Drinking Water Quality Regulator for Scotland

DRINKING WATER QUALITY REGULATOR FOR SCOTLAND

Drinking Water Quality in Scotland 2018 Public Water Supply

SAFEGUARDING YOUR DRINKING WATER QUALITY

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FOREWORD

This is the seventeenth report from the Drinking Water Quality Regulator for Scotland (DWQR). The report provides a summary of the quality of Scotland's public water supplies for 2018. My report also describes our work during the calendar year 2018 in scrutinising the quality of drinking water provided by Scottish Water.

Compliance with the standards set out in our legislation and in the EU Drinking Water Directive in 2018 was 99.90%. This is a slightly poorer performance than for the previous three years, with more samples than in 2017 failing the required standards at consumers' taps for measures relating to the appearance and acceptability of water such as manganese, iron and odour.

Scotland's weather in 2018 was challenging for Scottish Water with very cold weather during the March then a very dry Spring/Summer. The warm weather in summer 2018 led to very high demands for water across Scotland. Scottish Water worked extremely hard to ensure that services for consumers were maintained during these periods. The drawdown of reservoir levels and high water flows undoubtedly contributed to the increased number of failures for iron and manganese. There was also an increase in the number of water quality incidents related to taste and odour due to the presence of algae in the source water. I believe these issues have highlighted a lack of capability and resilience in Scottish Water's treatment assets which should be able to treat water regardless of the variations in source quality, and continued work is needed to ensure this.

I am very pleased that the number of water quality incidents has decreased significantly from 32 in 2017 to 23 in 2018 which in part reflects Scottish Water efforts on improving procedures and operator training through the introduction of the Competent Operator scheme. Scottish Water has also put in place operational solutions to reduce nitrite failures and the increased investment in service reservoir maintenance has reduced the repair backlog with no reservoirs reported as failing year on year.

Scottish Water has a large water quality investment programme that over a number of years has reduced the number of consumers at risk of receiving poor water quality in particular with regards to *Cryptosporidium* and disinfection by-products. A new treatment works for Oban went into supply at the latter part of 2018 and new works are scheduled for North Uist, the Ness area and Lairg during 2019/20, all of which will improve drinking water quality.

It is clear from drinking water quality performance in 2018 that Scottish Water must continue to invest in its water supply assets to ensure that they are more resilient to changes in source water quality and to drive improvement in performance.

Sue Petch
Drinking Water Quality Regulator for Scotland

2018 in review
Public Water Supplies in Scotland

238 Water Treatment Works

975 Water Storage Tanks

300 Water Supply Zones

Drinking water sources

There are 30,311 miles of drinking water distribution pipes in Scotland

We assessed:

319,124 tests were taken by Scottish Water

148,086 tests were taken at consumers' taps

99.90% of tests at consumers' taps passed

We reviewed 881 drinking water related events

We declared 23 incidents

We assess **every** fail | We review **every** event
We investigate **every** incident

1 DRINKING WATER QUALITY 2018

Water Treatment Works

Scottish Water has 238 water treatment works (WTW) that treat water to ensure it is safe to drink and complies with the standards set out in The Public Water Supplies (Scotland) Regulations 2014 (the Regulations). Treatment works in Scotland range from large supplies serving whole cities to very small works that supply small communities consisting of a few properties. Regardless of size, Scottish Water is expected to ensure that its water treatment works are capable of treating the range of raw water quality which may be found in source waters.

69,679 tests were carried out on samples collected at treatment works and, of these, 33 failed to meet the required standard. A summary of all the tests carried out on water supplied from treatment works is given in Table 2 of the Performance Tables.

Microbiological Quality at Treatment Works

Coliforms and *E. coli* are two parameters measured in water leaving treatment works to check that disinfection has been successful. All failures must be fully investigated by Scottish Water and reported to DWQR, the local NHS board and local authority.

When investigating sample failures at treatment works, Scottish Water consider a number of factors such as: changes in the quality of the incoming raw water; issues or unexpected changes in the treatment process; the circumstances of sampling, including the condition of the sample line and sample tap; and evidence from samples taken downstream in the distribution system. They should also consider taking additional samples, including between stages of the treatment process, to establish whether there is a genuine problem and where this might be. Data from on-line monitoring can also yield very useful information on quality around the time of the failure. Scottish Water routinely carries out root cause analysis of investigations of sample failures to help understand and resolve the causes underlying failures.

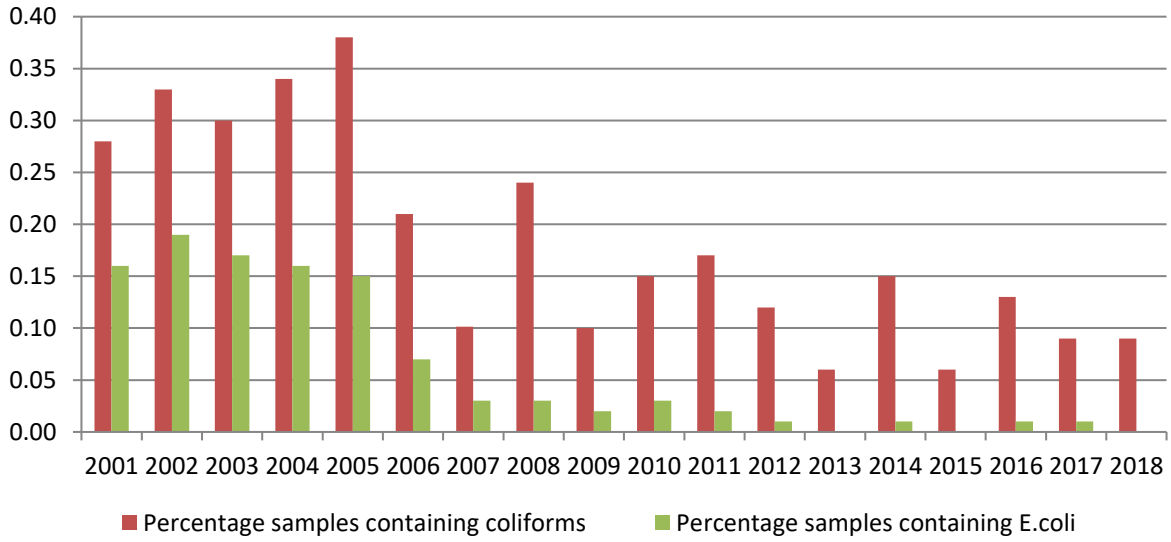


Figure 1 **Year on Year Microbiological Failures at Water Treatment Works**

Microbiological compliance, as shown in **Figure 1**, has improved over the years (summary data is given in Table 3 in the Performance Tables). There were 24 detections of coliforms at treatment works; while this was a slight increase on the 22 detected in 2017, the reduction in the number of samples taken in 2018 leaves the percentage of coliform samples failing the standard at exactly the same: 0.09%. No samples contained *E. coli*, compared with one detection in 2017.

Turret WTW, near Crieff, had two failures of the Total Coliforms standard in 2018. The first, in June 2018, was investigated by Scottish Water, but no cause for the failure could be determined. The second was attributed to potential issues with the sample point rather than the supply itself. DWQR staff carried out an audit of Turret WTW in 2019 and are satisfied that work is being planned to make improvements to the sample point.

A particularly high failure of the Total Coliforms standard was detected at Bonar Bridge WTW in September 2018, when a sample containing 9,800 coliform bacteria was reported. Investigations were carried out at the treatment works, samples were taken from the network and the treatment works was resampled. No issues with the treatment process were found. Investigations were also carried out by Scottish Water to determine whether there had been an issue with its sampling process or the laboratory analysis. No cause for this failure could be determined, but given the lack of other data to support that there was an issue with the supply, Scottish Water reported that it was unlikely to be representative of the quality of the supply.

Chemical Quality at Treatment Works

Water is tested for two chemical parameters, nitrite and turbidity, in samples taken from treatment works. Nitrite is a compound of nitrogen that can occur in supplies where ammonia is added to chlorine in a process called chloramination. This process needs to be carefully managed, and the presence of nitrite in significant quantities can indicate that it is not controlled as it should be. There were no failures of the nitrite standard in water leaving treatment works in 2018.

Turbidity is a measure of how much particles in the water scatters light – effectively how cloudy the water appears. Turbid waters cannot be properly disinfected, so a treatment standard of 1.0 nephelometric turbidity units (NTU) has been set in the Regulations. In 2018 there were nine exceedances of the standard for turbidity at nine treatment works, compared to ten exceedances in 2017. Of these nine sample failures, three were due to unrepresentative sampling by Scottish Water. Four were caused by disturbance of sediment that had accumulated in the treatment works' storage tanks of either lime, which is added to adjust pH, or naturally occurring manganese which had not been removed in the treatment process. There is more that Scottish Water can do to eliminate the number of final water turbidity failures through careful selection of appropriate sampling points, adequate cleaning of storage tanks and management of flow through tanks. Two turbidity failures could not be explained, despite Scottish Water carrying out root cause analysis of the failures. Summary data is shown in Table 4 in the Performance Tables.

Turbidity monitor, Poolewe WTW

Cryptosporidium at Treatment Works

Cryptosporidium is a microscopic protozoan parasite that can live in the gut of humans and other animals. *Cryptosporidium* oocysts can enter a water supply if faecal material is washed into the source (raw) water and oocysts are not removed by the treatment process. *Cryptosporidium* is not killed by chlorine and requires the water treatment process to be well optimised and monitored in order to ensure that it is physically removed. Scottish Water test water supplies for *Cryptosporidium* in order to verify that these processes are effective. Ultra-violet (UV) light can be effective at inactivating oocysts, and Scottish Water uses this process at a small number of sites as an additional layer of public health protection where physical removal of oocysts by the original treatment process is not achieved consistently.

Of 8,764 samples tested, 35, or 0.40%, contained *Cryptosporidium*, a slight reduction from the 0.48% in 2017. The 35 samples were taken from 23 treatment works, a slight increase in the 20 treatment works reporting *Cryptosporidium* detections in 2017.

Three treatment works, Invercannie, Bonnycraig and Rosebery have had *Cryptosporidium* detected in the supply at least once a year for five or more years.

Rosebery WTW in Midlothian had three detections of *Cryptosporidium* in 2018. Investigations by Scottish Water concluded that coagulation and clarification processes are inadequate as they are undersized and do not allow sufficient time for floc formation, which is exacerbated by high flows and periods of cold weather. A major upgrade has commenced to address these issues, and planned filter media replacement is expected to improve filtration and treatment capacity.

Invermoriston WTW beside Loch Ness recorded the highest number of *Cryptosporidium* detections, five, from any treatment works in Scotland in 2018. Inadequate treatment processes to remove *Cryptosporidium* from the raw water was the cause of these detections; Scottish Water installed UV disinfection as a temporary measure at the site in January 2019 to address this problem, and is due to complete a new treatment works for this area in 2020.

UV filter, Turriff WTW

Turriff WTW in Aberdeenshire had four *Cryptosporidium* detections in 2018 which were attributed to poor filter condition and performance. Scottish Water installed UV treatment in November 2018 to inactivate *Cryptosporidium*. Bonnycraig WTW, which serves Peebles in the Scottish Borders, recorded two *Cryptosporidium* detections, again, due to inadequacies in filter performance, and UV was installed in April 2017. In April 2019, DWQR served Scottish Water with enforcement notices for both Turriff WTW and Bonnycraig WTW due to ongoing *Cryptosporidium* detections in the supplies. These enforcement notices contain requirements for the short term, including optimisation of treatment processes and enhanced monitoring, as well as for improvements to the treatment works in the long term to adequately address the *Cryptosporidium* problem.

The enforcement notices can be found at http://dwqr.scot/regulator-activity/enforcement/.

Summary data is given in Table 5 of the Performance Tables.

Service Reservoirs

Service reservoirs are located at points in the distribution system to store water for hydraulic reasons and to meet the demand for water from consumers through the day. If these service reservoirs are not maintained they can be prone to inward leakage from contaminated surface water. This needs to be controlled through inspection and maintenance.

We inspect a selection of structures each year in order to ensure that they are being maintained and operated in a manner that minimises risk of contamination of the water.

Coliforms and *E. coli* samples are taken regularly from service reservoirs to check that disinfection is effective within the distribution system and to identify any instances where the water may have become contaminated. All *E. coli* and coliform failures must be fully investigated by Scottish Water and reported to DWQR, the local NHS board and local authority.

Summary results for service reservoirs in 2018 (Tables 6 & 7 in the Performance Tables) show a slight decrease in bacteriological sample failures compared to those in 2017, however no significant overall improvement in the number of coliforms detected in service reservoirs is shown over the last four years. DWQR has significant concerns about the condition of many of these assets and Scottish Water has increased inspection, cleaning and maintenance of these assets. **Figure 2** shows comparative annual performance since 2007.

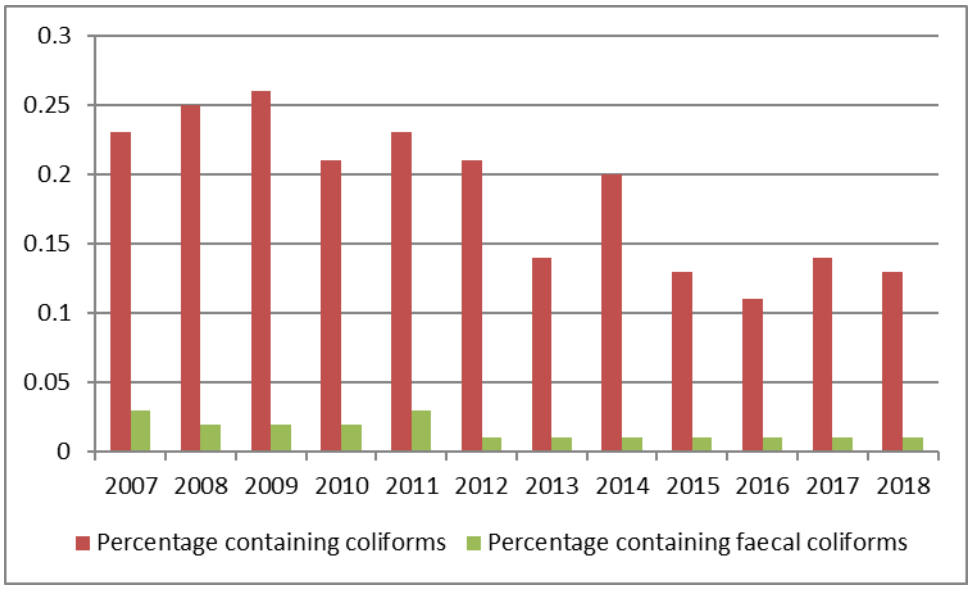


Figure 2 Year on Year Microbiological Failures at Service Reservoirs

The Regulations require that no sample from service reservoirs should contain *E. coli* and at least 95% of samples do not contain coliforms. One service reservoir failed to meet the 95%

requirement; two samples contained *E. coli*; and 66 samples contained coliforms. Scottish Water carried out a detailed Root Cause Analysis of each failure and were unable to determine a cause for the failures in around a third of occasions. Condition of the service reservoir was deemed to be the cause of the failure in approximately one third of occasions. Further details for notable failures are given below.

Failures for *E. coli* and coliforms at Dores, outside Inverness, were attributed to changes in pressure and a faulty air valve. In response, the reservoir was cleaned and the air valve closed off.

On Iona, an *E. coli* failure resulted in a 'boil water' notice and bottled water being issued to consumers. No definitive cause was found for this failure. This was assessed by DWQR as an incident and a full report can be found on the DWQR website.

Two coliform failures at Thainstone, Inverurie prompted an audit from DWQR. Scottish Water's investigation into the failures found leaks in the roof and around hatches which have been repaired. This reservoir also had failures in 2017 and 2013.

Lawton in Dundee, did not meet the regulatory requirement that 95% of samples should not contain coliforms. We declared an incident for this event and made a site visit to investigate in detail. The first failing sample had a count of eight coliforms, and two resamples also failed for three and 610 coliforms. Scottish Water found that the reservoir was in poor condition with a number of points where surface water could enter the reservoir. It was bypassed while repair work was carried out.

Achnahaird SR, Assynt

The monitoring requirement at service reservoirs is for weekly samples to be taken when they are in service and a 'live' part of the water supply route. There were shortfalls in the numbers of required samples taken from a number of service reservoirs. DWQR is satisfied that this is due to the reservoir being withdrawn from supply for a period of time for inspection, cleaning, repair or frozen sample points.

Our annual report for 2017 provided details of the number of reservoirs that had failed in at least three of the previous five years. In 2018 none of the reservoirs for which failures were reported have failed in the last five years and this indicates that the increased efforts by Scottish Water to maintain and upgrade reservoirs is beginning to address the backlog of repair work required on these assets.

Water Quality at Consumers' Taps

Scottish Water's supply area is divided into 300 water supply zones. Most sampling to assess regulatory compliance takes place at consumers' taps, and testing takes place for seventy items (known as parameters). The frequency of sampling is determined by the size of the population in the water supply zone.

In 2018, 148,086 tests were carried out on samples taken at consumers' taps. Of these, 151 failed to meet the standard set out in the Regulations. This means that 99.90% of the tests carried out complied with the standards. The equivalent figures for 2017 were 134 failing samples and 99.91% compliance, meaning that performance has not improved. Ninety supply zones had tests that failed to meet one or more of the standards, which is 21 more than in 2017 and five more than 2016.

Table 1 below shows only the parameters which had a failing test result recorded in samples taken from randomly selected consumers' taps.

Table 1 Summary of Failing Tests at Consumer Tap Samples During 2018

Parameter	Total No. of Tests	No. Failed Tests	No. Zones with Failures	% Compliance
Coliform Bacteria	15,100	42	33	99.72
Iron	5,422	36	29	99.34
Manganese	5,422	17	15	99.69
Lead (10)	1,590	15	14	99.06
Total Trihalomethanes	1,597	8	7	99.50
Aluminium	5,422	6	5	99.89
Hydrogen ion (pH)	5,457	5	5	99.91
Odour	5,459	5	5	99.91
E. coli	15,100	3	3	99.98
Turbidity	5,457	3	3	99.95
Nitrite	2,641	3	3	99.89
Clostridium perfringens	5,423	2	2	99.96
Nickel	1,590	2	2	99.87
Radon	41	2	2	95.12
Benzo 3,4 Pyrene	1,594	1	1	99.94
Taste	5,456	1	1	99.98
SCOTLAND	**148,086**	**151**	**92**	**99.90**

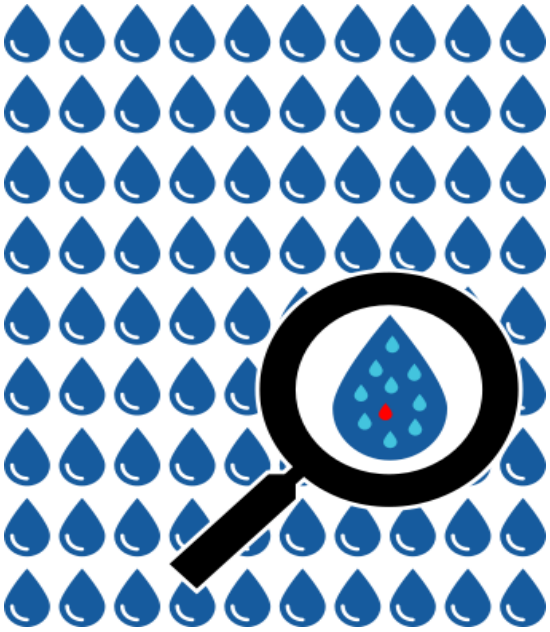


Figure 3 **Only Approximately One Test in Every Thousand Did Not Meet the Standard**

Some of the more important parameters are discussed in more detail below.

Coliform Bacteria

Coliform bacteria or 'Total Coliforms' represent the group of bacteria of which *E. coli* is one species. They are common in the environment and should not be in drinking water, but do not necessarily indicate contamination from faeces has occurred. They are readily killed by chlorine, which is added in small amounts to all of Scottish Water's supplies.

Coliforms were detected in 42 samples in 2018, eight more than in the year before. Five zones recorded more than one coliform failure in the year, with Clatto West A Zone, which covers part of Dundee, having four failing samples. Scottish Water carried out an in depth analysis of the failures in this zone which included reviewing service reservoir condition and performance data; operational activity such as burst repair; pressure and flow fluctuations; and water treatment works performance. They could find no evidence to link the failures together or to any specific cause.

When these failures occur, Scottish Water takes further samples from the premises and also from neighbours' taps to determine if there is a local property issue or a wider supply system concern. Scottish Water notifies the consumer of the findings and provides the appropriate advice in each case.

Although a lot of these failures are found to be caused by hygiene issues at the kitchen tap, and therefore outside Scottish Water's direct control, Scottish Water has shown that reductions in the numbers of failures in the public supply system are possible through activities such as thorough treatment of water; good maintenance of storage points and distribution systems; and careful management of residual chlorine and water age.

E. coli

E. coli is an extremely important parameter because it is an indicator of faecal contamination and the microbiological safety of the water. The detection of *E. coli* in a water sample may be an indication that the supply in that area has become contaminated or it may simply relate to the tap from which the sample was taken. Scottish Water must investigate each failure thoroughly to try to determine the cause and respond appropriately.

Compliance for this parameter is relatively stable with very few failures occurring each year. Three samples failed singly in separate zones in 2018. These were in Black Esk (Dumfries and Galloway), Rosebery B zone (Lothian) and Balmore C5 South (Strathclyde). All were attributed to issues with tap hygiene and not representative of the water supplied.

Clostridium perfringens

Clostridium perfringens is a secondary indicator of faecal pollution. Clostridial spores can survive in water much longer than organisms of the coliform group and can resist disinfection. Their presence in disinfected waters may indicate deficiencies in water treatment processes. If they are found in distribution systems and at consumers' taps, they can be an indicator of some historic contamination having occurred. The exact cause of these failures is often hard to determine conclusively.

Two failures of this standard occurred in 2018, with no specific reason attributed to either failure.

Iron

Iron occurs naturally in some water supplies but should be removed by the treatment process. It is used in water treatment as an alternative flocculant to aluminium at a few treatment works in Scotland. The most common cause of failures of the iron standard at consumers' taps is corroding cast iron water mains which can cause iron sediment to build up in distribution systems. High concentrations of iron can cause discoloured water supplies, greatly inconveniencing consumers.

Scottish Water has a large programme of renovation and cleaning of the water mains that cause the most significant water quality issues. This is delivering a reduction in the numbers of consumer complaints about discoloured water.

Compliance with the iron standard had improved, but the last few years have seen a slow deterioration, with 36 samples failing in 29 supply zones in 2018. One supply zone, Amlaird in East Ayrshire, recorded four failures, the cause of which has been resolved. Four supply zones recorded two failures of the iron standard. Significant investment work is being done by Scottish Water at all of these locations.

Manganese

Manganese occurs naturally in some raw waters, especially in the west of Scotland. If it is not removed effectively by the treatment process it can accumulate as fine black sediment in the distribution system pipework and cause severely discoloured water supplies and inconvenience for consumers. Even a relatively low concentration of manganese in the final water of a treatment works can accumulate in pipes and cause problems in distribution pipework. Overall compliance deteriorated slightly compared to 2016 and 2017, with 17 failures across fifteen supply zones.

Black Esk water supply zone in Dumfries and Galloway recorded three failures in 2018. This was primarily attributed to dry weather and low reservoir levels, with no effective treatment process to remove manganese. Scottish Water has installed a reservoir mixer to reduce the amount of manganese entering the treatment works from the reservoir, but this has had limited success. Further investment is likely to be needed and DWQR are reviewing this with Scottish Water.

Lead

In Scotland, lead does not occur naturally in significant concentrations in our water supplies. The problem arises when drinking water comes into contact with lead supply pipes; lead tanks; lead solder joints on copper pipes; or inferior quality brass fittings and taps, particularly for longer periods (for example overnight / weekends / holiday periods). This can result in high lead levels in the drinking water supply.

The Scottish Government has a project to review the policy in relation to the reduction of exposure to lead in drinking water. The project aims to raise awareness with consumers of the concerns regarding lead in drinking water and to promote the removal of lead service pipes and plumbing.

Scottish Water is also undertaking work to explore the lead issue as part of its lead strategy. This includes work to assess the practical issues encountered in replacing lead pipework in people's homes and gardens.

Although the majority of lead piping is privately owned and therefore outside Scottish Water's direct control, it does have a responsibility under the Regulations to minimise the risk from dissolved lead. In regulatory sampling, there were nine failures of the standard, with only one supply zone recording more than one failure. This was Daer Coulter supply zone in South Lanarkshire.

Scottish Water reported a further 158 failures of the standard to us from sampling carried out in response to consumer requests. These requests come from consumers who either have a personal awareness and interest in the health impact of lead or are perhaps, in relation to a change of ownership of a property. This number cannot be used to imply a wider issue with lead pipes across supply zones but does illustrate that for some property

owners, lead pipes remain a problem. In all the circumstances of a failing lead sample, Scottish Water will check the part of the pipe in their ownership and renew this if it is made of lead. Consumers are advised to replace their own supply pipe from the boundary of the road, into the building.

Total Trihalomethanes (THM)

THM are a group of disinfection by-products that can form when organic substances combine with chlorine used to disinfect the water. As Scotland's upland waters naturally contain high levels of these organic compounds, management of THM formation presents Scottish Water with a challenge. Scottish Water has devoted much effort to reducing the formation of THM in its water supplies and has made significant improvements, although this has slowed in recent years. In 2018, eight failures occurred within seven water supply zones.

In addition to meeting the standard for total THM, Scottish Water is also required to minimise the production of all disinfection by-products. During 2018, DWQR required Scottish Water to carry out additional operational monitoring for other disinfection by-products to demonstrate that they are minimising across a range of substances not just THM's. This monitoring commenced in the latter part of 2018 and is something we will report on for 2019.

Figure 4 shows the number of zones affected at different levels of THM within the standard. It illustrates that although the number of failures of the Prescribed Concentration or Value (PCV) did not reduce in 2018, there are fewer samples exceeding 50% and 90% of the standard. Continued efforts are needed to minimise the formation of disinfection by-products on an ongoing basis, particularly given that Scottish Water has highlighted in its Strategic Projections that the levels of organic substances in their source waters is rising and this will be a significant challenge for it in the future.

Most of the locations where failures were recorded in 2018 have work in progress to improve the treatment process to ensure that THM concentrations are minimised. These include Tullich WTW, serving Oban, where the completely new treatment works that came online in November 2018 has proven very effective at removing the compounds that combine with chlorine to make THM.

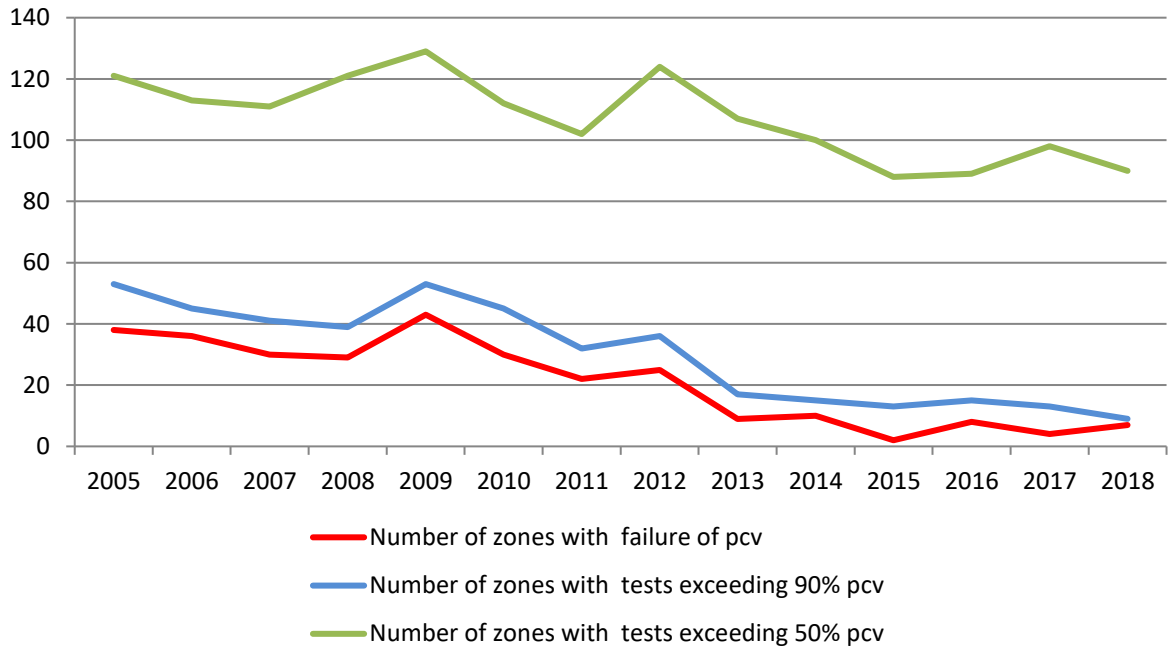


Figure 4 **THM Performance 2005 - 2018**

Nitrite

Nitrite forms when nitrifying bacteria react with the ammonia that is added to chlorine in a process known as chloramination. If the process is not carefully controlled and nitrifying bacteria are allowed to persist in the distribution system due to water lying in pipes for long periods (due to the length of the system and/or the amount of water being used by consumers), nitrite can build up and cause failures in the standard.

In 2018 there were three failures of this parameter which is a significant improvement on 2017. All were in different supply zones, suggesting that the measures Scottish Water has put in place to minimise the potential for nitrification are delivering improvements.

Nickel

Nickel is a metal that occurs in the environment only at very low levels. It is used for many different applications but mainly in the production of stainless steel and other metal products. Its presence in drinking water generally arises from contact with plumbing fittings, such as nickel or chromium-plated taps or certain types of kettles.

Two isolated failures occurred in 2018. These were attributed to the type of tap or plumbing fittings used in the domestic distribution network inside the property that was sampled.

Taste and Odour

There was one failure of the taste standard in 2018 in the Lochinvar zone in Dumfries and Galloway. This sample also failed the standard for odour, and was described as "musty", no reason for the failure was found and the consumer whose property the sample was taken from had not noticed a taste or odour in their water supply. Four other odour failures occurred. In Daer A zone in central Scotland the failure was described as a "vegetation" odour, it was not repeated in any resamples and there were no consumer contacts relating to it. A failure in the Turriff zone in Aberdeenshire was of a "pencil wood" odour – these are commonly associated with the use of black alkathene pipes and are usually limited to a single property. A failure was recorded in the Glenfarg Kinnesswood B zone in Fife and was described as having an earthy/musty odour. This was linked to a water quality incident relating to algae in the raw water reservoir and Scottish Water received 48 consumer contacts in relation to this issue. The fourth failure was in Clatto West A zone in Dundee and was described as an "oily" odour, resamples from neighbouring properties were satisfactory, though the owner of the property where the failing sample was originally taken refused Scottish Water entry to take resamples.

Turbidity

Turbidity in water is caused by suspended particles that obstructs light transmission through it, making it appear cloudy. The standard is primarily an aesthetic one, but high turbidities need to be investigated, especially in water leaving the treatment works, as they could indicate a problem with the treatment process and may mean that the effectiveness of disinfection has been compromised. Failures can occur at consumers' taps for a number of reasons, but the most common cause is the disturbance of sediment in corroding iron water mains. Three turbidity failures occurred in separate zones in 2018.

Hydrogen Ion (pH)

The pH of a substance is the measure of how many hydrogen ions it contains, with large numbers of hydrogen ions making it more acidic. Most waters in Scotland are naturally soft and acidic and therefore have a low pH. Such water can be corrosive to metals used in plumbing, therefore Scottish Water needs to correct this to bring the pH into the required range. Alkaline water with high pH values can sometimes occur where water is in prolonged contact with some water pipes containing cement. Waters with a very high pH can have a taste that some consumers find unpleasant. Compliance for pH was similar to 2017, with five failures occurring in five zones.

Aluminium

Aluminium can naturally occur in water. It is also used as a flocculant in some water treatment processes and, if these are not operating efficiently, it can enter the water supply system via this route.

There were six aluminium failures across five zones in 2018, similar to 2017 but significantly worse than the one failure in 2016. Most were attributed to disturbance of pipeline deposits and flushing of the supply restored water quality, however two failures occurred in Eela Water supply zone, Shetland due to a serious incident at the water treatment works. DWQR visited the site in early 2019 to investigate and has published an assessment on our website.

Radon

Radon is an odourless, colourless, radioactive gas that occurs naturally. It is released from certain rocks and the risk of occurrence varies according to geology. Although direct ingestion of radon in water is harmless, prolonged exposure to radon in air by inhalation has been linked to an increased risk of lung cancer. It is likely that any radon dissolved in water will readily gas off upon exposure to atmospheric pressure, adding to the total radon contact of the air.

Their reason that radon in drinking water is assessed is to limit the contribution it can make to the total concentration of airborne radon. There is no PCV (Prescribed Concentration or Value) for radon in water supplies but an action level has been set: where a sample exceeds 100 Bq/l, Scottish Water must undertake further investigation to identify the source of the high radon value. Two samples exceeded this trigger value in 2018; at Stronsay in Orkney and at Oykel Bridge in Highland. Scottish Water has undertaken the required investigations. The borehole supply at Oykel Bridge has now been replaced.

Consumer Contacts

When a consumer contacts Scottish Water regarding the quality of their water supply, the contact is recorded and classified according to the nature of the issue.

Scottish Water received 10,124 consumer contacts relating to water quality in 2018, equating to a contact rate of 19 per 10,000 population. This is a slight increase on 2017, but is still just over half the number recorded in 2012. Consumer calls about discolouration increased by nearly 30% on 2017's figure, but contacts reduced across most other complaint categories. Some of this increase is attributed to an upsurge in contacts from the Bradan supply zones in Ayrshire. This incident is discussed in more detail in Section 2 of this report, a change in water chemistry combined with increased flow during the summer months are considered to be significant causal factors.

We carried out an audit of consumer contacts in August to gauge the capture of information from consumers when they contact Scottish Water in relation to a water quality event. Through the cases selected for audit, it was our view that the use of certain contact types over the course of a water quality or loss of supply event, such as 'Requests for Further Information' or' Bottled Water Request' masks the real issue and reason for a consumer making the contact e.g. discoloured water, taste etc. This being the case, we were concerned

that Scottish Water understated in their corporate reporting the real extent of consumer concerns around water quality issues. Although there are no concerns around the total number of consumer contacts received, within that total, the number of contacts recorded against particular water quality issues has a low confidence of accuracy.

Scottish Water were in the process of introducing a new consumer contact management system and this had the capability to address the recording issue. As a result of both these factors, the numbers referred to in the following analysis will be affected by the change made for the final four months of the year. The data collected during 2019 and future years, will provide a truer picture of the issues of concern to consumers.

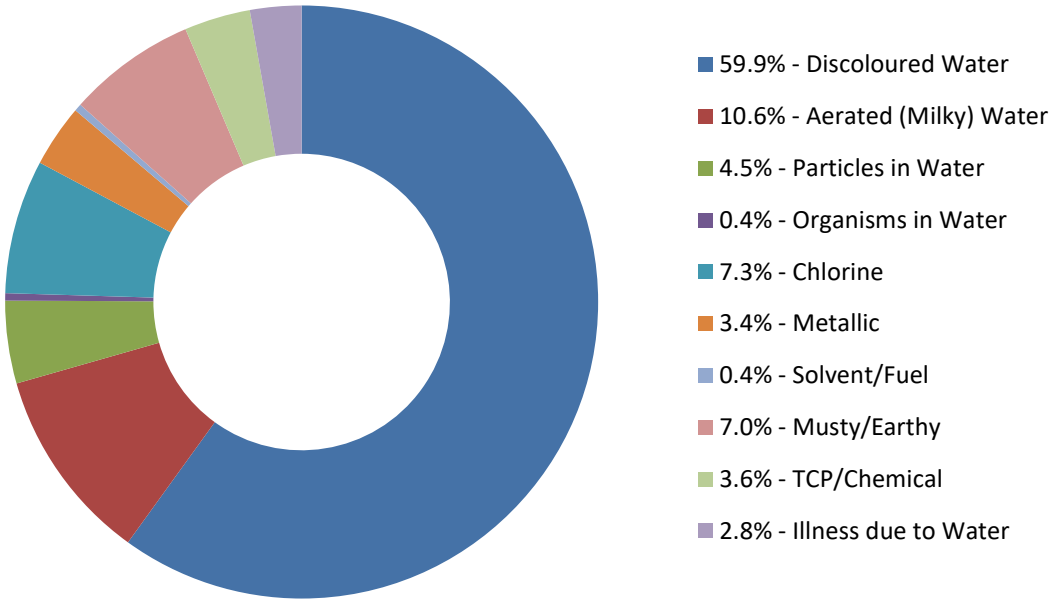


Figure 5 **Breakdown of Consumer Contacts by Type**

Figure 5 shows 60% of contacts were received in response to discoloured water and 11% about aerated (or milky) water. These two categories not only reflect problems with the condition of the water supply network but they also highlight problems caused by operational activity where flow changes within the water mains are caused by the operation of valves or by burst mains. The diagram also shows a significant proportion (22%) of contacts relating to the taste or smell of the water supply causing concern to consumers.

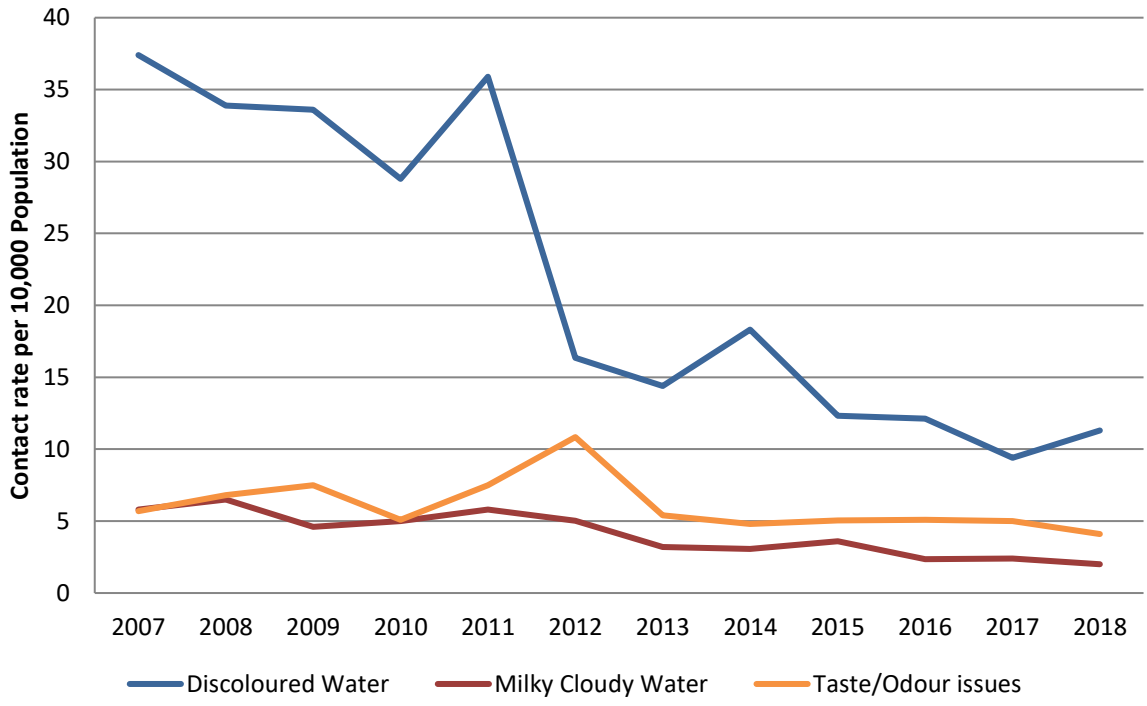


Figure 6 Trend in Key Contact Categories

Although there is a general downward trend in complaints, the slight upward turn in discolouration contacts as shown in **Figure 6** is concerning, although this is possibly a reflection of the better recording of contacts in the final four months of the year.

Chlorine was the largest category for taste and odour, very closely followed by musty/ earthy. As in 2017, the majority of musty/earthy contacts were from areas supplied from Carron Valley treatment works due to the presence of geosmin, a substance usually associated with algal blooms. These have reduced significantly since 2017 indicating that the installation of temporary treatment to remove the geosmin has been partially effective and DWQR will be reviewing with Scottish Water what further action needs to be taken. Three separate water quality incidents relating to taste and odour complaints occurred during 2018 were caused by algae in the source waters.

Chlorine complaints accounted for 30% of all taste and odour contacts, equating to 1.4 per 10,000 consumers. This represents the lowest ever level of contacts for chlorine.

In geographic terms, the areas where most issues were raised by consumers are shown in **Figure 7**. There are six zones where more than 200 contacts were received, reduced slight reduction on 2017. The chart shows these supply zones ranked by contact rate. The majority of contacts in all these areas concerned discolouration.

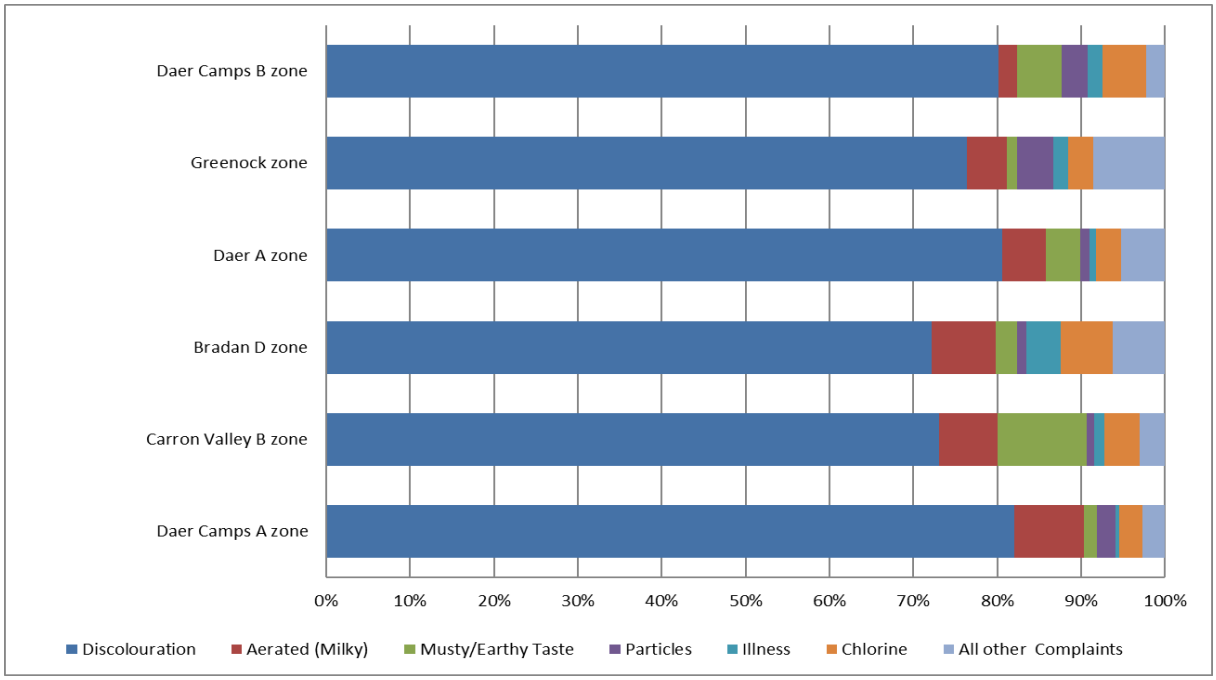


Figure 7 **Water Supply Zones With Most Water Quality Complaints**

Consumer Contacts to DWQR

Scottish Water has a responsibility to investigate water quality complaints and supply issues. We guide consumers to report any concerns to Scottish Water in the first instance to enable their investigation and resolution. Where consumers are dissatisfied with Scottish Water's response and have pursued and completed a formal complaint with Scottish Water, the DWQR can carry out an investigation of the issues. A summary of our complaint determinations may be found on the DWQR website.

No formal complaint investigations were undertaken by DWQR in 2018. This is good news as it means that Scottish Water has been able to successfully resolve consumer issues about quality via its internal complaints process.

As well as dealing with formal complaints about Scottish Water, DWQR receives many contacts from consumers and other organisations about water quality matters, a summary of these is shown in **Table 2**. We are able to offer impartial advice and assistance, although callers with a specific water quality issue who have not spoken to Scottish Water about it are referred to them. For the first time, calls about private water supply issues exceeded the total for the public water supply, with 96 private supply calls compared to 47 calls in total relating to the public supply.

Table 2 Consumer Contacts Received by DWQR

Contact Category	Number of Contacts					
	2018	2017	2016	2015	2014	2013
Appearance						
Discoloured Water	2	4	12	3	6	6
Aerated (Milky) Water	0	0	2	0	1	2
Particles in Water	1	2	1	0	1	2
Organisms in Water	1	1	0	0	1	0
Taste and Odour						
Chlorine	2	5	4	2	9	5
Metallic	0	0	0	1	0	2
Solvent/Fuel Taste/Smell	0	0	0	1	0	0
Musty/Earthy	0	1	2	0	0	2
TCP/Chemical Taste/Smell	0	0	0	0	0	1
Other contact about Water Quality						
Illness due to Water	2	5	4	2	2	2
Other Contact	21	7	4	6	3	10
Total Public Water Supply Water Quality contacts	**29**	**25**	**29**	**15**	**23**	**32**
Public water supply issues & requests for information	5	35	21	8	23	27
Private water supply issues	96	59	29	23	16	12
General Enquiries to DWQR	13	5	36	32	37	21
Total Consumer Contacts to DWQR	**143**	**124**	**115**	**78**	**99**	**92**

2 WATER QUALITY EVENTS AND INCIDENTS

Scottish Water is required to tell the DWQR about all events that have affected or could affect water quality or cause concern to consumers. This includes all regulatory sample failures; operational sample failures that are significant or unexpected; any failure of a treatment process; significant numbers of consumer contacts; and issues which attract significant media interest.

Incidents are fully investigated by DWQR staff, a written assessment is produced and recommendations are made, where appropriate. A short summary of the incident assessment is published on the DWQR website. For the most serious incidents, enforcement action or even prosecution may be considered.

There were 881 events reported to DWQR during 2018, the majority of which were not significant. **Table 3** shows the numbers of events and the Scottish Water operating areas where they occurred. A summary of incidents is available on our website www.dwqr.scot.

Table 3 Event Classification 2018

	Not significant	Minor	Significant	Serious	Major
East	183	36	6	3	1
North	100	31	3	0	0
South	184	51	7	0	0
West	261	12	2	1	0
Total	**728**	**130**	**18**	**4**	**1**

Twenty-three of these events were classified by DWQR as incidents which is an appreciable reduction from the 32 declared in 2017. There were 11 fewer incidents declared within the three categories of significant loss of control of treatment process, failure of disinfection process and alternative supplies being issued. The reasons why events were classified as incidents in 2018, are illustrated in the chart in **Figure 8**. Almost half of all incidents were caused by a failure of disinfection or loss of control of a critical treatment process.

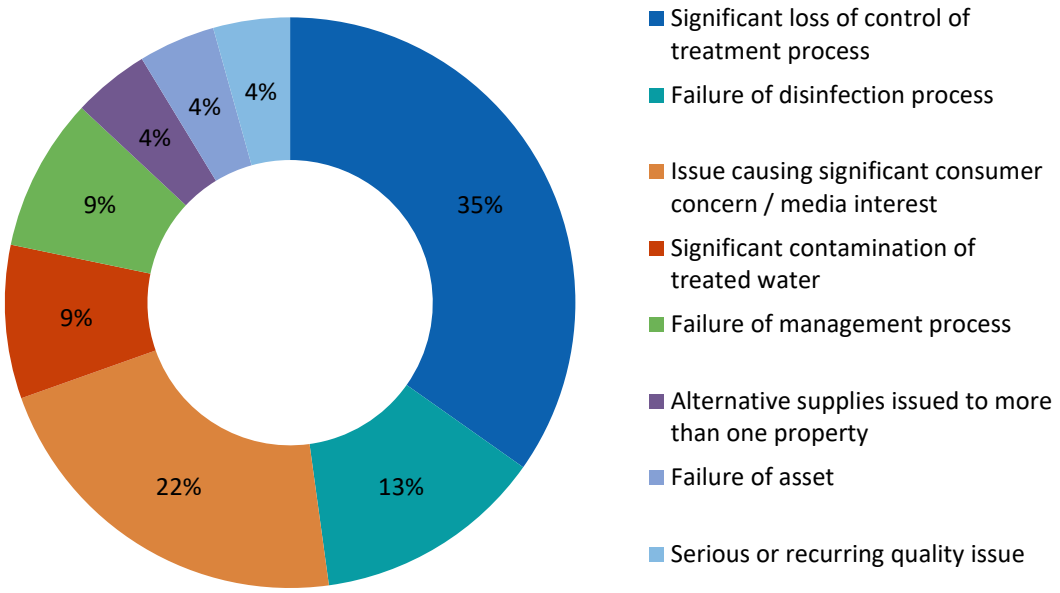


Figure 8 **Reasons for Determination of an Incident**

Eight of the 23 incidents concerned situations which had a direct impact on the supply to consumers. Of the eight: five of those caused significant concern or media interest over water quality; one where a failure of management processes caused the water supply to be interrupted and caused discolouration; one where alternative water supplies were arranged; and one where a local service reservoir was bypassed to limit contamination.

A number of incidents were made worse by a lack of internal escalation by Scottish Water staff that resulted in prolonging the incident or increasing its severity. Scottish Water has recognised the impact that poor escalation can have on the quality of water supplied to consumers and to its reputation. Steps have been taken to reinforce the need for escalation and Scottish Water has reviewed procedures to ensure this vital aspect of managing an issue is clearly set out.

Each Incident Assessment can be viewed on DWQR website www.dwqr.scot. A number of those are worth highlighting however as they illustrate significant consumer issues or present important learning points for Scottish Water. These are set out below.

Turriff Regulatory Supply Zone – Consumer concerns of taste and odour; August 2018

On 17th August, through awareness of community group comments on social media of taste concerns in the Turriff water supply, Scottish Water's Public Health team (PHT) arranged sampling of the supply at points in the distribution system and at consumers' taps. Concerns were that possible algal growth in the raw water supply may be causing tastes in the final water. Due to the warm dry conditions being experienced over the summer, abstraction

from the River Deveron had been increased to meet the water demand placed on the treatment works by consumers. Concerns for possible algal activity had led to increased monitoring of the raw water entering the works in July and this indicated the presence of 2-methylisoborneol (MIB). Whilst MIB is not toxic, it does cause earthy or musty type tastes if not removed by the water treatment process, usually by powdered or granular activated carbon. Turriff water treatment works does not have a carbon based treatment process and subsequently MIB was present in the water supplied. The first consumer contact of these tastes was received on 10th July and a further two within the following three weeks. At its height, during the week commencing 20th August, 20 contacts were received. The sampling arranged by the PHT on 17th August, confirmed the presence of MIB in the consumer tap samples. Tests for Geosmin and toxic algae confirmed these were not present in the supply. Attempts were made to reduce the impact of the algal presence through the temporary application of powdered activated carbon to the filters. This measure however could not be sustained due to blinding of the filters and significant reduction in throughput. Monitoring of the supply continued and although the level of consumer contacts gradually reduced through to October, a total of 89 contacts were received from consumers in relation to this issue.

Categorised as a 'Serious' water quality event, we considered this incident to have been caused by the presence of MIB in the raw water and that this is most likely due to the increased abstraction from the River Deveron. There are no specific treatment options currently in place at Turriff to remove MIB and Scottish Water took practical steps to try and enhance the process to mitigate the impact of the taste and odour on consumers although, ultimately, these could not be sustained. Scottish Water responded appropriately to the potential for algal growth in the raw water supply by increasing monitoring for the key algal species. With awareness of the emerging consumer concern, appropriate sampling was carried out within the distribution system and at consumers taps. An Operational Management Plan for algae has been put in place for 2019.

DWQR was concerned with Scottish Water's under reporting of consumer contacts received for this event. Requests for further information led us to conclude there were 89 contacts made in relation to the issue extending from 10th July through to mid-October. The reality of the number of contacts illustrated a wider consumer concern over their drinking water quality and consequently elevated the categorisation of the event from 'serious' to 'major'. This issue was identified more generally in DWQR's August 2018 Audit of Consumer Contacts. Given the timing of this event, the DWQR was content that the recommendations made in the audit report and completion of the required actions would address the range of issues regarding recording of consumer contacts experienced here.

Bradan Regulatory Supply Zones - Consumer concerns around discolouration; April 2018

Scottish Water introduced a process of chloramination at the Bradan water treatment works on the 9th April 2018. This works has a very large supply area and, by the 18th April, it was estimated that the entire supply area was receiving chloraminated water. Although there was an established procedure for changing from chlorination to chloramination, Scottish Water decided, due to the practicalities of flushing such a large distribution system, not to follow the procedure fully in relation to conditioning of the network prior to the change. Instead, a targeted flushing exercise was carried out on areas considered to be more at risk from water quality issues and around 27% of the network was flushed between 2016 and 2018 in readiness for the changeover. On the 10th April, 11 consumer contacts were received from the area, all reporting taste and odour issues. The situation was escalated internally on the 4th June following a total of 20 exceedances of the iron standard and an increase in consumer contacts reporting discolouration. This led to enhanced water quality sampling from the treatment works and the network, monitoring of consumer contacts and targeted night time flushing. Although flushing points were selected based on consumer contacts and failing iron samples, the programme did not lead to an improvement in water quality. Sheffield University, who are water industry experts on discolouration research, were engaged to assist with understanding the problem and to advise on remediation actions that could be taken. As a result, a new targeted programme of low velocity flushing was commenced. Significant monitoring of the supply was undertaken with up to 560 samples taken per week and the installation of turbidity loggers across the network.

DWQR considers it likely that elevated iron, turbidity, and discolouration of the supply were due to the changing water chemistry following the introduction of the chloramination process at Bradan water treatment works and was the cause of this incident. It has been categorised as a 'Serious' water quality event. The change in the chemistry of the supply, along with the greater persistence of monochloramine in the network, led to increased corrosion of iron mains and destabilisation of biofilm, thereby increasing the leaching of metals from pipework and mobilising entrapped pipe material deposits. Increased and variable flows through the network due to higher seasonal demand in the summer are likely to have caused a hydraulic disturbance, exacerbating the situation. A further contributory factor may have come from an increase in water temperature over the summer months, which will have increased chemical reactivity and microbiological activity. Given the complex nature of this incident, the different mechanisms for iron release into the supply and the need for Scottish Water to better understand an ongoing issue, DWQR was disappointed that Scottish Water had not carried out appropriate analysis to determine the proportions of soluble and particulate iron in the Bradan supply.

DWQR is satisfied that Scottish Water's initial targeted flushing of the system was a logical attempt to deal with discoloured water in the network. When this flushing did not improve the situation, it drew on industry experts to advise on an approach to resolve the issues and we requested monthly updates to allow monitoring of the situation. However, in light of this incident, which has caused severe and prolonged discolouration of the supply, DWQR

considered that Scottish Water must review its procedure for the introduction of chloramination to ensure that supplies at risk from increased iron and turbidity failures from the network are adequately conditioned or rehabilitated before any change is made.

The chloramination system at Bradan WTW was inspected by DWQR on the 27th November 2018 and we were content that Scottish Water was adequately managing the chloramination process at the treatment works. A full audit of the treatment works on the 14th March 2019 was also carried out. There were a number of findings which will be reported separately in a formal audit report, but examination of water quality trends from online instrumentation showed that treatment processes were operating effectively. Examination of sample results show that the primary aim of the switch from chlorination to chloramination, of reducing the formation of Trihalomethanes (THM) in the Bradan system, has been successful. There has been a substantial reduction in the concentration of THM at consumers' taps, with little increase in THM levels in the distribution system.

Scottish Water has been actively reviewing the condition and operation of the Bradan network since the beginning of the incident, and has provided DWQR with draft findings of this review and proposals for further work.

DWQR made ten recommendations for Scottish Water to consider. Key amongst those were to: report monthly to DWQR, until further notice is given, on progress with investigations and remedial works to reduce iron and turbidity sample failures and discoloured water consumer contacts in the Bradan network; review its procedure for the introduction of chloramination to ensure that supplies at risk from increased iron and turbidity failures from the network are adequately conditioned; consider the use of the measurement of soluble and insoluble iron concentrations in samples taken in the Bradan network and to provide DWQR with a sampling plan which sets out the locations of on-line turbidity monitors in the Bradan network along with a schedule of parameters to be analysed and frequency of analysis that Scottish Water intends to follow over the course of 2019.

Lawton Service Reservoir – Microbiology – Failure of Asset; June 2018

A sample taken from the outlet of Lawton service reservoir failed for eight coliforms on 15th June. A resample on 16th June failed with three coliforms and a further sample on 18th June also failed with 610 coliforms. Due to the repeat nature and levels of the failures, the tank was bypassed on 19th June and drained for inspection on 22nd June. There was one failure of samples taken at consumers' taps in the area over the period of reservoir failures. The reservoir remained bypassed whilst repair works are carried out and subsequent sampling and routine monitoring carried out showed water quality to be satisfactory. Investigation of the condition of the service reservoir identified a number of issues with the structural integrity which permitted routes of ingress of surface water into the storage space from which contamination could occur. This was categorised as a 'Significant' water quality event. DWQR was satisfied from the reports provided and our visit that these defects were the likely cause of the sample failures.

Lawton SR hatch, before repairs

Scottish Water took the necessary actions to respond to this event, isolating the service reservoir and taking samples to verify there were no continuing issues for consumers. DWQR was however of the view that the incident could have been avoided. An investigation in response to similar microbiological failures in September 2016 identified actions to remove the tank from service for cleaning and investigation but this had not been carried out due to risks at the time to the security of supply from other utility works being carried out in close proximity to strategic water supply mains in the area. Had this been achieved, the defects would have been identified and the required repairs scheduled. At the time of our visit however, contractors were on site and part way through a work programme to repair the structural defects.

Dufftown Service Reservoir – Management processes – Discoloured Water; June 2018

A consumer contact reporting poor pressure in the Aberlour area, alerted Scottish Water to a failure of pumps to activate to maintain the level in Bluehill service reservoir (SR) which was due to a communications problem with the signal from the reservoir to the pumping station. This was found to have been caused by a power interruption and the field operator activated the pumps on manual control. With flow restored on 1st June, the distribution system re-pressurised with the exception of the supply main to Dufftown SR. The problem was believed to be an air lock in the water main and work was carried out to try and pinpoint where the issue lay. Ultimately, the cause of loss of flow was a blockage of the meter by a buoyancy float. It was later identified that the float had become detached from a tether connected to a submersible remotely operated vehicle (ROV) used in a reservoir cleaning operation at Bluehill SR in 2017. With the blockage removed and the meter re-installed, the water supply was restored to the service reservoir. Samples taken at consumers' taps on 2nd June, to monitor the loss of supply event, showed failure of the standards for aluminium, manganese, iron and turbidity, the maximum values for which were 543 µg/l Al; 88.5 µg/l Mn; 879 µg/l Fe and 13.7 NTU turbidity. Further samples taken on 3rd June showed water quality to have returned to normal.

The overriding factor causing the failure of water quality standards was the drain down of the main and re-establishing flow causing the disturbance of deposits in the supply main. The ROV float had been drawn towards and into the outlet pipe from the reservoir, as the level of water dropped within the SR and subsequently transported within the water mains to the meter point. Scottish Water's response to the pressure issue was appropriate although we considered there to have been inadequate consideration given to the potential for

disturbance of water mains deposits on restoration of flows in the pipe to the reservoir. Categorised as a 'Significant' water quality event, the effects of discoloration and the failures of standards could have been mitigated by more thorough flushing of the mains prior to activating the inlet to the service reservoir. Provision of tankered water into Dufftown tank, as the pressure issue was investigated and resolved, maintained supplies to consumers. DWQR was particularly concerned however with the inadequacy of the safeguards in place with contractors which permitted equipment to be left within the reservoir after cleaning operations. Scottish Water's reservoir cleaning contractor has since amended their operational procedures for use of ROVs. Scottish Water has also committed to reviewing their Distribution Operations Maintenance Systems and Impact Assessment Form used in the planning of all work to be carried out on the distribution system, to be more cognisant of risks where ROV cleaning methods are to be employed.

Bonnycraig Treatment Works – Disinfection processes; June 2018

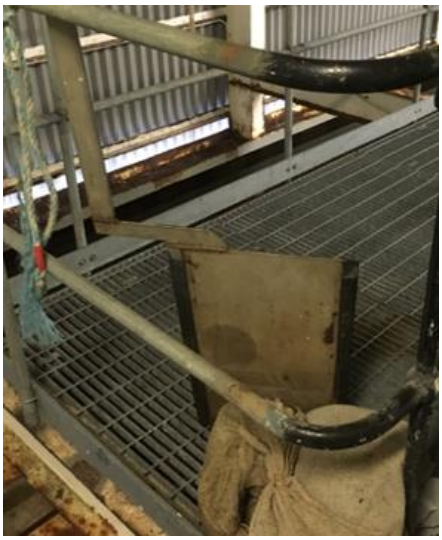
Cryptosporidium was detected in the final water from Bonnycraig WTW on seven occasions from 27th June to 11th July 2018. An investigation following the first detection discovered that there had been failures of the Ultra Violet (UV) treatment process over the previous three days and the UV dose required to inactivate *Cryptosporidium* had not been achieved during short periods over this time. Scottish Water's investigation of the incident found that the UV intensity sensors were faulty. This caused the UV control to switch over from duty to standby reactor. However the fault would quickly clear and the duty reactor would take over again after a three minute warm-up period. This changeover and back again, caused UV intensity to drop below the required level to inactivate *Cryptosporidium*. During the investigation it was also found that the outlet valve from filter number five was not being adequately controlled, resulting in much higher than usual turbidity and forward flow, from this filter to the UV reactors. This control of flow through filters is a key factor in reducing the risk of breakthrough of *Cryptosporidium* oocysts and filtered water turbidity is recognised in the Badenoch (1990) and Bouchier expert group (1990) reports as an indicator of increased risk. The final water turbidity was not affected by the increased turbidity from this single filter, so it had not been noticed that there was an issue. This has been categorised as a 'Significant' water quality event.

Scottish Water undertook a comprehensive investigation into the UV failures. The turbidity and flow fluctuations from filter five were found to be at fault and responsible for the *Cryptosporidium* breakthrough and DWQR was disappointed that individual filter turbidities were not being routinely trended to notice the issue with filter five. Also, that the UV failures were only discovered following the *Cryptosporidium* detection. We had concerns over the capability and performance of this water treatment works following a further two water quality events, one of which again involved the UV process, and served Scottish Water with an Enforcement Notice requiring improvements at this site.

Eela Water Treatment Works - Loss of control of treatment process; November 2018

On 7th November, the polyelectrolyte batching at the site failed due to insufficient capacity in a temporary service water pipe. The alarm which would have alerted staff had also been wrongly assigned a low priority so was not passed to standby staff by the Control Centre. Once water quality had deteriorated, a filtered water aluminium alarm alerted staff and the polyelectrolyte dosing was quickly reinstated. Aluminium levels in the filtered water were above the PCV for four hours, peaking at 454 µg/l. This issue was not escalated correctly within Scottish Water to enable appropriate sampling to take place.

The following day, planned work commenced to clean one of the two flatbed clarifiers (FBCs) at the site. The approach used to return the FBC to service after cleaning was to introduce it at a very low flow to enable a floc blanket to form. However, flow through the plant was higher than the last time the FBC was cleaned and the other clarifier was no longer able to take the full works output. Additionally, the very rudimentary flow control at the site meant that it was not possible to properly restrict (or measure) the flow through the reintroduced clarifier. Consequently the level of water stored in the clear water tank was dropping throughout the operation, adding pressure on staff to complete the process as quickly as possible. Shortly after re-introduction of the FBC, aluminium concentrations and turbidities began to rise, reaching in excess of 300 µg/l. Concentrations did not return to normal for approximately six days.



Rudimentary penstock - the only means of controlling flows to clarifiers at Eela WTW

The following week, senior operations staff visited the site to discuss the two issues that had occurred. It was assumed that as the other clarifier that would take the full works flow was now clean, similar issues with elevated post-clean aluminium concentrations would not recur. It was agreed that the planned clean of the second FBC should proceed, and this took place on the 27th November using the same process. Unfortunately, similar issues were encountered, and aluminium concentrations exceeded the standard in service reservoir samples until at least 12th December. The second event appears to have been more severe than the first due to a hydraulic effect that appears to have occurred when the clear water tank dropped below a certain level, causing flow fluctuations back through the works that effectively scoured aluminium deposits on the filters into supply. Overall, this was considered to be a 'Serious' water quality event.

Samples taken from 17th December onward at service reservoirs met the standard although results just below the PCV for aluminium were being recorded at consumers' taps until well

into January 2019. No consumer complaints were received in relation to either of these events.

Although there were significant failings with Scottish Water's approach to managing the incident, DWQR was of the opinion that staff were put in a difficult position by having to maintain and operate an ageing, ill-equipped asset, running at well above its design capacity. The specification of this plant falls well short of the standards we expect of a water treatment process in the 21st century. Scottish Water are currently carrying out improvements at this site. A lack of rigour around planning and escalation procedures exacerbated the issues and resulted in the same mistake being repeated during the second FBC cleaning operation with even worse consequences.

By their own admission, Scottish Water's response in terms of escalating this cluster of events, triggering the necessary reporting and sampling actions, fell well short of its own expectations. We discussed this with staff and are satisfied that lessons have been learned in this respect. In practice, it is unlikely that an enhanced approach would have shortened the duration of the first FBC cleaning event, although it might have prevented the cleaning of the second clarifier from taking place. Although breaching the PCV, the concentrations of aluminium are not likely to have presented a risk to health.

The management procedure (Treatment Control process) used to approve maintenance activity failed to appreciate and address the risk from the FBC process, partly because clarifier cleaning was considered as a low risk activity on a generic basis, with inadequate consideration being given to site specific risks. The area staff fully appreciate the deficiencies in Scottish Water's actions with respect to this incident and DWQR has confidence that lessons have been learned. It is vital however that these learning points are shared across the company.

3 AUDIT AND INSPECTION

An important part of DWQR's scrutiny role is to audit and inspect activities undertaken by Scottish Water. We can choose to inspect any aspect of Scottish Water's activities that could affect water quality. Inspections commonly undertaken include water treatment works, storage points, distribution system activities, response to consumer water quality issues and analytical services. Auditing takes place against the requirements of the Regulations, as well as water industry best practice. We also audit the completion of investment projects. Typically site visits will be done before DWQR signs off the larger water treatment works projects and DWQR will audit a selection of Scottish Water's self-certification projects.

The inspection process provides a number of benefits:

- It enables DWQR to verify that Scottish Water is complying with regulatory requirements at sites across Scotland
- It allows DWQR to see new initiatives and areas of best practice
- It is an opportunity for DWQR staff to meet site-based Scottish Water staff and discuss water quality issues with them
- It raises awareness of DWQR and the Regulations amongst Scottish Water staff
- It enables verification of the delivery of investment work
- It enables DWQR to build an awareness of common trends, risks or deficiencies across Scotland and use these to inform future policy and guidance.

We select sites for inspection using a risk based process that takes into account sample failures and water quality events and incidents. DWQR may also choose to inspect sites randomly or directly following incidents. Other types of inspection may be undertaken in response to a particular issue or concern. In the past, we have inspected the procurement of services affecting water quality and actions to complete DWQR recommendations.

To make sure we are consistent, all our inspectors use standardised inspection templates, and the audit process is subject to an ISO accredited procedure. DWQR also participates in benchmarking audits with other regulators in the UK and beyond to drive consistency and to spread best practice.

Where issues are noted during an inspection, these are recorded as recommendations that are tracked and followed up. If common themes are identified, these are progressed centrally with senior Scottish Water staff. Elements of best practice are also highlighted. Scottish Water always has an opportunity to comment on draft inspection reports and co-operates fully during the technical inspection process.

Once an inspection report has been finalised, the completed report is sent to Scottish Water and a summary placed on the DWQR website.

Water Treatment Works Inspections

In 2018 DWQR completed eight inspections of water treatment works. These are listed in **Table 4**. Scottish Water staff operated their plants with a high degree of professionalism and many examples of best practice were noted. As the inspections were risk or incident triggered, particular attention was paid to the deficiency that had triggered the audit, whether this was asset based or procedural.

Back Tolsta WTW, Lewis

Most sites visited were maintained and operated to a high standard, but a number of issues were identified including:

- Deficiencies in raw and treated water quality monitoring, both on-line monitoring and manual sampling. This was not only to give confirmation of water quality, but also to inform treatment process operation;
- The need for automatic control of critical processes which can respond to changing water quality demands;
- Deficiencies in control systems and their resilience;
- The need to provide resilient disinfection processes and improve contact time.

Table 4 Water Treatment Works Audited during 2018

Location	Date	Reason for Audit	No. of Recommendations
Picketlaw (Eaglesham)	March	Risk based	11
Rawburn (Eyemouth)	June	Risk based	8
Burncrooks (Carbeth)	August	Risk based	4
Back Tolsta (Lewis)	August	Risk based	4
West Lewis (Lewis)	August	Risk based	3
Lithtrathen (Kirriemuir)	September	Risk based	4
Loch Calder (Caithness)	October	Risk based	8
Roberton (Hawick)	November	Risk based	3

In addition to full site audits, DWQR also undertakes site visits in relation to water quality events and incident investigations and to follow up on remedial works recommended by DWQR following previous incidents. The sites visited are listed in **Table 5.**

Tarbert WTW, Argyll

Table 5 Sites Visited in Conjunction with Incident Investigations during 2018

Location	Date
Penwhirn WTW	January
Fort Augustus WTW	February
Mannofield WTW	March
Kirkmichael WTW	March
Tarbert Argyll WTW	May
Carron Valley WTW	May
Greenock WTW	May
Castle Moffat WTW	June
Lochinvar WTW	August
Lawton SR	September
Spey Badentinan WTW	November
Bradan WTW and network	November

Benchmarking

DWQR retains close contact with the other water quality regulators in the UK and Europe to share best practice. During 2018 DWQR attended audits with the Drinking Water Inspectorate in England. These were excellent benchmarking opportunities: both to ensure DWQR's operations team are auditing to a high standard; and to make sure Scottish Water's standards for operations and procedures are of the same quality (or better) than other water providers.

Storage and Distribution

We audited 15 distribution systems and storage reservoirs in 2018.

Our recommendations included preventing ingress of contamination, security and record keeping.

Tongue SR, Caithness

Table 6 Distribution System Audits 2018

Location	Date	Reason for Audit	No. of Recommendations
Penwhirn RSZ (Stranraer)	January	Risk based	0
Sandhead SR (Rhinns of Galloway)	January	Risk Based	1
Fineview SR (Glenluce)	January	Risk based	1
Sandhead SR (Galloway)	January	Risk based	1
Glencorse D RSZ & Marchbank B RSZ (Edinburgh)	February	Risk based	3
Daer B RSZ (Cambuslang)	February	Risk based	0
Inverness RSZ	March	Risk based	0
Bonar Bridge RSZ (Invershin)	March	Risk based	2
Newmore B RSZ (Invergordon)	March	Risk based	0
Clatto West RSZ (Dundee)	March	Risk based	0
Hoy Calder RSZ (Caithness)	October	Risk based	2
Mannofield (Thainstone SR) (Inverurie)	November	Risk based	2
Invercannie RSZ (including Torphins Cockardie SR) (Banchory)	November	Risk based	1
Turret West DMA (Alloa)	November	Risk based	2
Amlaird RSZ (Kilmarnock)	December	Risk based	3

Services

Scottish Water has two UKAS accredited laboratories which undertake all sample examination and analysis for Scottish Water and private contractors. These sites are audited by DWQR every two years and will next be audited during 2019.

During 2018, DWQR carried out an audit of consumer contacts. The audit was undertaken to see how well information is taken and recorded from consumers when they contact Scottish Water in relation to a water quality event; how this is reported to DWQR in water quality event notifications, outcomes and incident reports; the use of and reporting of social media interactions and the overall reporting of consumer contact numbers to regulators and stakeholders.

Through the cases selected for this audit, we were concerned that Scottish Water understates in its corporate reporting the real extent of consumer concerns around water quality issues. Although there are no concerns around the total number of consumer contacts received by Scottish Water, within that total, the number of contacts recorded against particular water quality issues has a low confidence of accuracy. This not only has immediate impact within the duration of an event but also results in a lack of visibility of the real size of water quality concerns in supply areas to inform future consumer response activity and investment need. As a result, we notified Scottish Water that it is required to record consumer contacts against the appropriate water quality category from the 1st January 2019.

Table 7 Audit of Services

Location	Date	No. of Recommendations
Scrutiny of Customer Contacts	August 2018	6

Investment

Scottish Water has been directed by Scottish Ministers to achieve a number of different objectives to improve and protect drinking water quality. DWQR has a role to monitor progress with delivery of these outputs through the Outputs Monitoring Group (OMG) and also signs off those outputs associated with water treatment works improvements from the 2010 – 2015 period, a small number of which remain outstanding. The replacement treatment works for Poolewe and surrounding area was

Membrane filters, Poolewe WTW

completed in March 2018 which now leaves just four schemes from the 2010 – 2015 period to complete, all of which are currently being constructed.

Scottish Water entered a new investment period from 1 April 2015 which will run until 31 March 2021. This includes a number of outputs for improving and protecting drinking water. Scottish Water self-certifies completion of these and DWQR audits a selected number.

Scottish Water completed investment at two sites; Amlaird and Bradan which were covered by Enforcement Notices. A third Enforcement Notice concerned replacement of the treatment works at Tullich which was due for completion in September 2018. DWQR agreed to extend the completion period to December 2018 due to a number of issues which had impacted on completion, including restriction on raw water availability for commissioning due to very dry weather. The new treatment works went into supply at the end of November 2018.

A small number of outputs were completed during 2018 as most projects are at option selection stage or still under construction, these included new treatment works at Lochaline and Stoer.

DWQR staff undertook a number of sites visits and audits during the year, either to review progress or for the purposes of assessing the project's readiness for the output completion to be signed off. These are detailed in **Table 8**.

Table 8 Investment site visits undertaken during 2018

Location	Solution	Reason for Site Visit
Poolewe WTW	New treatment works	Sign off
Muirdykes WTW	New Manganese removal treatment	Sign off
Killin WTW	Replacement media in limestone contactor	SW sign off audit
Lochearnhead WTW	Replacement media in limestone contactor	SW sign off audit

ANNEX A INFORMATION LETTERS ISSUED DURING 2018

There were no information letters issued to Scottish Water during 2018.

Copies of all Information letters are available to view on the DWQR website:

www.dwqr.scot

ANNEX B CURRENT UNDERTAKINGS AND ENFORCEMENT NOTICES

Where water supplies do not comply with the required water quality standard, there are a number of mechanisms available to DWQR to ensure that the necessary steps are taken to achieve compliance. These are set out in DWQR's Enforcement Policy, which is published on the DWQR website. www.dwqr.scot

Undertakings

In general, the DWQR will seek to secure compliance with legislation through co-operation, discussion and offering advice. This process of co-operation and discussion may result in Scottish Water giving a legally binding Undertaking to Scottish Ministers, under the provisions of the Water (Scotland) Act 1980, setting out the steps that Scottish Water will take to secure compliance with the legislation. Such Undertakings provide a visible commitment from Scottish Water that the necessary improvement will be made.

In 2018, there were no on-going Undertakings:

Enforcement Notices

When DWQR has evidence that Scottish Water has contravened a drinking water quality duty and the contravention is likely to recur *and* Scottish Water does not appear willing to take timely steps to rectify the situation, DWQR may serve an Enforcement Notice on Scottish Water under Section 10 of the Water Industry (Scotland) Act 2002. Such an Enforcement Notice must set out specific actions to be taken by Scottish Water within specified timescales. Failure to complete such actions by the due date is a criminal offence under Section 12 (5) of the Act.

In 2018, there were four active Enforcement Notices:

Invercannie water treatment works - *Cryptosporidium*

Amlaird water treatment works and supply zones – THMs

Bradan water treatment works – THMs

Tullich water treatment works – THMs and *Cryptosporidium*

ANNEX C STATISTICAL METHODS USED IN THE REPORT

Water Quality Compliance Data for Local Authority Areas

In order to present drinking water quality data by local authority area, it has been necessary to report data for the group of supply zones within that area. Water supply zone boundaries do not fit local authority boundaries exactly, so the data for any supply zone which falls wholly or partly into the local authority area has been included.

This approach means that data from some supply zones is included twice or more in the Local Authority Area tables. For example, the same data for Glencorse A supply zone is included in the sections for East Lothian, Midlothian and City of Edinburgh.

Zonal Compliance

Zonal compliance is simply the percentage of samples meeting the PCV (Prescribed Concentration or Value) for that parameter.

Mean Zonal Compliance

Mean zonal compliance (MZC) for an area is built up from zonal compliance figures for individual parameters in individual supply zones. This is a helpful tool when considering water quality at national, regional and local level as it provides a simple means of summarising drinking water compliance and comparing year on year performance. It is this measure which is used as the overall measure of drinking water quality by Drinking Water Inspectorate (DWI) for companies in England and Wales and it allows us to compare national performance. It uses only the 39 parameters that are listed in Schedule 1 of The Public Water Supplies (Scotland) Regulations 2014 for which there is a numerical value.

All parameters are weighted equally in the calculation but the sheer number of pesticide determinands has the potential to skew the MZC calculation by placing undue weight on pesticide analysis. For that reason, results for the individual pesticides not specifically mentioned in Schedule 1 of the Regulations have been pooled to produce a single "All Pesticides" parameter. The large number of different pesticides analysed every year is determined using a risk assessment process to define specific sampling requirements in each supply zone.

MZC can be quite variable year on year as it can deteriorate significantly should a parameter fail in a very small zone sampled only once per year – effectively giving 0% compliance for that zone. This is a particular issue in Scotland, as some of the water supply zones are very small, serving populations in single figures. Regulatory sample frequencies are based on population, hence sampling for certain parameters in these zones is infrequent, with perhaps only two samples being taken for each parameter per year. If one of these samples fails, this will adversely affect MZC to a much greater extent than a sample failure in a large supply.

For this reason the measure of overall water quality compliance at consumers' taps is also calculated and used to report year on year comparative performance.

Overall Quality Compliance

The Overall Quality Compliance for Scotland as measured at consumers' taps is simply the number of samples taken which met the required standards for parameters which have a numeric value in the Regulations.

Worked Examples

Zonal Compliance

The zonal compliance for iron for a notional supply zone, Zone 1, is calculated as follows:

	No. samples taken for iron	No. samples failing	Zonal Compliance (Iron)
Zone 1	52	2	96.15

Mean Zonal Compliance

In order to calculate the MZC for iron for a group of ten zones which include Zone 1, the arithmetic mean of all the zonal compliances for iron is taken.

Zone 1	96.15
Zone 2	98.6
Zone 3	100
Zone 4	100
Zone 5	100
Zone 6	100
Zone 7	100
Zone 8	100
Zone 9	100
Zone 10	100
MZC	99.48

ANNEX D ABBREVIATIONS USED IN THE REPORT

Bq/l	Becquerels per litre
DMA	District Metered Area
DMI	Distribution Maintenance Index
DWI	Drinking Water Inspectorate for England and Wales
DWQR	Drinking Water Quality Regulator for Scotland
FBC	Flatbed Clarifier
ISO	International Standards Organisation
mg/l	milligrammes per litre
MIB	2-Methylisoborneol
MZC	Mean Zonal Compliance
NHS	National Health Service
NTU	Nephelometric Turbidity Unit
OMG	Outputs Monitoring Group
PCV	Prescribed Concentration or Value
PHT	Scottish Water's Public Health Team
ROV	Remotely Operated Vehicle
RSZ	Regulated Supply Zone
SR	Service Reservoir
THM	Trihalomethanes
TIM	Operational Performance Index
µg/l	microgrammes per litre
UKAS	United Kingdom Accreditation Service
UV	Ultraviolet Light
WTW	Water Treatment Works

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