Contents

Water Quality Compliance Monitoring

The Inspectorate received 342 regulatory breaches in the third quarter of 2019 for assessment (an increase from 279 in Q2), and a further 69 samples where the fluoride concentration did not meet the specification required by Public Health England in fluoridated water supply zones.

Inspectors still continue to make recommendations to address a wide range of deficiencies including sampling and analysis; risk assessment; and the quality of investigations.

Integrity of service reservoirs again appeared in several recommendations to companies. Companies should be regularly reviewing operational data, weather conditions and routine site audits to proactively manage the risk to reservoir water quality. Service reservoirs represent an integrity risk point in the distribution network and regular internal inspections and data review can help companies adopt a more proactive approach to managing that risk.

Water quality at treatment works

Microbiological failures at treatment works

Table 1: Q3 2019 – Microbiological tests

Parameter	Total Number of tests	Number of tests not meeting the standard
Water leaving water treatment works		
E.coli	46,486	2
Coliform bacteria	46,486	17

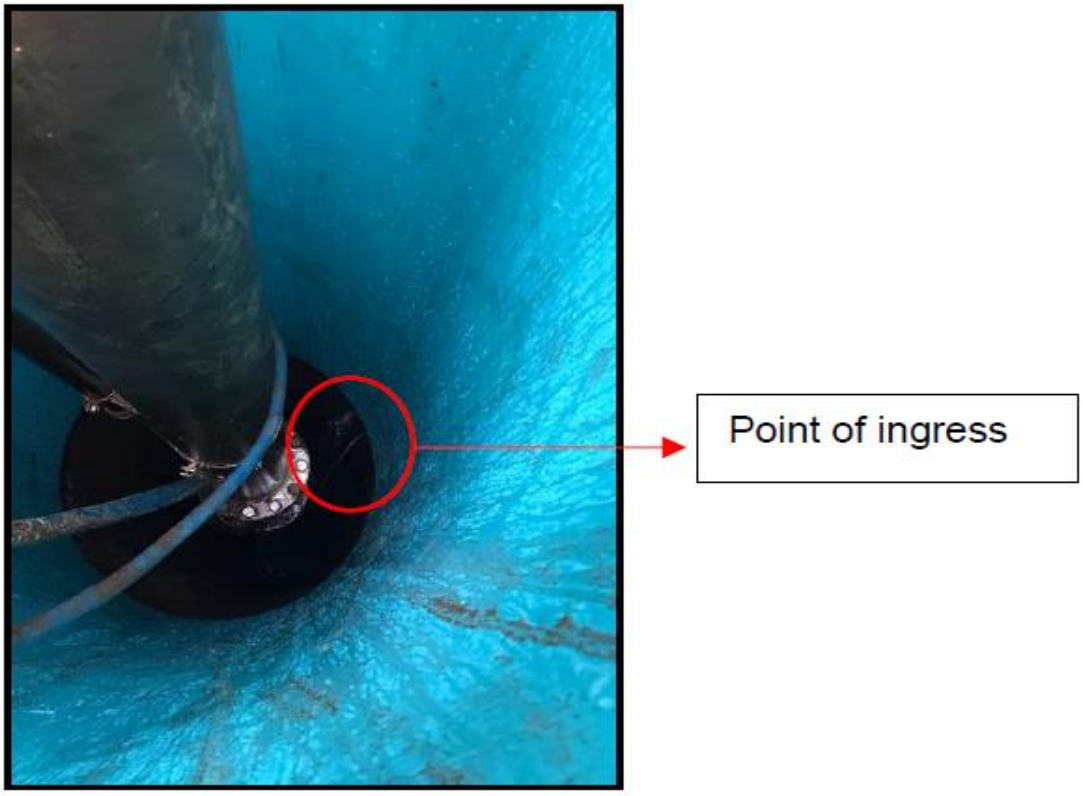
There were two *E.coli* failures at treatment works in this quarter (YKS 1 and AFW 1), and there were also 17 coliform breaches (AFW 1, ANH 2, CAM 3, SRN 2, SEW 1, SVT 3, UUT 2, YKS 3). For Q3 there was an increase in both *E.coli* and coliforms at works.

E.coli at treatment works

During September Yorkshire Water detected *E. coli* at Great Heck No2 works. Although initial investigations suggested that disinfection by UV and hypochlorite dosing had not been compromised, the company removed the site from supply proactively. The headworks had been originally constructed

in subterranean chambers but was raised in 2016-17 to bring them above ground level in order to reduce the risk of inundation by flood water. It was this work that upon investigation was found to have been leaking into the borehole. Significant ingress was identified from the flanged connection on the headworks which is below ground. Levels of *E.coli* were >100/100ml which is an unacceptable risk even with UV disinfection. It is disappointing that the very works intended to protect against ingress was in fact the very cause of the failure. The company response was to remove the works on discovering the failure, putting public health first and should be commended. Root cause analysis by the company in future could well focus on how to prevent retrofitting improvements from creating hazards to water quality. The works remains out of supply while remedial works are carried out. The company have sent pictorial evidence of the point of ingress (see below), which has been repaired and will be tested within a target date of reinstating the works during January 2020.

Figure 1: Ingress within the head works at Great Heck No.2



Also in September Affinity Water detected *E. coli* at Holywell works. An investigation by the company included re-samples at the works, service reservoirs and properties downstream of the works, and these were all satisfactory as was the operational records for the works itself. Two

samples were taken on the same day at the works which were a raw and a final water sample. The investigation indicated that the samples were most likely inverted as disinfection by-products were found in the raw sample which is before the disinfection process and none were found in the final sample. Whilst this is circumstantial evidence it provides a basis to substantiate an error by the sampler. Human error always remains a potential cause for such circumstances and is very difficult to eliminate by just “retraining” the sampler which is the company solution. The lessons learnt by a company should focus on how a process or procedure makes it unlikely for a recurrence, as reliance to stick the right label on the right bottle will always be prone to error. At the high levels of water quality experienced in this country, a single *E. coli* detection is notable.

Coliforms at treatment works

Seven of the coliform failures at works in this quarter were deemed unlikely to recur by Inspectors, and three were covered by legal instruments. Of the 17 coliform failures in the third quarter, there were seven that required further action from the Inspectorate.

Enforcement action is being considered following a second coliform failure at Southern Water’s Broadwater works. The company’s original inspection could not find a cause for the breach. However, several risks have been acknowledged and recognised in the company’s own hazard reports.

Cambridge Water detected coliforms at three water treatment works during July. Two of these detections at Duxford Grange and Babraham works and a zonal compliance sample in Coton, as well as five other operational samples at works, were all identified as *Serratia marcescens*. A further zonal sample at Cambridge South zone taken at the same time as Duxford Grange and Babraham works also contained an unidentified Serratia spp. Serratia spp is commonly found in the environment, is particularly hardy and well known to analytical microbiologists as a potential contaminant. *Serratia marcescens* is notable by the red coloration and is easily identifiable on culture. This bacterium was subsequently found in the bottles used for diluting the spray disinfectant for sampling, which is the very solution intended to prevent contamination. Recommendations were made regarding regular checks of the analytical provider, (who dilute the disinfectant sprays). A disinfectant blank to quality assure the spray is now used but arguably should have been something that was normal practice and a lesson for all laboratories.

Failures at Heydon final water as well as Heydon Reservoir 1a, confirmed as the same species, *Serratia proteamaculans*, implying that the failures from Heydon Borehole PS and Heydon Reservoir 1a were directly linked to each other, but not conclusively to the other failures with Serratia spp. Investigations on site did not identify any other reason as all samples in the downstream zone were satisfactory. However, the company removed Heydon from supply. The outcome of these investigations are a clear learning to all companies of the consequence of laboratory associated contamination which always remain a risk.

Coliforms were detected at South East Water's Maidenhead Pumping Station. The contact tank is known to have what is described by the company as an 'egress' leak point as the tank is said to be under positive pressure. Such a leak may well be described as a moot point because pressure is relative to a number of variables including the volume and therefore weight of the water in the tank relative to the external environment. Potential contamination by external contaminants may be possible on fluctuation of flows and pressures during pumping or by external factors such as heavy rain. Because there have been two coliform detections in a three-year period from this site, concurrent with evidence of a leaking contact tank, the Inspectorate considers there is sufficient evidence for foreseeable risks of supplying unwholesome water with potential risks to public health from Maidenhead Pumping Station. Recommendations have been made to complete any remedial work required on the tank and work will be followed up at liaison meetings. Consideration will be made as to whether this should be formalised within a Notice to secure regulatory mitigation of future risk.

Turbidity at treatment works

There were four PCV failures for turbidity at treatment works between July and September 2019 (BRL 2, NNE 1, SWT 1).

Enforcement action was considered at Bristol Water's Barrow Treated 1 works in August. The company acknowledge that the increase in turbidity was likely due to mobilisation of particulates from the outlet main of the contact tank following flow changes. Because this is likely to recur, enforcement action is being considered unless the company can demonstrate sufficient mitigation measures to prevent a recurrence. Bristol Water also detected increased turbidity from a sample at their Cheddar works in July. The sample failure was detected from a shared line whilst a sample from a new sample line at Cheddar works did not show a similar turbidity. The failure is unlikely to recur now the new line has been commissioned and is operational.

A turbidity increase at Northumbrian Water's Fowberry works in July is covered by a legal instrument which covers improvements to the boreholes on site and cleaning the associated pipework that has been implicated in several turbidity detections at this works.

A turbidity detection at South West Water's Wilmington works in September was deemed unlikely to recur.

Water quality at service reservoirs and in distribution

There were eight *E.coli* failures at service reservoirs in this quarter (ANH 2, DWR 1, SVT 1, SWT 1, NNE 2, SEW 1) as opposed to one in quarter 2. Six of these reservoirs were assessed as unlikely to recur following extensive investigations. Out of the six, five were taken out of supply to facilitate root cause analysis and in the sixth investigation the sample line was from a 2" main feeding a property rather than the reservoir outlet. The Inspectorate will closely monitor any further *E.coli* detections at these sites.

At South East Water's Wych Cross reservoir, *E.coli* was detected in September. During a follow up internal inspection, ingress was observed at the hatch upstands and recommendations were made. This site had a coliform detection in June but action was postponed as upstream reservoirs were out of service at the time. The company have therefore accepted the risk of a microbiological failure over operational supply in the absence of any option from the neighbouring company. The future focus for the company should therefore be to close this risk gap rather than accept unnecessary risk to consumers.

Northumbrian Water detected *E.coli* in their South Moor reservoir in July. Recommendations were made due to an assessment that the company failed to adequately monitor chlorine levels on returning the reservoir to supply following a period of standing of eight days. Simple procedures and processes outlined in the Water UK best practice guidance would have avoided this failure.

Coliforms were detected in 50 samples in quarter 3 (AFW 2, ANH 5, BRL 1, DWR 3, ESK 1, HDC 2, SEW 5, NNE 8, SRN 1, SVT 8, SWT 3, TMS 4, UUT 2, WSX 3, YKS 2) as opposed to 16 in quarter 2. The Inspectorate considered that a recurrence was unlikely or that satisfactory investigations had been carried out in 45 of these breaches. The number of failures in this period was notable being three times the number of the previous period which may reflect metrological conditions. It is in this context that companies should always investigate thoroughly the possibility of ingress as a real cause of this rising trend. It is commendable to note that three companies with the highest number of failures, (ANH, SVT & NNE), in all cases carried out in depth investigations including internal inspections, inundation or flooding tests and enhanced monitoring. Taking the viewpoint that a coliform failure is an opportunity to carry out early response to secure the asset from future failures is to be commended. Recommendations were made to several companies about investigations which could well be improved to mitigate future risk including regularly reviewing plate count data and looking at weather conditions in relation to spotting reservoir ingress and water quality deterioration in a timely manner. In some examples the importance of routine reservoir inspections and risk based

targeting of inspections was emphasised as assessing risk must be dynamic rather than set to an engineering standard period.

Table 2: Q3 2019 – Microbiological tests

Parameter	Total Number of tests	Number of tests not meeting the standard
Water leaving service reservoirs		
E.coli	51,701	8
Coliform bacteria	51,701	50

Water quality at consumers' taps

E.coli - 12 failures

In the third quarter, there were 12 *E.coli* detections at consumers' taps (TMS 5, ANH 1, ESK 1, SRN 1, UUT 1, DWR 1, SVT 1, CAM 1). Southern Water had problems gaining readmission to a property where a boil notice had been left. Due to the length of time since the initial notification the company decided they should lift the notice. The Inspectorate has asked Southern Water to review its process for issuing and lifting notices as there are health implications of leaving a boil notice in place, but also for lifting a notice without clear samples. Companies would be advised to adopt clear strategies for applying and lifting boil notices in a timely manner as these are short term mitigations.

The Inspectorate was satisfied that the remaining companies had taken sufficient action to investigate the breaches and provide advice that would identify each of them as unlikely to recur.

Taste and Odour – 63 failures

The quarter recorded 23 Taste failures (DWR 4, SBW 1, HDC 1, NNE 1, SRN 4, UUT 4, SVT 3, WSX 3, YKS 2) and 40 Odour failures (DWR 4, AFW 4, ANH 7, ESK 5, SBW 1, SEW 2, HDC 1, NNE 1, SRN 2, UUT 5, SVT 6, WSX 2).

There was a slight increase in the number of taste and odour failures in quarter 3, but this is largely in line with the seasonal increase observed in 2018.

A number of odour failures were rejected by laboratory staff for taste testing. Despite an analytical rejection, no advice was given to consumers

that the water should not be consumed on any of these occasions. Further investigations into Anglian Water's handling of taste and odour analysis is ongoing. Companies are reminded they have a responsibility and duty to inform consumers of any results that impact on water quality.

Lead – 22 failures

Twenty-two samples exceeded the PCV for lead between July and September this year (ANH 2, SES 1, AFW 1, SEW 1, TMS 7, YKS 2, SVT 8). Nine failures were in zones where improvement notices have already been issued and the Inspectorate considered sufficient action had been taken to prevent a recurrence in a further 12 cases.

In one case, the Inspectorate initiated further action. Following a failure in Severn Trent Water's Coventry zone in July, the Inspectorate recommended the company provide greater clarity in its definition of supply and service pipe and issuing advice to consumers ahead of planned work.

Plumbosolvency control is used widely across England and Wales to protect consumers at risk from lead in the water supply infrastructure. It is only effective as a control measure if it is applied in a controlled and consistent manner. All companies are advised to review the performance of their orthophosphate dosing and ensure that they are delivering consistent effective dosing to all supply zones. Where this is not the case companies should revise and resubmit their risk assessments for lead and take appropriate action to address the issues found.

Nickel – 5 failures

Of the five nickel failures in the third quarter (ANH 2, SVT 1, YKS 2), the assessing Inspectors considered in all cases that sufficient action had been taken to consider the breaches unlikely to recur. Nickel remains a rising concern due to the availability and relative cheap cost of fittings with exposed nickel. The sensitivity of some individuals is becoming more apparent and not to tackle this problem as it is emerging risks a future legacy. The Inspectorate has been in discussions with WRAS to work with the industry to ensure that fittings made of nickel are clearly identifiable so that consumers, plumbers and house builders can avoid products at the root of this emerging issue.

Aluminium – 4 failures

There were four aluminium breaches in the third quarter (NNE 1, SVT 1, YKS 1, TMS 1). The failure in the Sacriston zone of Northumbrian Water occurred as a transient disturbance in the area following a burst main 2 hours before sampling. Initial resamples in the area failed for aluminium and iron. The company carried out flushing to remove the discolouration. No further action was taken by the Inspectorate although investigations into the breaches at Waveley Road (SVT), Knaresborough (YKS) and Royal Docks West (TMS), did not identify a root cause.

Iron – 27 failures

There were 27 iron failures in the quarter (DWR 5, BRL 1, HDC 1, NNE 2, SVT 4, SEW 3, UUT 7, WSX 1, YKS 3). Of these 26 were considered to be

either trivial, unlikely to recur or there were legal instruments in place to address the risk of recurrence.

In September, there was an exceedance in South East Water's Butlers Green zone. The company are planning rezoning the DMA to increase pressure and improve cleansing of the network, but the Inspectorate has recommended that the company need to instigate some short term measures to improve water quality promptly as the compliance of this water supply zone is currently above the PCV for iron. Where a supply remains at risk of non-compliance with the standards and therefore likely to recur, enforcement would be the most likely outcome.

Manganese – 3 failures

There were three failures for manganese in this quarter (DWR 1, YKS 1, UUT 1). The failure in United Utilities Quarry Hill zone in August is covered by a legal instrument for improvements. The failure in Abergale/Rhyl zone (DWR) also failed for iron and the 12 inch cast iron trunk main upstream of property is to be replaced as part of company zonal studies. No definitive cause was found by DWR or YKS for their breaches. The conditions of mains and historic deposition of metals from the source water increase the risk of re-suspension coincident with sampling. Repeated failures or failures in conjunction with other metals require further investigation and remediation to reduce the future risk.

Benzo(a)pyrene – 2 failures

In July, South West Water detected an exceedance of the Benzo(a)pyrene standard in their Dousland zone. An exceedance of this parameter is normally associated with the degradation of coal tar lined mains. However, the main supplying the property is a 6 inch cast iron main lined with polyethylene and as such no failures have previously been experienced in this zone. An initial resample also failed and further investigations concluded that a burst main on the inlet main to an upstream service reservoir at Hardwick was the most likely cause of the failure as the lining of the main is bituminous. The company have mitigated the risk by adopting site specific arrangements including the closure of the inlet valve to the reservoir should there be a similar burst. All further resamples taken in response to the burst have passed.

In August United Utilities detected Benzo(a)pyrene in a sample from Heswall zone. In response the company collected resamples from the original failing and neighbouring properties - all resamples were clear. The property is supplied by a polyvinyl main and no work was ongoing in the network which could have impacted on the detection. There have been no previous Benzo(a)pyrene or other PAH detections in the zone. No contacts relating to hydrocarbon type taste or odours were received and the company could not identify a likely cause for the exceedance.

Cyanide - 2 breaches

There were 2 breaches of cyanide in Middleton and Bowes supply points in August served from Lartington works (NNE). The breaches were notified as

an event with a subsequent audit by the Inspectorate. The event and audit assessments are currently ongoing.

Copper – 1 breach

Copper was detected in a sample from a consumers tap in Sandown/Central zone by Southern Water in July. Investigations by the company identified the cause to be most likely arising from the domestic plumbing. The consumer was advised to employ an approved plumber to investigate fixtures and fittings. The use of approved plumbers such as WaterSafe should always be used to ensure materials in premises are of an appropriate quality from an approved list.

Fluoride – 69 outside operational limits

There were 69 occasions where fluoride levels were found to be outside the operational limits, none were above the permitted standard (ANH 21, NNE 24, SST 6, SVT 15, UUT 3). Fluctuation of operational limits can occur when dosing at treatment works is shut down or where there are operational changes to the way the water supply is distributed. For instance, Northumbrian Water stopped dosing at Horsley Works in January 2019 for operational reasons. Public Health England who are the responsible authority for fluoridation were made aware.

Pontardawe Taste and Odour

This example case describes the supply of water variously described by consumers as having a chlorine, metallic, chemical or a disinfectant taste and odour. This unacceptable outcome followed a configuration of the network supply in July to conserve water during the summer of 2018 and was consequential upon returning the network in September introducing water which had resided in a cement-lined trunk main for a prolonged period. Opportunities were missed in the risk assessment which may have avoided the outcome including simple on-site taste and odour tests and, fundamentally, pH measurement. For wider learning the event is described in detail below.

In 2018, Dwr Cymru Welsh Water altered the configuration of the supply network serving 4,279 consumers in Pontardawe, near Swansea, to conserve water during the hot summer. An area usually fed from Crai water works was transferred to the Felindre works system in order to conserve raw water stocks at Crai as a part of the company's drought plan. This change involved isolating a section (6,290 metres) of a 600mm diameter cement lined trunk main that would normally supply water from Crai works to Pontardawe. The company carried out a risk assessment of this planned change, which identified that the reduced flow in the trunk main could affect water quality when it was returned to supply. As a precautionary measure, a trickle cap was installed on the main to maintain a sweetening flow, and weekly flushing of the main was specified as a requirement in the risk assessment.

A similar change had, apparently, been made in the past without a detrimental effect on drinking water quality. On 3 September 2018 the company reversed the network changes, and restored the supply from Crai to Pontardawe through the 600mm trunk main. Water which had been standing in the 6,290 metre section of main for two months was put into supply. The company monitored flow in the main and carried out on-site tests for turbidity. There was no on-site monitoring of pH, taste or odour, and no samples were taken for laboratory analysis. The following day, consumers contacted the company complaining about objectionable tastes and odours.

The network change was reversed, restoring the supply from Felindre. Flushing was carried out in the network and a bottled water station was established at a local supermarket. The company received 75 complaints between 4 and 6 September; 71 of objectionable taste and/or odour and four complaints of illness.

The outcome was an avoidable event because the effect of a very low flow of soft (low alkalinity) water in a large-diameter cement lined main should have been considered in the company's risk assessment of this planned change. The risk assessment was based on a network model, with assumptions made about the flow through the trickle cap and the volume of the weekly flush. It was not verified by anyone else in the company with appropriate skills and knowledge. The company was unable to provide the Inspectorate with any evidence that weekly flushing had been carried out in accordance with the risk assessment. The trickle cap was not calibrated and the company did not know what flow of water, if any, had been maintained through the trunk main whilst it was out of commission. The risk assessment did not consider the effect of cement lining on stagnating low alkalinity water, and did not identify the need to monitor pH, taste, or odour when the main was returned to supply.

The Inspectorate sent questionnaires to consumers affected by the event, and took witness statements from affected consumers, one of whom was the head teacher of a primary school. Consumers confirmed that they rejected their drinking water for consumption because of the taste and odour. Some consumers were concerned because they were not informed about the bottled water station. Some consumers reported that, on contacting the company, they were told that the water was safe to drink. The Inspectorate has repeatedly raised concerns with water companies that consumers should not be given this advice until there is analytical information available from sampling to confirm it.

The company attributed the cause of the event to deterioration of the cement lining of the trunk main. The Inspectorate considered that the company's risk assessment of the planned change was seriously flawed, because consideration of the effect of the cement lining on the pH of the water, which could cause changes to water quality that consumers might notice, was a basic consideration that a competent water supplier should have foreseen.

The Inspectorate concluded that unwholesome water was supplied to consumers because consumers reported unacceptable tastes and odours. There was evidence that the company supplied water that may have been unfit for human consumption since it was rejected by consumers. The company accepted that they were responsible for the event. They also agreed that samples taken failed regulatory standards and that consumers rejected their tap water for consumption because of unacceptable taste and odour. However, the company did not agree that water supplied to consumers was unwholesome or unfit. The measure of 'unfit' is a matter for the Court to decide. After assessing all the circumstances and the actions taken by the company to prevent a recurrence, the Inspectorate made a number of recommendations and issued a formal warning letter to the company in November 2019.

Since the event, Dŵr Cymru Welsh Water has amended i ts procedures to ensure that samples for pH, taste and odour are taken in similar circumstances.

Water companies should ensure that there is appropriate scientific input into risk assessments for major planned changes in order to assess likely effects on drinking water quality and public health. Actions such as regular flushing and monitoring, which may be a requirement following a risk assessment, should be clearly documented in operational procedures and records should be kept to verify that they have been carried out in accordance with the plan.

Audit Programme – Risk Identification

The Drinking Water Inspectorate advocates a water safety plan (WSP) approach to identify and mitigate risk from source to tap. From the point of abstraction to the boundary box at properties, all assets are fully under the control of water suppliers meaning water treatment processes and distribution systems should be designed, operated and maintained at a standard so as not to unnecessarily add additional risk. However, water companies need to be prepared for risks where they may not have full control in consideration for necessary actions. Such risks include those presented by raw water which require mitigations either in the catchment, source or asset design and operation.

A series of seven audits were undertaken, in the third quarter focussing on such challenges. The risks were diverse in nature, with a mix of microbiological and chemical risks upstream and at assets focussing on examples of good and conversely poor risk identification and mitigation. The

findings and outcomes of six of those audits are reported below. One remains under investigation.

Raw water risks

Collaboration, planning and proactive action by companies in working towards controlling catchment hazards where interdependency exists is strongly encouraged. Working with stakeholders helps shared outcomes. For instance, farmers are vital to our society as the starting point of our food chain. Their activities have to balance the needs of the environment and can influence the catchment from which source water is derived. Water company operators and asset planners should be aware of the risks a works may face and these must be appropriately captured and available in drinking water safety plans. A good example of which was observed at the audit of Yorkshire Water's Irton works.

To help reduce contamination of their catchments, Yorkshire Water has shared information about water quality to support farmers in obtaining scheme grants to improve on-farm infrastructure including: installing and repairing roof gutters, segregation of clean and dirty water systems; concreting of yards to make them easier to keep clean (and prevent contaminated faecal material being washed away). It was also noted that roofing was also installed over slurry stores to reduce the pollution risk to the local watercourses feeding Irton works. Since 2018 the company has held 12 influencing events for the farmers in the region covering a wide variety of topics all aimed at reducing the water quality risk from Farming activities: e.g. Manure management, nutrient management, soil condition, pesticide management and farm infrastructure. The company provided biofilters and 2 pesticide wash down areas at farms upstream of the Irton works. Such an approach is welcomed, however, the water safety plan approach is to review the impact of these measures to ensure that the impact of catchment measures is continually weighted and updated.

During the visit to Southern Water's Sandown works, on the Isle of Wight, it was noted that livestock were present in a field adjacent to the works intakes. Company staff present at the audit were unsure if this had been identified in the WSP. As a living and working document, a water safety plan should be available to all staff and not compartmentalised as the objective of such a plan is source to tap. Details were subsequently provided showing a generic assessment for pathogenic bacteria and protozoa "from a number of known livestock and dairy farms across the catchment and there may be poultry and pig farms". The use of a generic assessment fails a key criteria of a WSP, to be an assessment of the supply system to which is relates. Assessment of the immediate catchment to ensure that all current catchment risks specific to the supply system was recommended.

Treatment Process Risks

Manganese from raw water is a challenge for a number of water companies and treatment works, not least Sandown works (SRN). The company are trialling greensand media for enhanced manganese removal in one microfloc rapid gravity filter. The investigation into the effectiveness was ongoing at the time of the audit. The granular activated carbon (GAC) was replaced in two vessels with the remaining two scheduled for replacement in 2019 (a programme of work subject to a notice). The company were unable to demonstrate a good understanding of how the manganese concentrations were changing when employing this mitigation. Any mitigation as part of a WSP must be verified to determine effectiveness, this is also a key criteria which the company has failed to enact. Continuous monitoring for manganese at appropriate stages was suggested to help meet the investigation requirements of the notice.

As part of the investigation into repeated bacteriological investigations in treated water from Strensham works, Severn Trent Water has methodically investigated the role of ingress into treated water assets, establishing which parts may be subject to ingress. A summary of this investigation, as provided by the Company, may be seen below and is an example of good practice in investigating a long term water quality issue.

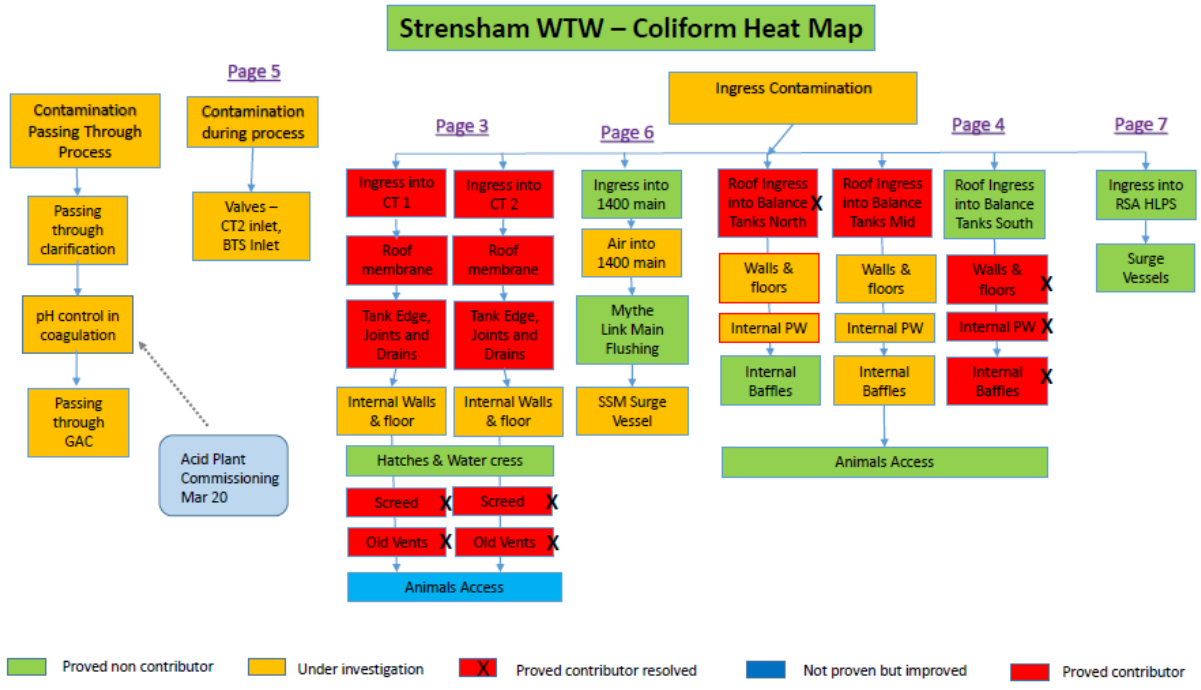


Figure 2: Microbiological heat map at Strensham works

Following an event at Affinity Water's Iver works, the Inspectorate recommended improvements to the process returning supernatant water to

the head of the treatment works. The turbidity reading at the time of the audit exceeded 10 NTU, a value in excess of recognised good practice, (Twort et al), this value applies if the return is <5% of the raw intake.(Lower values of <5 NTU were suggested by Logsdon, 1998). However, the arrangement was likely to be unrepresentative as the monitoring arrangement comprised of a turbidity probe located in a break tank on a pumped sample line (fig. 3). Sediment is likely to accumulate in the bottom of such a tank which when disturbed, for instance by opening the cabinet doors, will cause an erroneous reading. The company installed a new monitoring kiosk (fig. 4).

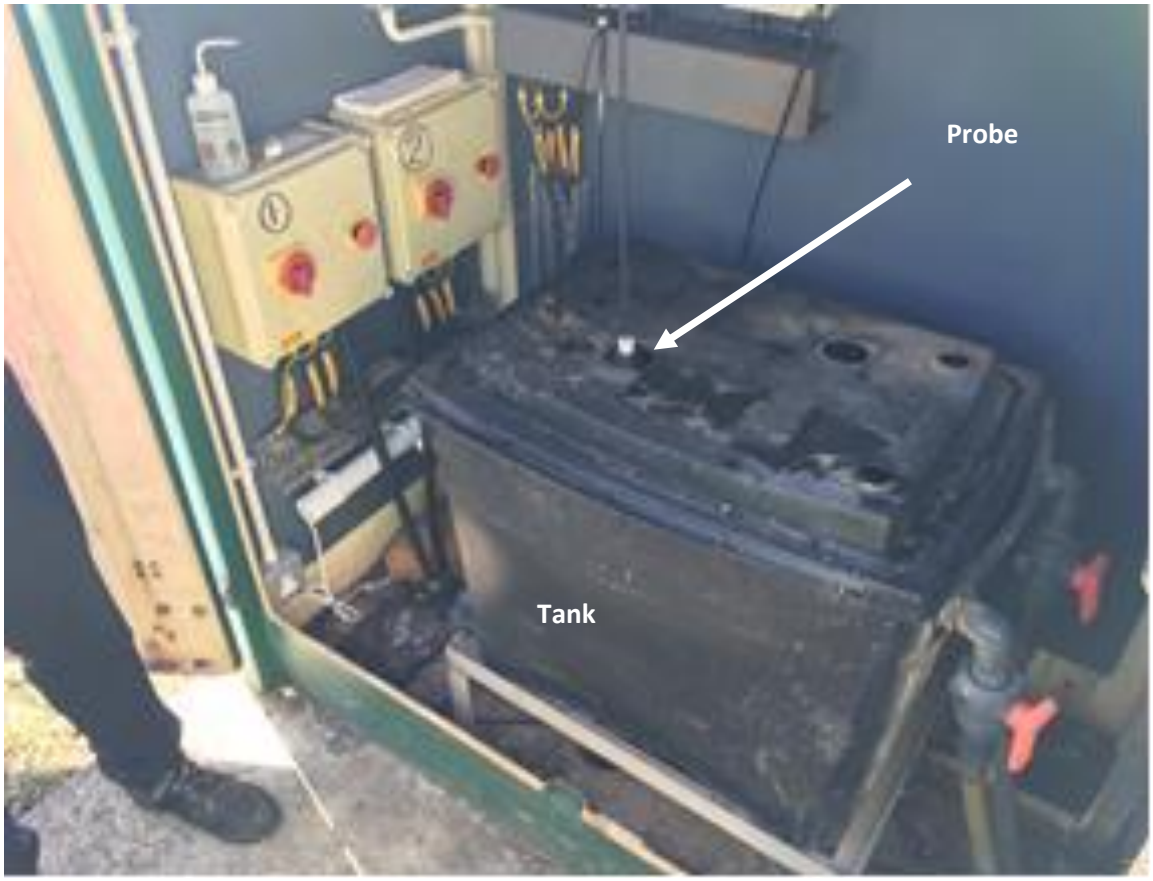


Figure 3: Sample tank for supernatant turbidity monitor at Iver works

Figure 4: New supernatant turbidity kiosk at Iver works

There are currently no clear means to remove turbid water at this stage on this site and should the supernatant return exceed 10 NTU only a short period of suspension of return is possible. Such an arrangement presents an ongoing water quality risk should there be for instance of *Cryptosporidium* oocysts in supernatant return as this will overload the treatment processes rendering the works effectively inoperable. The absence of a run to waste facility at Iver works, which has variable raw water quality presents a significant risk. A recommendation was made for the company to install an intercept, containment, discharge or run to waste system as appropriate to protect public health.

Since 2016, Thames Water's Chingford works experienced two flooding events after which capital investment prevented further flooding of critical equipment at the GAC stage. Protection of a vital utility should be commended. It was also welcome to see that sludge supernatant from the DAF process is not recovered at Chingford works due to the high risk of *Cryptosporidium*, an example of hazard identification and appropriate risk mitigation. Badenoch (1990) stated that the dilution of wastewater

supernatant with the raw water intake could ensure this recovery is satisfactory. However, with oocysts present in the raw water “the situation is transformed to become potentially dangerous”. The wastewater pumping station is automatically level-controlled and pumps the waste off site to a sewer re-pumping facility.

Structural Issues

Since assets are under the control of water suppliers, no additional risk should be added due to a failure to adequately operate or maintain an asset. At Thames Water’s Chingford works it was noted that hatches were suitably secure and positioned on adequate concrete upstands. However, it is disappointing to observe a missing seal with water staining from the top of the hatch downwards suggesting possible ingress in light of the missing seal (fig 5). Similarly, a hatch, which contained a sample line, was around 20cm deep in water within the interior and the point at which the line and cabling entered was not sealed. Three open holes (approx. 0.5 to 1cm in diameter) were observed on the plate potentially permitting access to insects. Recommendations we made in both cases.

Figure 5: Missing hatch seal on Chingford Contact Tank

Southern Water installed a frame and plastic covering over the contact tank at Sandown works, as a temporary mitigation to address known leaks in the roof. The covering was ineffective with water still pooling on the tank roof (fig. 6). It would be reasonable to question why ongoing maintenance had not prevented leaks in the contact tank roof. Notwithstanding this, mitigation in response to a leaking roof might well be to fix the roof as a high priority. The Inspectorate recommended that the company reviews the drainage and prevents pooling on the tank roof in the interim.

Figure 6: Ongoing run off of surface water onto Sandown's contact tank roof

Severn Trent has had a number of bacteriological failures at Strensham works attributed to ingress. Historically, ingress has been remediated by repeatedly patching the roof with more concrete. Such a strategy might be questionable as it proved to be. Over the years the integrity of the walls of the contact tanks were compromised as the extra concrete load on the roof exceeded the design load capacity of the walls. The contact tanks have been covered with a 'tent' to mitigate bad weather risks, whilst longer term repairs are completed (fig. 7). About 2,000 tonnes of additional concrete is being removed from the roof to bring it back within the design specification. Electric diggers rather than conventional ones are being used to eliminate the risk of fuel spills. A salient lesson as the additional cost to the company

could well be in excess of that had the roof been repaired properly in the first instance.

Figure 7: Protective cover over the contact tank at Severn Trent's Strensham works

At Iver works (AFW), the filter outlet channels were covered in warped and poor fitting steel chequer plates (fig. 8). Recommendations were made. The design of Iver works is such that the backwash tank is located beneath the filters. This is not an unusual configuration as designers seek to reduce the footprint of works by stacking process stages. More common is the location of a contact tank under the filters. This design saving is still used in recent builds and should be considered as designing in additional and unnecessary risk. When the concrete deteriorates with age leakage from the filter to the tanks below can occur and has been observed in older works. This effectively bypasses the treatment process and will inevitably lead to a water quality risk. Affinity Water have not included the old backwash tank at Iver works on their internal inspection programme since it is situated beneath the filters and difficult to access.

Figure 8: Debris and poor fitting plates above the filter outlet channel at Iver works

Without an inspection the company cannot conduct a complete risk assessment. Whilst the company acknowledge that an inspection would make the risk assessment more robust they have chosen not to complete this. Instead, the company are considering the inclusion of another back wash water tank in the scope of treatment improvements at the works scheduled for AMP7.

Located next to the treatment building at Wessex Water's Milborne works is an electrical substation, of which the oil filled cooling system was not considered as part of the drinking water safety plans. The company acted swiftly to capture the risks across its works negating the need for a recommendation from the Inspectorate.

General Site Issues

At Chingford waste is pumped off site to a sewer re-pumping facility (independent of Chingford WTW). It is not possible for any contents from the wastewater pumping station to travel back to the treatment process due primarily to the level difference and an interlocking treatment process preventing the overfilling of the wastewater pumping station. This is good practice and enhances the risk mitigation of waste described in the Treatment Process Risks section above. Companies are advised to consider all sewage risks are captured and reported as part of their risk assessment as it must be a responsive living document. However, details of the sewage arrangements at Chingford works identified four medium or high risks and a number of more minor risks. The Inspectors recommended that the company updates its regulation 28 report in light of these findings.

Badenoch 1990 when referring to service reservoirs stated that the grazing of grassed roof covers by livestock should be discouraged. He observed that ingress of oocysts pose a particular risk when no further treatment barrier exists. The use of sheep for grazing near raw impounding reservoirs and other non-treated water areas is well known and utilises an otherwise unused green resource, provided this does not add unnecessary risk. However, a livestock trailer (fig. 9), parked in the grounds of Chingford works was assumed by Thames Water to belong to the local farmer for the purposes of transporting sheep. Whilst the presence of the vehicle on site does not itself present any direct or immediate contamination risk, given the link between sheep and waterborne parasites, its presence on a restricted clean water site does raise a question as to why it is there.

Figure 9: Sheep trailer in restricted area at Chingford works

The maintenance and hence appearance of a water treatment works should always be in keeping with a site which provides a food product. Chingford works was on the whole well maintained. It was somewhat let down by a large diameter pipe left near the refuse point (fig 10). It was indeterminate whether or not it was for disposal. Additionally, a ground maintenance contractor's chemical storage box was found to be unlocked, representing an un-controlled risk. In the interests of safeguarding against any unnecessary spillages or pollution risks on site, the Inspectorate recommended that

refuse points, containers and overall waste disposal arrangements are reviewed and improved.

Figure 10: Discarded pipe at Chingford works

On the land surrounding Wessex Water's Milborne works were a number of paddocks with horses present. The ground sloped down towards the works meaning that there was the possibility of run off from the paddocks into the site. The borehole head works and the roof of the contact tank were raised above ground level reducing the risk of contamination. However, consideration of ditches or drains at the site boundary could improve the situation. Site security was low and the chlorine injection chamber was not locked. Companies need to remain vigilant to this type of security risk.

Site Operation

The following case study reflects one of the worst examples of risk normalisation where a risk assessment is carried out by those unqualified to consider public health resulting in the readjustment of a company policy to suit the engineering work of a particular site. The outcome is unacceptable and puts an uncalculated risk into normal practice without reference to water

quality scientists. This type of behaviour has resulted in some of the most significant accidents in history.

A new UV plant was installed at Southern Water's Sandown works in April 2019 to mitigate for microbiological risks associated with ingress into the contact tank. UV should not be used as the mitigation against a structural ingress risk but as part of a multi-barrier treatment solution. Instead any ingress should be resolved by repair to the structure. In August, the company identified that the UV plant was having difficulty in maintaining the company standard UV dose of 40 mJ/cm2. It is possible that manganese coating the sleeve of the UV tube reduced the lamp intensity.

Southern Water's Engineering Technical Services Team conducted a risk assessment and decided to lower the site shutdown criteria to 26 mJ/cm^2 which had the effect of increasing the risk of the water treatment process by normalising the intended mitigation to a lower standard. The UV plant had still not been handed over to operations from the project team and at the time of the incident, the company had not updated the Site Specific Disinfection Policy or site manual and operating plans did not reflect the presence of the new UV process. The company failed to notify the Inspectorate of this challenge to disinfection and the Inspectorate advised the company to raise this as an event.

It is worth re-emphasising that this event poses a number of issues to regulatory compliance and the protection of public health. The UV reactors had been installed as an additional temporary step to mitigate the increased risk identified by ongoing leakage in the contact tank. Southern Water had been unable to remove the tank from supply due to issues with alternative supplies.

The UV process was installed as a disinfection step and clearly should have been included in the site specific disinfection policy. The Inspectorate's guidance on regulation 26 requires companies to have disinfection policies for its treatment works and that those policies should be kept under regular review, so when new treatment is introduced, this needs to be included in the policy straight away. Disinfection policies should also be free from ambiguity in how disinfection is achieved. A failure to do so could be considered a failure of the design and continuous operation of a treatment works and could lead to an offence under the regulations.

In this case, the decision to operate at a lower UV dose was not in line with the companies overarching policy for UV treatment and the decision to operate at this level was not authorised by trained and competent water quality staff. This is not appropriate and again highlights the risk companies take when new capital schemes are not operated by trained water treatment staff, but instead are left in 'limbo' where process control and operational responsibilities remain unclear. Ultimately, of course, companies are responsible for the design and operation of their treatment works and shall bear the consequences when deficiencies occur.

Companies must consider, as part of their drinking water safety plans, the risks associated capital schemes pose to their treatment processes and in particular the risks faced in the period between the commencement of commissioning and full handover to operational staff.

Southern Water are subject to a Regulation 28 notice, which requires the company to develop a new methodology for the completion of site specific disinfection plans and it was further recommended that more timely amendments to disinfection policies are made. During the audit, it became apparent that only the process scientist for the site was aware of the current site specific disinfection policy. A recommendation was made for the company to review how it disseminates and communicates its disinfection policies and ensures all relevant staff understand it and readily have access to it.

Wessex Water's Milborne St Andrew works represents a further example of how risk normalisation becomes embedded in day to day acceptance. The audit team identified short lived drops in chlorine concentration, yet the treatment works continued to operate as if this was normal. The company's investigation subsequently identified that every Wednesday morning dosing significantly reduced due to the changeover of duty chlorine cylinders.

Whilst such risks may be short lived, companies should consider the operation of chlorine changeover systems with a view to avoiding any loss of chlorination upon changeover.

The contact tank at Milborne works was due for major programme of changes such that it is used for the purpose it was intended, that is a contact tank and NOT for onsite blending with other supplies. Companies are reminded of paragraph 26.10 of the guidance which requires that contact tanks should not be used to provide on-site storage or blending.

Whilst there is a procedure for the use of override switches for chlorine instrumentation at Thames Water's Chingford works, it is possible for the plant alarms to be manually overridden when it is in supply, which presents a significant potential risk to breaches of regulation 26.

Thames Water asserted that this operation would only be employed to perform specific tasks such as enabling maintenance and to set shutdown times, and would only be carried out by competent process controllers. Mitigation of risk is reliant on individuals being suitably trained and deemed competent. Whilst this may well be the case, the use of overrides have been used in other companies to overcome safety systems when under pressure to re-start a works. Recommendations were made to ensure that the policies, procedures and risk assessments covering this process were robust and which are set out in an existing improvement notice for Thames Water.

The empty bed contact time for the GAC plant at Chingford works does not meet the company asset standard of 15 minutes and the Inspectorate

recommended Thames Water assesses the risk of this deficiency and update its regulation 28 report for Chingford treatment works accordingly.

Air Valves

Yorkshire Water provided evidence of its air valve risk assessment methodology and procedures for their operation and maintenance. The company has recorded 15,298 air valves on its asset database. The company has acknowledged that air-valves represent a real risk of ingress and identified the location and hydraulic profile of all air-valves for its pump-fed service reservoirs, in order to prioritise inspections. The company does not proactively inspect each location on a routine basis, an approach it considers pragmatic. The combination of location, condition and the pressure situation, impact upon the risk. The company has taken the approach to inspect at risk locations following indications of unusual activity. For example after service reservoir coliform detections. The Inspectorate welcomes the risk approach of Yorkshire Water. The company are now working towards including routine proactive inspection of 'at risk' air-valves for service reservoirs.

Severn Trent Water's Strensham works has four air valves. All of these were replaced as part of water quality investigations or other site upgrades. These are inspected every 6 months. None of the air valves are in chambers that are considered likely to flood.

A recommendation was made that Thames Water include the risks associated with ingress via air valves within its drinking water safety plans. The company is planning a desktop study to identify the highest risk air valves before developing an inspection programme. Reactive inspections of air valves are planned in response to service reservoir failures downstream.

Affinity Water were unable to demonstrate that any inspections or maintenance had been carried out on air valves associated with Iver works or its downstream reservoirs due to a lack of records. The company failed to adequately address the Inspectorate's recommendation that a suitable air valve inspection policy be produced. Such inaction may lead to uncontrolled risks of ingress to the water supply network.

Companies such as Affinity Water should have in place a risk based air valve inspection policy and this should be considered alongside the guidance laid out in the Principles of Water Supply Hygiene including paragraphs 8.1 and 8.3 and also Technical Guidance Note 2. Not to do so retains unnecessary risk within the assets of a company.

General Issues

During the site walkover at Sandown works (SRN), it was identified that a treated water main was attached to a run to waste hose (fig. 11). There was no backflow protection in place and no vermin protection either. Although

the installation of the run to waste pipe was well intentioned in allowing improperly treated water to be removed from the supply system, it was poorly executed on this occasion. A simple fittings inspection would have identified this unnecessary risk.

It is important that such temporary alterations to treatment works are appropriately risk assessed by those with the competence to ensure water quality and public health are protected.

Figure 11: Temporary hose connected to treated water main at Sandown works

The Inspectors welcomed the development of a dedicated Disinfection Room for WQ instrumentation including chlorine dosing control, turbidity and a dedicated bench testing area at Iver works (AFW).

Figure 12: Dedicated Disinfection Room at Iver works

Important developments relating to regulation 31

Two issues have recently emerged that relate to approval under regulation 31. Whilst Water UK is already aware of these issues the purpose of this note is to ensure that they are brought to the attention of the water industry and contractors more widely.

Approval under regulation 31(4)(a) requires products to be tested against set protocols by designated laboratories. The requirements are set out on our website:

http://www.dwi.gov.uk/drinking-water-products/advice-and-approval/index.htm

The tests are intended to ensure the products do not leach harmful substances, cause taste or flavour problems or lead to microbial growth. The most complex of the tests requires leachate preparation and analysis by gas chromatography mass spectrometry (GCMS). Following the closure of one of the test laboratories, LGC, there is now only one laboratory that can carry out leachate preparation and GCMS testing.

Whilst the approval process can continue, the consequence is that testing may take longer or applicants may decide not to pursue testing. In turn this

may slow innovative products being made available to the industry. Water companies would be advised to consider this collectively to avoid any impact on their supply chain. Solutions might well be collaborative working towards further laboratories becoming designated as this will be of benefit to the industry. Details of the requirements to become a designated laboratory can be found on our website

http://www.dwi.gov.uk/drinking-water-products/advice-and-approval/protocol0.pdf

The second issue relates to in-situ relining of mains. In September, NSF announced that it would terminate all its certification activities for the in-situ resin lining of water mains against the requirements of the Water Industry Specification WIS 4-02-01 and the Water Industry Guidance Note IGN 4-02-02. The conditions of approval for in-situ applied pipe coating products require that they must be applied by a certified contractor and in accordance with the WIS and IGN. NSF was the only certifying body and at the time of ceasing the scheme it only had one certified contractor which was accredited for a product which is no longer available. Effectively this means that in-situ resin relining of mains can no longer be conducted. Applications for approval of in-situ applied pipe coatings will continue to be processed, however, the industry will need to ensure a certifying body and certified contractor are available before these products can be used.

Legal Instruments

The legal instrument reporting requirements are being revised. The first change was notified to the industry during this quarter, with a reduction in the annual progress report burden. The Inspectorate only requires a summary report for those schemes which are on target, full reports only being required for those schemes which have been delayed.

New Legal Instruments Issued

In the third quarter of 2019, the Inspectorate served six new legal instruments, all of which were notices under Regulation 28(4) (1 NNE, 1 SEW, 1 SST, 1 SVT, 2 WSX).

Four of these notices are associated with AMP7 improvement programmes; NNE – discolouration, SEW – Chromium, WSX – Nitrate (x2).

A new notice was served on South Staffordshire Water for Clorthal at Slade Heath. The notice requires the company to identify and install long term solutions for the presence of Tetrachloroterephthalic acid (TPA) a metabolite of the herbicide Chlorthal-dimethyl (Chlorthal) in ground water. This product is no longer approved for use in the EU. The short-term control measures are the reduction in site output and the use of temporary GAC

contactors. The company will investigate more sustainable, long term and efficient treatment options such as ion exchange.

A notice was served to Severn Trent Water for improvements to the contact tank and associated equipment at Strensham WTW, following a series of 5 microbiological contamination events over 2 years.

Closures

The Inspectorate received 34 closure reports in the third quarter of 2019 (1 ANH, 3 DWR, 1 SRN, 22 SVT, 2 TMS, 2 UUT, 2 WSX, 1 HDC).

Dŵr Cymru submitted three closure reports for improvement schemes at Glascoed, Cwmtillery and Tynywaun treatment works.

Thames Water submitted a closure report for improvements at Hambeldon treatment works, which should deliver improved turbidity and *Cryptosporidium* control. The second closure was for improvement works to the contact tank at Bishop Green treatment works.

The Wessex Water closures were for turbidity improvement work at Little Cheney and Codford treatment works.

The high number of closures submitted by Severn Trent Water were associated with discolouration improvement notices. The Inspectorate assessed the discolouration performance improvements made by the company and concluded that some could be closed, some should be extended and others needed a change of solution to deliver the required outcome. The Inspectorate will continue to work closely with the company to improve performance in this area.

Change Applications

Two applications to change legal instruments were received by the Inspectorate during quarter three (1 ESK, 1 NNE).

Milestones

Companies submitted 52 milestone reports (independent of closure reports, change applications and annual progress reports) to the Inspectorate during the third quarter of 2019 (2 DWR, 2 ESK, 3 PRT, 27 SRN, 1 SST, 6 SVT, 6 TMS, 4 UUT, 1 ANH).

Portsmouth Water submitted milestone reports for three of the disinfection notices that the company have. The inspectorate will continue to work with the company to improve disinfection across its asset base.

Southern Water are maintaining the momentum built up with their transformation programme. The treatment works hazard reviews (HAZREVs) account for over half of the milestone reports submitted during the quarter. The company have now completed assessments of over 85% of their treatment works, which is producing a very detailed register of the water quality risks at those sites. The company face a challenge in mitigating those risks, but continue to work towards this goal.

All of the Thames Water milestone reports received within the quarter were associated with their transformation programme notices. These included updates on membrane plant installations; reviews of company policy, outputs and control measure from company's Hazard Review programme; review of training material, gap analysis and action plans for flood control measures; and in management and competency reviews.

Radioactivity waivers

During the third quarter of 2019, the Inspectorate received two applications from Leep Utilities to cease regulatory monitoring for radioactivity parameters under regulation 6.

Regulation 15 Applications

There were no applications under regulation 15, to use new sources during the third quarter of 2019.

Recommendations

During the third quarter the Inspectorate made 165 recommendations to water companies (AFW 12, ANH 10, BRL 1, DWR 2, NNE 4, SBW 2, SVT 15, SEW 5, SST 12, SWT 11, SRN 10, TMS 9, UUT 46, WSX 4, YKS 22). Generally, audits and events account for the largest numbers of recommendations made and this holds true for the 3rd quarter of 2019 (complaints 4, compliance 20, audits 74, events 60, legal instruments 7).

The high number of recommendations made to United Utilities and Yorkshire Water were contributed to by a number of unsatisfactory audits (as reported in the Risk Audit section).

PR19 Notices

The vast majority of AMP7 improvement programmes supported by the Inspectorate have now had legal instruments issued. There has been a strong focus on Nitrate risks by some companies, with both catchment management and treatment/blending schemes being implemented. There are a number of large scale treatment work upgrades aimed at reducing the risk of supplying unwholesome water. Other companies have focused on taste and odour improvements and reducing disinfection by-products. There has also been a strong focus on improving discolouration performance with schemes focusing on both treatment works (reducing metals output and hence the seeding of supply networks) and on improving the networks themselves.

As the beginning of the next investment period approaches, the Inspectorate expects companies to be preparing to deliver the work which has been committed to and look forward to receiving the first progress reports.

Research on Private Water Supply Chemical Disinfection Systems

Regulatory sampling of drinking water in England and Wales shows that the microbiological quality of public water supplies is much better than that of private water supplies. This suggests that, where disinfection is being applied in private supplies, it may not always be effective in removing or inactivating potentially harmful microorganisms. The research investigated how the implementation of chemical disinfection by private water supplies might be improved.

Commercial sodium hypochlorite is the most commonly used chemical disinfectant for potable water supplies. On-site electrically generated sodium hypochlorite (OSEC) and chlorine dioxide are also used. Chlorine dioxide is commonly used for supplies provided for food and drink processing.

Private supplies do not have as robust disinfection arrangements as public supplies. For example, they are unlikely to incorporate a purpose-designed contact tank to provide the contact time for disinfection instead relying on storage tanks or reservoirs to provide a mechanism to do this. Private supplies are likely to be operated on the basis of maintaining a target residual concentration entering the distribution system.

The report identified that community private supplies (those serving only, or predominantly, domestic properties) have less robust disinfection arrangements than commercial private supplies (those operated by commercial entities to serve their commercial activities). Community supplies tend to be reliant upon manual sampling to monitor residual disinfectant; are unlikely to routinely monitor any other water quality parameter; are unlikely to include any remote monitoring or detection of failures; and often have old infrastructure, the condition of which can be difficult to assess.

Risk assessments by local authorities (LAs) are a valuable mechanism for identifying vulnerabilities in private supplies. Constructive relationships between LA staff and private supply owners were evident at all the supplies visited.

A number of key suggestions are made that would improve the reliability and performance of chemical disinfection for private supplies. These suggestions and other findings of the report have brought the attention of local authorities and private water supply users through a workshop and the publication of two leaflets on the DWI website:

- Private Water Supply Chemical Disinfection Systems Owner Guidelines
- Private Water Supply Chemical Disinfection Systems LA Guidelines