L of water containing 5mg/L (ppm) free available chlorine.
   - 15ml of 23% (w/v) sodium bisulphite will neutralise 1000L of water containing 5mg/L of free available chlorine.

TGN15 - INSTALLATION AND MAINTENANCE OF FINAL WATER AND SERVICE RESERVOIR SAMPLE POINTS

Introduction

The Water Supply (Water Quality) Regulations 2016 or their equivalents in the devolved administrations, hereafter 'the Regulations', require that water companies produce and supply wholesome water. Water companies are required to verify final water quality and effectiveness of disinfection by ensuring samples are taken at the point at which water leaves the site of production. In addition service reservoirs in the supply network must also be sampled to ensure water quality targets and residual chlorine levels are maintained. The location and specification of sampling points must ensure that samples taken are representative of water going in to supply. For full principles to be applied to the sampling of drinking water from treatment works and piped distribution systems, please refer to BS ISO 5667-5.

Good Practice

Installation - Water Treatment Works

1. For each water treatment works there should be at least one sample collection point after the final stage of treatment.

2. For water treatment works with more than one water source, designated sample collection locations should be representative of the output of each water source.

3. Final sample collections points should be as close as possible to the water treatment works generally the point at which the treated water leaves the works.

Installation - Service Reservoirs

1. If the service reservoir has a common inlet and outlet main, samples should only be taken when the main is acting as an outlet ensuring that the sampled water is representative of water that has been stored in the service reservoir.

2. If the service reservoir has two compartments which are hydraulically linked, then this can be treated as a single reservoir and sampled at one sampling location.

3. If the service reservoir has two compartments which are not hydraulically linked, then two sampling locations must be positioned on the outlet of each tank, so that samples are representative of water stored in each compartment.

4. If the service reservoir has two compartments which are not hydraulically linked but the individual outlets combine into a common outlet, a single sample location may be adequate.

5. Sample points should be located as close as possible to the service reservoir up stream of the first customer.

General considerations

1. Ideally, taps and associated sample lines should not be connected to any other equipment, or used for other purposes
   .
2. Taps should not be fitted with attachments or inserts and should be clean, free from

extraneous matter that may affect the microbiological quality of the sample being taken.

3. If the tap is to be flame-disinfected, it is important that there are no flammable materials or fumes nearby.

4. The sampling line should be as short as possible, in good condition and capable of being flushed at full flow rate.

5. The sampling line should not include T-junctions, which might result in stagnation.

6. The sampling line should be dedicated to the supply of treated final water to the sample tap or water stored in service reservoir.

7. Sample points should be in a secure location, protected from adverse weather, vandalism and contamination from the environment.

8. Sample points should not be located in locations which require confined space training.

9. Sample points must include adequate drainage to avoid flooding and risk of contamination.

Construction Materials

1. All materials used for construction, maintenance and repair of sample point locations, including any apparatus which is likely to come into contact with treated potable water must be approved under Regulation 31 of the 'Regulations'.

2. All treatment works and service reservoir sample points should be fitted with sampling taps of hygienic design which comply with National Standards.

3. All sample lines should be constructed from a suitable material and comply with National Standards.

Maintenance

1. All personnel who carry out work around treated or partially treated drinking water must comply with requirements of TGN 1(Medical screening).

2. Periodic cleaning, disinfection and flushing of the sample point should be carried out by appropriately trained personnel.

3. Sample lines and sample taps should be replaced periodically dependant on construction materials selected.

4. All sample points should be inspected periodically and consider the following;
    i. Health and safety access.
    ii. Damage which present potential for ingress or vermin.
    iii. Sample area hygienically clean and will not introduce contamination.
    iv. Clean waste sink and back plate.
    v. Sample tap in good condition (i.e.no leakage or dripping).

TGN16 - QUALITY ASSURANCE OF ON-LINE WATER QUALITY MONITORING INSTRUMENTATION, USED FOR THE CONTROL AND MONITORING OF DISINFECTION PROCESSES.

Purpose

This document sets out the principles, to be considered by drinking water quality specialists, in drawing up suitable operational quality assurance procedures and practices; for on-line water quality monitoring instrumentation associated with disinfection.

Specific guidance is given relating to the measurement of chlorine and turbidity that are based upon the requirements of Regulation 16 (3) which applies to samples taken for compliance with parts 4 and 5 of the Water Supply (Water Quality) Regulations. Other approaches to quality assurance may also be applied by companies but are not detailed within this guidance note.

It is acknowledged that other parameters have an impact upon disinfection (e.g. pH), but these are not included within this guidance. Water companies should assure themselves that the risks associated with the monitoring of other parameters have been assessed and documented and where necessary appropriate steps have been taken to verify the readings from on-line monitors.

Background

1. The industry relies on and may from time to time provide the DWI with on-line water quality monitoring data, in order to demonstrate that the regulations around disinfection have been adhered to.

2. It is important that these data are fit for purpose and that companies can demonstrate that the robustness of these data are to a similar standard to that of other water quality data submitted to the DWI.

3. This will be achieved by the implementation of procedures, based on this guidance, to ensure that chlorine and turbidity data associated with primary disinfection on a particular site are traceable and auditable.

Methodology

1. Appropriate Standard Operating Procedures and suitable records to be developed and implemented by water companies for the operation of on-line turbidity and chlorine monitors at the point of disinfection and, where appropriate, at the point the water is supplied from a treatment works.

2. The procedures and records are readily available to the operator, other relevant staff and 3rd parties as appropriate.

3. For analytical quality control, an appropriate on-site comparative standard or comparison with an accredited on-site test should be used. This should be suitable for the instrument and analytical methodology and be fully traceable

4. Any standards that are prepared “in-house” should also be fully traceable.

5. The approach for chlorine is based on a direct comparison of the on-line instrument

reading with the result obtained from an accredited on-site test undertaken by a competent person.

6. Due to the sensitivity gap between on-site and on-line measurements of turbidity, an alternative approach of comparing the instrument reading with the value of a known standard is used. As with chlorine this activity should be undertaken by a competent person.

7. Companies should develop appropriate action and warning limits and procedures for reacting to these limits ensuring they are included in the Standard Operating Procedures.

Quality assurance method for chlorine

1. Undertake instrument suitability and AQC tests on the hand held device to ensure it is operating with its control limits and record as appropriate.

2. Collect a representative sample of the water supplying the on-line chlorine monitors and note the instrument chlorine reading at that time.

3. Determine the level of free chlorine using the hand held instrument
t.
4. Subtract the on-site test result from the on-line monitor value recorded and plot on a difference chart.

5. If the result falls outside the calculated action or warning limits, investigate and record any corrective actions as appropriate.

Quality assurance method for turbidity

1. Due to the nature of the analytical methodology associated with on-line turbidity measurement, a suitable primary reference standard is to be used as the comparator for quality assurance purposes.

2. The reference standard will have been ascribed a known reference value. (NOTE: The reference standard used should be different from the standard used to calibrate the instrument.)

3. Test the reference standard as per manufacturer's instructions and record the measured value.

4. Subtract the measured value from the reference value and plot on a difference chart.

5. If the result falls outside the calculated action or warning limits, investigate and record any corrective actions as appropriate.

Results and Data Handling

1. The data produced when undertaking the comparative QA analyses will be recorded and plotted on difference charts, these will provide confidence in the on-line analytical measurements.

2. The initial AQC data collection (to set up the difference charts) will require that a minimum of 20 measurements are collected over a representative time frame that will

capture any seasonal variations. It is suggested these data are collected over the first 12 months.

3. The appropriate AQC frequency thereafter will be determined by each water company, according to the stability of measurement. It is anticipated that AQC will be conducted at least monthly but the frequency must be based upon sound science and enable the company to demonstrate that the monitor results are continually fit for purpose.

4. The difference charts will incorporate statistically calculated AQC control limits.

Response to Measurements Outside of Control Limits

1. Initial measurements which yield results outside of control limits will trigger actions to be undertaken by the operator, detailed within the instrument's Standard Operating Procedure.

2. Deviations which cannot be resolved by the operator will be passed to a more senior member of staff to determine the appropriate action.

3. Any deviations which may have an adverse impact on disinfection efficacy or confidence in the results produced by the on-line instrumentation will trigger an investigation by the water company. The outcome of these investigations will be used to ensure continual improvement.

4. Water companies should consider whether the impact on disinfection efficacy or confidence in the results needs to be reported to the Drinking Water Inspectorate in line with its obligations under the Water Industry (Suppliers Information) Direction.

Operator Training and Competency

1. Instrument operators to be provided with appropriate training and support to fulfil three criteria.
   - Underpinning knowledge and understanding the importance of the parameters being measured, the basis of the measurement methodology, the instrumentation being relied upon and requirements for analytical quality control.
   - Knowledge of the specific operational procedures, the manufacturer's instructions for specific instrumentation and any Standard Operating Procedures for undertaking Quality Assurance.
   - Continuing Professional Development or demonstration of on-going competence – regular audits and method witness.

2. The frequency of operator audits or method witnessing is determined by the water company but must be sufficient to maintain confidence in the competence of individuals responsible for undertaking these important tasks.

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