Drinking Water Quality Regulator for Scotland

DRINKING WATER QUALITY
IN SCOTLAND 2015

PUBLIC WATER SUPPLY

SAFEGUARDING YOUR DRINKING WATER QUALITY

CONTENTS

Supporting Information

Public Supply Performance Tables 2015 http://dwqr.scot/information/annual-report/

Summary of Incidents 2015 http://dwqr.scot/information/annual-report/

FOREWORD

This the fourteenth 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 2015. Our report also describes the work of the DWQR during the calendar year 2015 in scrutinising the quality of drinking water provided by Scottish Water (public supplies). Information relating to Scotland's private water supplies will be published separately in September 2015.

In 2015 the figure for compliance with the standards set out in our legislation and in the EU Drinking Water Directive was 99.92%. This is the highest ever compliance, and demonstrates continued improvement in the quality of drinking water that consumers in Scotland receive. This reflects on-going investment in water quality and the focus given by Scottish Water to improving operational practices and maintenance of its assets.

Compliance with standards is not the only measure we use to assess how well Scottish Water is meeting its drinking water quality duties. The numbers of contacts received by Scottish Water from consumers who are dissatisfied with the quality of their supply is also an important indicator. The number of contacts continues to decrease, with only 0.2% of consumers reporting concerns with the quality of their supply, almost half that of numbers reported six years ago.

The compliance achieved in 2015 and reducing consumer concerns are very welcome news, but challenges remain. In 2015 we investigated 35 drinking water quality incidents. These incidents occurred for a variety of reasons, though some common themes were evident during 2015, these included failure of critical alarms and lack of monitoring. It is essential that Scottish Water learn from these incidents and build this into their risk assessment process, ensuring that lessons learnt are shared across operating areas and remedial action is not restricted to the affected location.

One major incident affecting drinking water quality occurred during June 2015, when over 6,000 properties in North Lanarkshire suffered restrictions on the use of their water for two days after contamination of the supply. We have investigated this event thoroughly, and submitted a report to the Procurator Fiscal. Consequently, it has not been possible to include details of the incident in this report; I will make my findings public as soon as I am able.

Very high levels of compliance with standards and the ensuing high level of public confidence is something that we expect Scottish Water to safeguard, through robust risk assessment and the diligent operation of resilient water supply systems. It is vital that the progress that has been made is maintained and further built upon.

Sue Petch
Drinking Water Quality Regulator for Scotland

EXECUTIVE SUMMARY

In Scotland, the public water supply is provided by Scottish Water. All other supplies, owned and managed by individuals, are known as private water supplies. The Drinking Water Quality Regulator for Scotland (DWQR) regulates the quality of water supplied by Scottish Water, ensuring that drinking water supplies meet the requirements of the Public Water Supplies (Scotland) Regulations 2014 ("the Regulations").

Some key facts about the public water supply in Scotland for 2015 are shown below:

Scottish Water supplied 1.37 billion litres of drinking water per day

from 240 water treatment works

through 47,000km of water mains

99.92% satisfactory samples from consumers taps

Scottish Water, takes and analyses its own samples to demonstrate that the water supplied complies with regulatory requirements. In 2015, 317,107 samples were taken across drinking water assets, though predominantly from consumer's taps This sampling and analysis is independently accredited, and is consistent with water industry practice in the rest of the UK.

The DWQR assesses Scottish Water's monitoring programme and results, these are discussed in Section 1 of this report. We also inspect a range of Scottish Water activities and assets that could affect quality and investigate any water quality incidents that are reported. Information on our audit and investigative work is given in Sections 2 and 3 of this report. During 2015 we conducted the following activities in fulfilment of our supervisory function:

Investigated 35 drinking water quality incidents	Assessed Scottish Water's sampling and monitoring programme of 317,107 samples	Evaluated 746 water quality event notifications
Responded to 78 consumer contacts	Carried out 26 technical inspections of assets and activities	Reviewed risk assessments and improvement plans for 240 supplies

1 DRINKING WATER QUALITY 2015

Water Treatment Works

Scottish Water has 240 water treatment works (WTW) that treat water to ensure it is safe to drink and complies with the standards set out in 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 works are capable of treating the range of raw water quality which may be found in source waters.

The majority of regulatory analysis takes place on samples collected from consumers' taps, but some important sampling also takes place on water as it leaves each treatment works. The number of samples which need to be collected each year varies depending on the volume of water supplied by the treatment works.

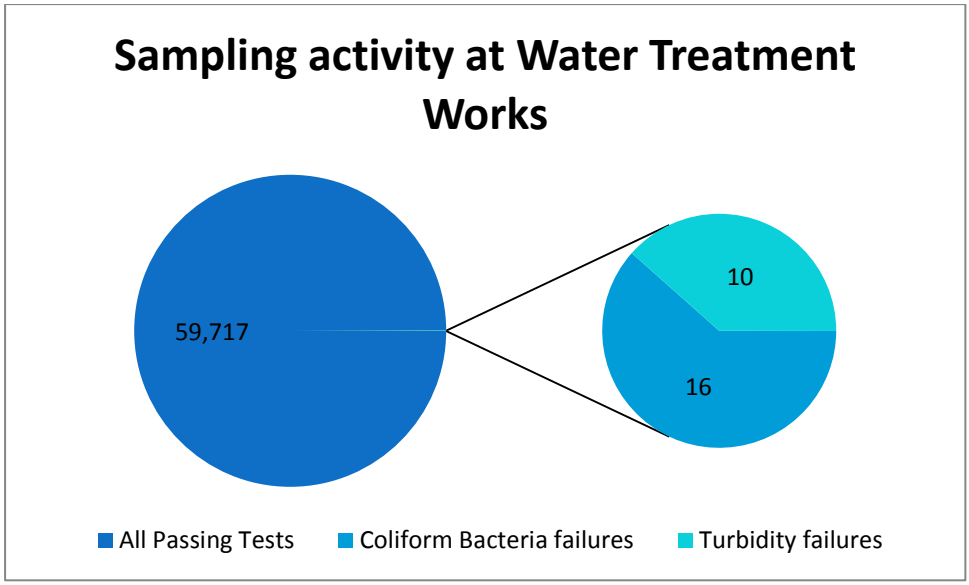

Figure 1 Proportion of treatment works sample failures

Over 60,000 tests were undertaken on samples collected at treatment works. Of these, only 26 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 in order to verify 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 should be considering 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. Consideration should be given to 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 and this has been beneficial in understanding and resolving the causes underlying many failures.

Colony counts are also monitored at water treatment works. Although there is no numerical standard for these, they are a useful indicator of microbiological activity, and again can provide a measure of the effectiveness of the disinfection process, especially when trended over time.

Microbiological compliance, as shown in **Figure 2**, has improved significantly over recent years (summary data is given in Table 3 in Performance Tables). There were 16 detections of coliforms at treatment works, representing a significant improvement.

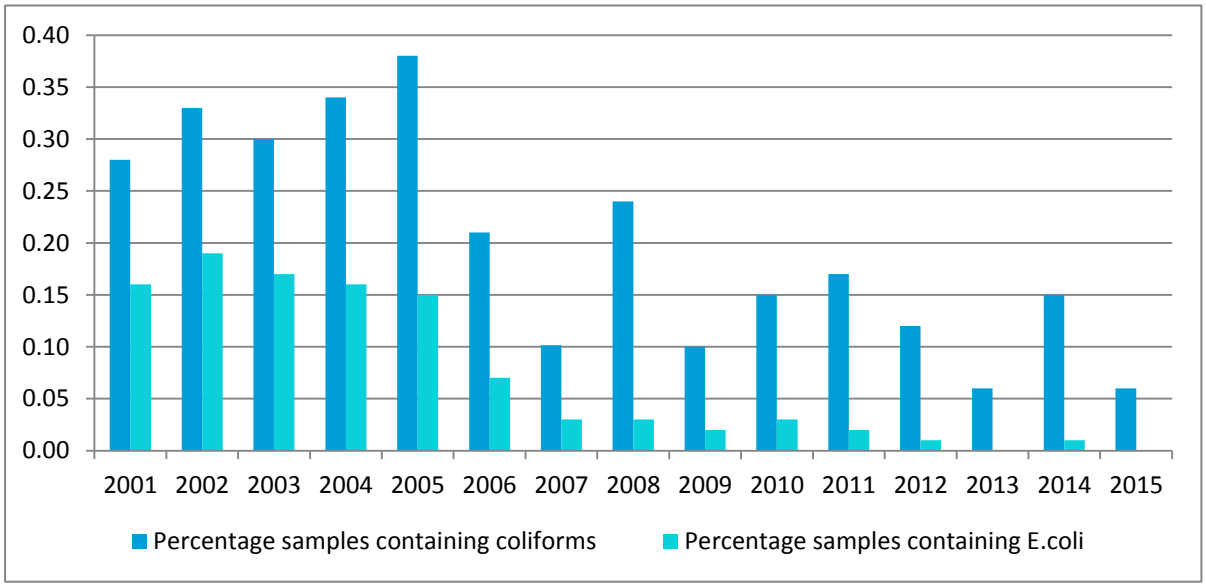

Figure 2 Year on Year Microbiological Failures at Water Treatment Works

Two treatment works recorded more than one coliform failure in 2015 – Glenfarg in Fife and Invercannie in Aberdeenshire.

At Invercannie, two failing samples were taken during the summer months. Scottish Water could not find a definite cause, but suggested a potential cause as level fluctuations in the contact tank and also identified the need for improvements to the final water sample tap.

The two failures at Glenfarg were also during the summer months and were attributed to deficiencies in the amount of chlorine contact time available at the site under certain flow conditions. A number of improvement measures were highlighted by Scottish Water.

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 tightly managed, and the presence of nitrite in significant quantities can indicate that it is not controlled as it should be. For the fourth consecutive year, no exceedances of the standard for nitrite were recorded at water treatment works.

Turbidity is a measure of the extent to which particulate matter in the water scatters light – effectively how cloudy the water appears. Turbid waters cannot be properly disinfected, hence a treatment standard of 1 NTU has been set in the Regulations. In 2015 there were 10 exceedences of the standard for turbidity at 9 treatment works, less than in 2014. Summary data is shown in Table 4 in Performance Tables.

One site – Carron Valley WTW in central Scotland – recorded two samples which failed the ex-works standard for turbidity. Both were attributed to specific flow conditions in the sample line following start-up of the pumps to Gartcarron. DWQR audited the works in 2015.

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 inactivated 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 tests water supplies for *Cryptosporidium* in order to verify that these processes are effective.

The number of detections of *Cryptosporidium* in final water samples reduced significantly from 124 in 2014 to 84 in 2015 (Table 5 in Performance Tables). The treatment works reporting the most frequent detections were Lochaline, which currently has no effective barrier treatment but which has investment planned for completion in 2017; and Craignure on Mull, which now has a membrane treatment process.

The mid-Skye works of Elgol, Torrin and Strollamus, which all reported frequent detections, were decommissioned in March 2015 and the area is now supplied from Broadford WTW which has a robust treatment process.

Tullich WTW, which supplies Oban, recorded eight detections in 2015. The existing works was not designed to remove *Cryptosporidium*, a new treatment works is currently under construction and is due to be completed in September 2017. Scottish Water has installed temporary treatment using ultra-violet light, which inactivates *Cryptosporidium* oocysts, in the interim.

Rosebery WTW in Midlothian reported four oocyst detection events, despite having a treatment process that should provide a robust barrier. DWQR visited the site on several occasions to investigate and discuss the matter with Scottish Water. Various improvements to the process have been made which include improvements to flow monitoring and control of raw water blending; Dissolved Air Flotation process control and filter flow control.

Service Reservoirs

Service reservoirs are located at points in the distribution system to store water, both for hydraulic reasons and to even out the demand for water 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. Scottish Water adopts a risk-based approach to cleaning and refurbishing storage tanks.

DWQR inspects a selection of structures each year in order to ensure that they are being maintained and operated in a manner that minimises risk to water quality.

Coliforms and *E. coli* are two parameters measured in samples regularly taken from service reservoirs to verify that disinfection is effective within the distribution system and to identify any instances where the water may have become contaminated. All 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 2015 (Tables 6 & 7 in Performance Tables) show that there was a lower overall incidence of bacteriological sample failures than reported in 2014. The Regulations require that no sample from service reservoirs should contain *E. coli* and at least 95% of samples may not contain coliforms. Sixty three samples contained

coliforms (two service reservoirs failed to meet the 95% requirement) and five samples contained *E. coli*. The *E. coli* failures were as follows:

At Callanish on the Isle of Lewis the failure was caused by ingress to the reservoir and was subject to a full incident report which can be found on our website www.dwqr.scot

At Cauldhame reservoir on Orkney, the single *E. coli* failure was attributed to a low chlorine level due to low water turnover in the reservoir and also may have been subject to some environmental contamination as slurry was being spread in the field adjacent to the sampling kiosk. The chlorine level at this reservoir was subsequently boosted and the reservoir cleaned.

A failing sample from Borve reservoir on Skye was attributed to water ingress via the underside of the roof slab.

No cause could be determined for the *E. coli* failure at Perth Muirhall reservoir, which was in a good state of repair with adequate chlorine levels.

The condition of the reservoir – including the inlet and sampling tap – was the cause of the *E. c*oli failure at Sunnylaw, Dunblane. As a result of the failure the reservoir was cleaned and inspected, with the sample tap pipework replaced and a drain fitted to prevent splash-back.

Microbiological failures were recorded from 55 service reservoirs which is a better position than 2014 where 96 reservoirs were affected. **Figure 3** illustrates the trend in performance against this measure.

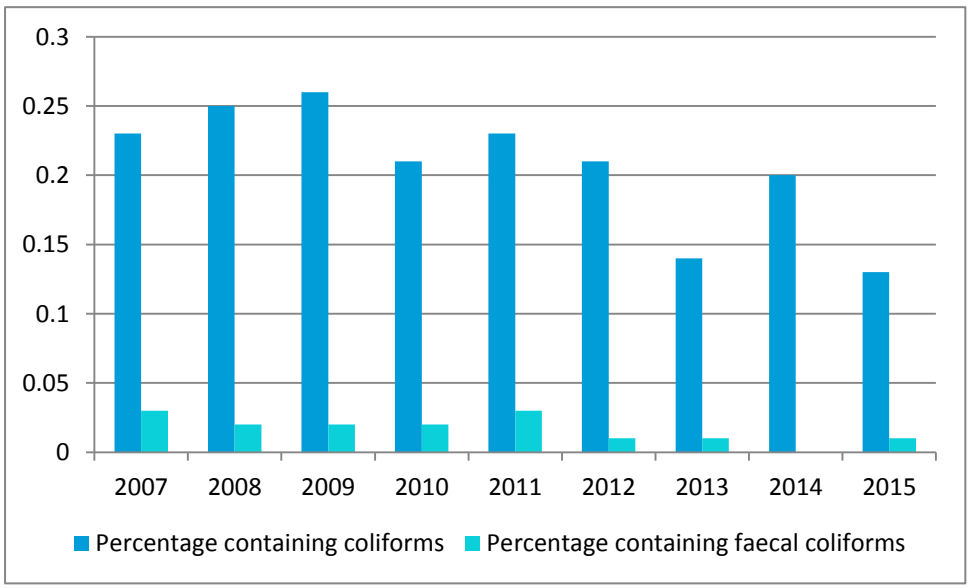

Figure 3 Year on Year Microbiological Failures at Service Reservoirs

All service reservoirs except two met the regulatory requirement that 95% of samples should not contain coliforms. These failures were at Largie near Insch in Aberdeenshire where 3 out of 52 samples contained coliforms, and Conerock, near Aberlour in Aberdeenshire where 1 sample out of 13 contained coliforms. Coliform failures have occurred previously at both of these sites: Largie in 2014, 2013 and 2011; and Conerock in 2013, 2012 and 2011. The failure at Largie in 2013 was attributed to the internal condition of the reservoir which was subsequently cleaned in 2013, further failures have been attributed to the excessive age of the water and Scottish Water has acknowledged that action needs to be taken; most likely the permanent decommissioning of the asset. Conerock was recognised by Scottish Water as having historic poor compliance and was cleaned and inspected in June 2015. A number of other service reservoirs have had coliform failures in at least three of the last five years, these are:

Bruichladdich on Islay (2013, 2014, 2015), Scottish Water have installed a new sample point and upgraded the secondary chlorine dosing including improved dosing controls.

Graemsay (2011, 2012, 2013, 2015), this reservoir was cleaned in 2013 in response to the previous failures. An investigation into the 2015 failure has concluded there were a number of potential reasons for the failure which the previous investigations had failed to identify relating to the sample point and location of the secondary chlorine dosing point.

Maunderlea (2011, 2014, 2015), this reservoir was cleaned in 2014 and no significant defects were found. Investigations into the most recent failure identified the presence of vermin in the sample kiosk and repairs carried out to prevent access.

Whitehills Auds (2011, 2014, 2015), this reservoir failed for coliforms on two occasions in 2015. Scottish Water have identified the reservoir to be in poor condition and have withdrawn it from use.

The monitoring requirement for service reservoirs is to take weekly samples when they are in service and a 'live' part of the water supply route. A number of reservoirs fell short of recording 52 samples in the year and DWQR is satisfied that this is substantially due to the reservoir being withdrawn from supply for a period of time for inspection, cleaning or repair.

Water Quality at Consumers' Taps

Scottish Water's supply area is divided into 290 water supply zones. Most sampling to assess regulatory compliance takes place at consumers' taps, and testing takes place for 51 parameters. Sampling frequencies are determined by the size of the population in the water supply zone.

In 2015, 149,491 tests were carried out on samples taken at consumers' taps. Of these, 123 failed to meet the standard set out in the Regulations. This means that 99.92% of tests

carried out at consumers' taps complied with the standards. The equivalent figures for 2014 were 160 failing samples and 99.89% compliance, demonstrating an improved performance.

Seventy-seven supply zones had a sample taken in 2015 that failed to meet one or more of the standards, which is a significant improvement on 2014's figure of 94. The better performance stems from fewer failures of microbiological parameters.

Scottish Water's overall figure for Mean Zonal Compliance (MZC) in 2015 was 99.91% (the methodology for calculating this measure is shown in Appendix D). This allows comparison with performance in England and Wales, where the MZC measure is used as an indicator of overall drinking water quality.

Table 1 below shows the failing test results of samples taken from randomly selected consumers' taps. Compliance for a number of key parameters is then discussed in more detail. The number of samples taken for each parameter that Scottish Water is required to test for is shown in Table 8 of the Performance Table report.

Table 1 Summary of Failing Tests on Consumer Tap Samples During 2015

Parameter	Total No. of Samples	No. Failed Samples	No. Zones with Failures	% Compliance
Failing Parameters				
Coliform Bacteria	14,100	34	29	99.76
E. coli	14,100	1	1	99.99
Hydrogen ion (pH)	5,104	5	5	99.90
Aluminium	5,069	3	3	99.94
Iron	5,069	28	21	99.45
Manganese	5,069	13	11	99.74
Lead (10)	1,499	15	15	99.00
Total Trihalomethanes	1,578	2	2	99.88
Individual Pesticides	12,855	1	1	99.99
Benzo 3,4 Pyrene	1,503	1	1	99.93
Clostridium perfringens	5,071	1	1	99.98
Copper	1,499	1	1	99.93
Nickel	1,499	5	5	99.67
Nitrite	2,430	6	4	99.75
Odour	5,108	3	3	99.94
Taste	5,105	4	4	99.92
All other parameters	64,332	0	0	100.00
SCOTLAND	**149,491**	**123**	**77**	**99.92**

E.coli

E. coli is an extremely important parameter because it is an indicator of faecal contamination and the microbiological safety of the water. Compliance for this parameter is relatively stable with only a few failures occurring each year. One sample failed last year, compared to three in 2014.

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. On investigation, this failure was found to be an error within the laboratory and not a representation of actual drinking water quality.

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 do not necessarily indicate faecal contamination, but should not be present in the water supply as they are readily deactivated by chlorine, which is added in controlled amounts to all of Scottish Water's supplies.

Coliforms were detected in 34 samples in 2015, an improvement from the 63 recorded the previous year.

There does not appear to be a geographical pattern to the exceedences, with the majority (24) of the failures occurring singly in different supply zones. Five zones recorded two failures. When these failures occur, Scottish Water takes further samples from the premises and also from neighbours to determine if there is a local property issue or a wider supply system concern.

Scottish Water has demonstrated that improvements are possible by such means as thorough treatment of water, diligent maintenance of storage points and distribution systems to ensure their integrity and cleanliness and careful management of residual chlorine and water age. A significant proportion of failures however are found to be caused by hygiene issues at the kitchen tap. Scottish Water notifies the consumer of the findings and provides the appropriate advice in each case.

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 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. High pH values can sometimes occur where water is in prolonged contact with some water mains containing cement. Waters with a very high pH can have a taste that some consumers find unpleasant.

Compliance for pH deteriorated in 2015 with five failures in 2015 in five separate zones compared to a single failure in 2014. These were attributed to the water mains or supply pipe materials and residence time or turnover of the water, flushing of the supply restored water quality.

Aluminium

Aluminium can be naturally occurring 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 via this route.

Compliance for aluminium deteriorated on the best ever performance of one failure in 2014. There were three aluminium failures in 2015 in three separate zones. One occurred in Killylour zone which was deemed to be a consequence of poor treatment. Scottish Water has carried out improvements at the treatment works to put in place more robust treatment processes and these were completed in May 2016.

Iron

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

Scottish Water has embarked on a large programme of renovation of the water mains that cause the most significant water quality issues and has developed techniques and measures to ensure that quality is managed on an on-going basis in the meantime. This should also have the effect of reducing the number of discolouration complaints received by Scottish Water from consumers.

Although compliance with the iron standard has improved over the years, 2015 saw a slight worsening of performance with 28 samples failing within 21 supply zones. Carron Valley B zone suffered four failures, all of which were attributed to the condition of water mains. A study is planned to be completed by 2017 to inform of the required investment for mains rehabilitation works.

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 distribution system pipework and cause severely discoloured water supplies and great inconvenience for consumers. Overall compliance continued to improve in 2015, but has

further to go. 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.

Two water supply zones recorded more than one failure in 2015, Black Esk in the South Region and Kaim Lochwinnoch in the West. Both Black Esk failures were attributed to disturbance of deposits in water mains and the Kaim Lochwinnoch to higher seasonal manganese in the raw water supplying Kaim WTW. The treatment process at this works is not able to remove manganese and Scottish Water plan to main-out the zone in 2017 and supply the area from an alternative treatment works and allow de-commissioning of Kaim.

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 (e.g. overnight/ weekends / holiday periods). This can result in high lead levels in the drinking water supply.

DWQR has established a project to review policy to drive achievement of a reduction of exposure to lead in drinking water. The project looks to strengthen or introduce mechanisms with a range of stakeholders and influencers to raise awareness with consumers and promote the removal of lead service pipes, and plumbing.

Although the majority of lead piping is privately owned and therefore outside Scottish Water's direct control, the company does have a responsibility under the Regulations to minimise the risk from dissolved lead. The standard for lead reduced from 25µg/l to 10µg/l at the end of 2013. Against the 10 standard, over the past three years there have been 17, 12 and in 2015, 15 failures. All of those 15 occurred singly, in separate zones. In the majority of cases, the failures have been attributed to the domestic plumbing system. Scottish Water needed to replace three of their own communication pipes as a result of the failing samples. They also notified the householders of the health risks of lead and that they should seek to replace their own customer-side pipework.

Scottish Water is required to treat water supplied to zones where there is a demonstrable risk of failure of the lead standard. This is achieved by adding small amounts of orthophosphoric acid to the supply and optimising the dosing to provide a coating to lead pipes and thereby reducing the plumbosolvency effect. Of the 15 failures, eight occurred in zones with this treatment in place, although three are currently not fully optimised. Seven zones were considered to be of low risk of failures and Scottish Water must keep these under review. In four of these cases, customer-side pipes were acknowledged to be of lead. The cause was undetermined in the other two.

DWQR served Scottish Water with a Consideration of Enforcement letter in July 2015, after assessment of instances of lead failures indicated that dosing of orthophosphoric acid at three WTWs had ceased. The subsequent measures put in place by Scottish Water provide

reassurance that a more rigorous approach to the continual maintenance and optimisation of dosing for this important safeguard is pursued.

Total Trihalomethanes (THM)

THM are one group of disinfection by-products that can form when organic substances combine with chlorine used to disinfect the water. As Scotland's upland waters are naturally rich in 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 continued to make inroads on this issue, recording two failures within two separate supply zones in 2015 which is a significant improvement from the position in 2010 when 62 failures were recorded.

In addition to meeting the standard for total THM's, Scottish Water is also required to minimise the production of all disinfection by-products. **Figure 4** shows reducing numbers of zones affected at different levels of THM within the standard which suggests not only improvement at the prescribed concentration or value (PCV), but a more in-depth progress and that Scottish Water is endeavouring to reduce by-product formation.

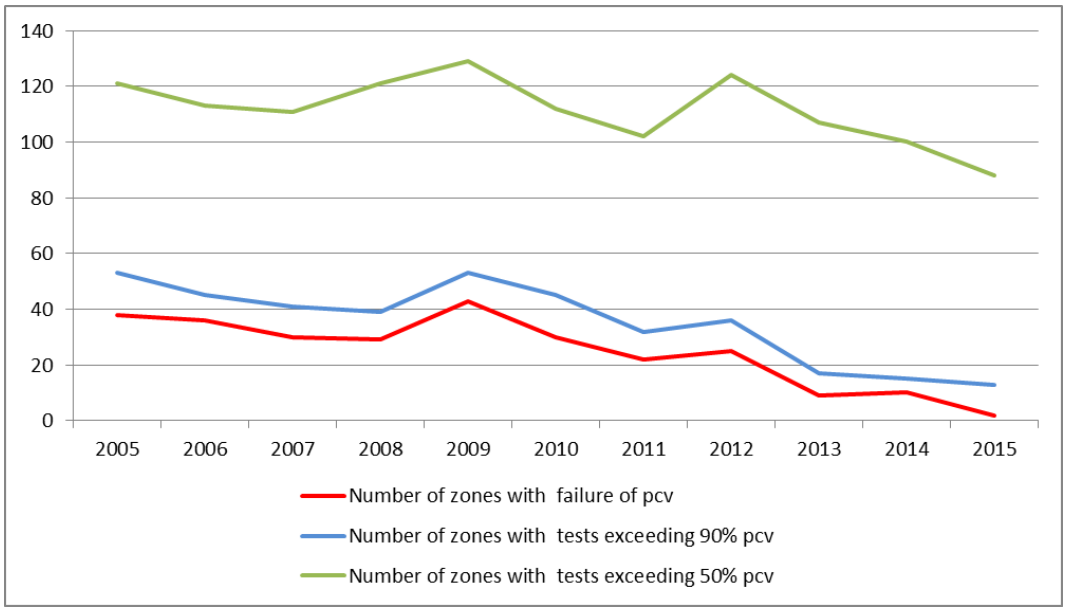

Figure 4 THM Performance 2005 - 2015

One of the failing zones, Tullich, also records a further three samples with THM values within 10% of the PCV. Scottish Water has given Scottish Ministers a legally binding commitment on delivery of improved treatment at Tullich WTW which is due for completion by September 2017.

A failure was recorded in Burncrooks water supply zone and the water treatment works that supplies this area is included in the investment plans for the current period (2015 – 2021). In

addition, there are another 12 zones with measurements of THM values in the band of 90 – 100 µg/l indicating they are perhaps at risk of exceeding the PCV and Scottish Water has investment plans for eight of these. For the remaining four, DWQR expects Scottish Water to recognise these risks in their drinking water safety plans and continue to persevere with their work to minimise formation of THM.

Individual Pesticides

One exceedence of individual pesticides occurred during 2015 where MCPA was detected above the permitted levels in a sample taken within Corsehouse supply zone. The failure has been attributed to farming activities in the catchment to Corsehouse WTW and work was undertaken with catchment stakeholders to prevent pesticides reaching watercourses and, ultimately, the treatment works.

Benzo 3,4 pyrene

Polynuclear aromatic hydrocarbons, or PAHs, form a class of diverse organic compounds, one of which is Benzo 3,4 pyrene (also known as Benzo (a) pyrene). The main source of PAH contamination in drinking water is usually the coal tar coating of old water mains or distribution pipes, used to protect the pipes from corrosion.

There was a single failure of this standard in a sample from the Milngavie M5 Drumchapel South supply zone. Resamples proved satisfactory and Scottish Water was unable to determine a specific cause for the detection in the sample.

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 will resist disinfection. Their presence in disinfected waters may indicate deficiencies in treatment. In distribution systems and at customer taps, they can be an indicator of some historic contamination having occurred.

There was a single failure of this standard in a sample from the Balmore C5 supply zone, the cause of which was attributed to kitchen tap hygiene.

Copper

The primary source of copper in a supply is most often corrosion caused to copper plumbing. Concentrations often increase during distribution to points within buildings especially if the water is of a low pH. It may also reflect the quality of the pipe material. At high levels it will impart a bitter taste to the water and may cause it to appear to have a blue colour.

There was a single failure of this standard in a sample from the Tomich supply zone in the North Region which was attributed to the domestic plumbing.

Nitrite

Nitrite forms when nitrifying bacteria act on ammonia that is added to chlorine in a process known as chloramination. If the process is not tightly controlled and nitrifying bacteria are allowed to persist in the distribution system due to high water residence times, failures of this parameter can result.

In 2015 there were six failures of this parameter which again continues the improvements made in 2014. One supply zone, Roberton in the Borders, accounted for three of those failures and the others occurred singly in different zones. In all three instances, the cause was attributed to the residence time of the water within the distribution system.

Nickel

Nickel is a compound 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.

Five exceedences occurred during 2015 across five separate zones which were attributed to the type of tap or cause unknown.

Taste and Odour

Failures of the standard for taste occurred at three locations in 2015, in Turriff, Glencorse A and Skerries (Shetland) supply zones. A further odour only failure occurred in the Staffin zone on Skye. As these were all on different water supplies it is highly likely that they are attributable to localised causes.

Consumer Contacts

When a consumer calls 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 11,245 consumer contacts relating to water quality, equating to a contact rate of 22.5 per 10,000 population. This is the lowest rate of contact experienced by Scottish Water, having almost halved over the past six years. The reduction in consumer calls about discoloration largely accounted for the overall improvement on last year's 14,012 contacts, although the number of calls about tastes and odours tempered the performance.

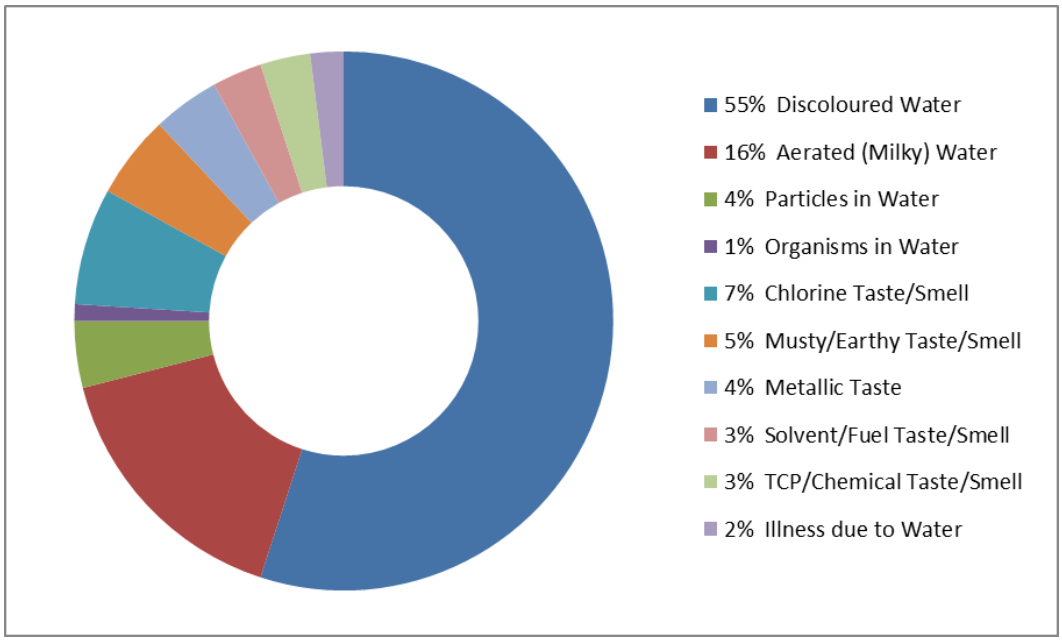

Figure 5 Breakdown of Consumer Contacts by Type

Figure 5 shows over 71% of calls were received in response to discoloured water and 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 the significant proportion (22%) of contacts relating to the taste or smell of the water supply causing concern to consumers. A water quality incident in the Motherwell area at the end of June was a significant contributor to the overall level of contacts for discoloration and the range of taste and odour categories.

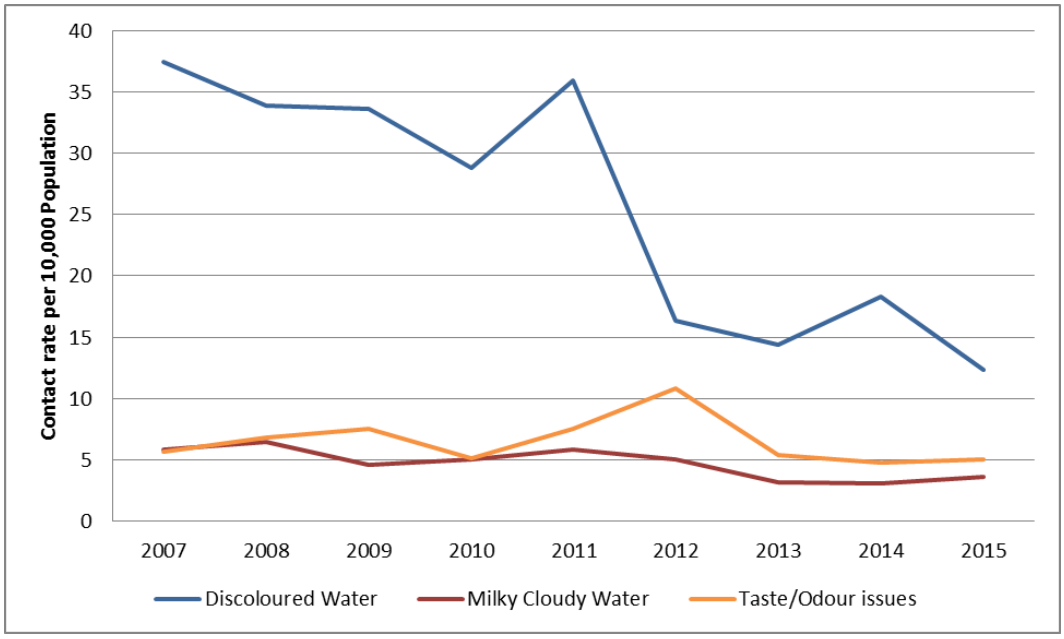

Figure 6 Trend in Key Contact Categories

Whilst it is acknowledged that the proportions of categories will shift as the overall numbers change, **Figure 6** further illustrates the point in terms of the trends in key contact types. The downward trend has continued this year through the general decrease in discolouration complaints but the slight upturn in aerated water is caused by an event in the Alnwickhill area of Edinburgh, which is discussed later in the report.

Over 30% of all taste and odour complaints are about chlorine - the level of complaints is 1.5 per 10,000, and this again, is the lowest level seen over the past eight years. This is welcomed by DWQR but this issue continues to be an emotive subject with consumers as it often highlights a concern with the general levels of chlorine in supplies. It is important that Scottish Water continues to review chlorine residuals in water supply systems to ensure these are appropriate and to identify opportunities to reduce the amount of chlorine being added whilst not compromising microbiological safety. Other taste and odours tend to be episodic, driven by a particular event.

Although the chart illustrates the significant improvement made in reducing discoloration for consumers across the country, the issue remains a consistent concern in some parts. **Figure 7** shows the areas of the country covered by the public water supply networks (light blue shading) and highlights those where discoloration contacts have been significantly above the average rate over the past few years. **Figure 8** provides more detail of the zones in which they occur.

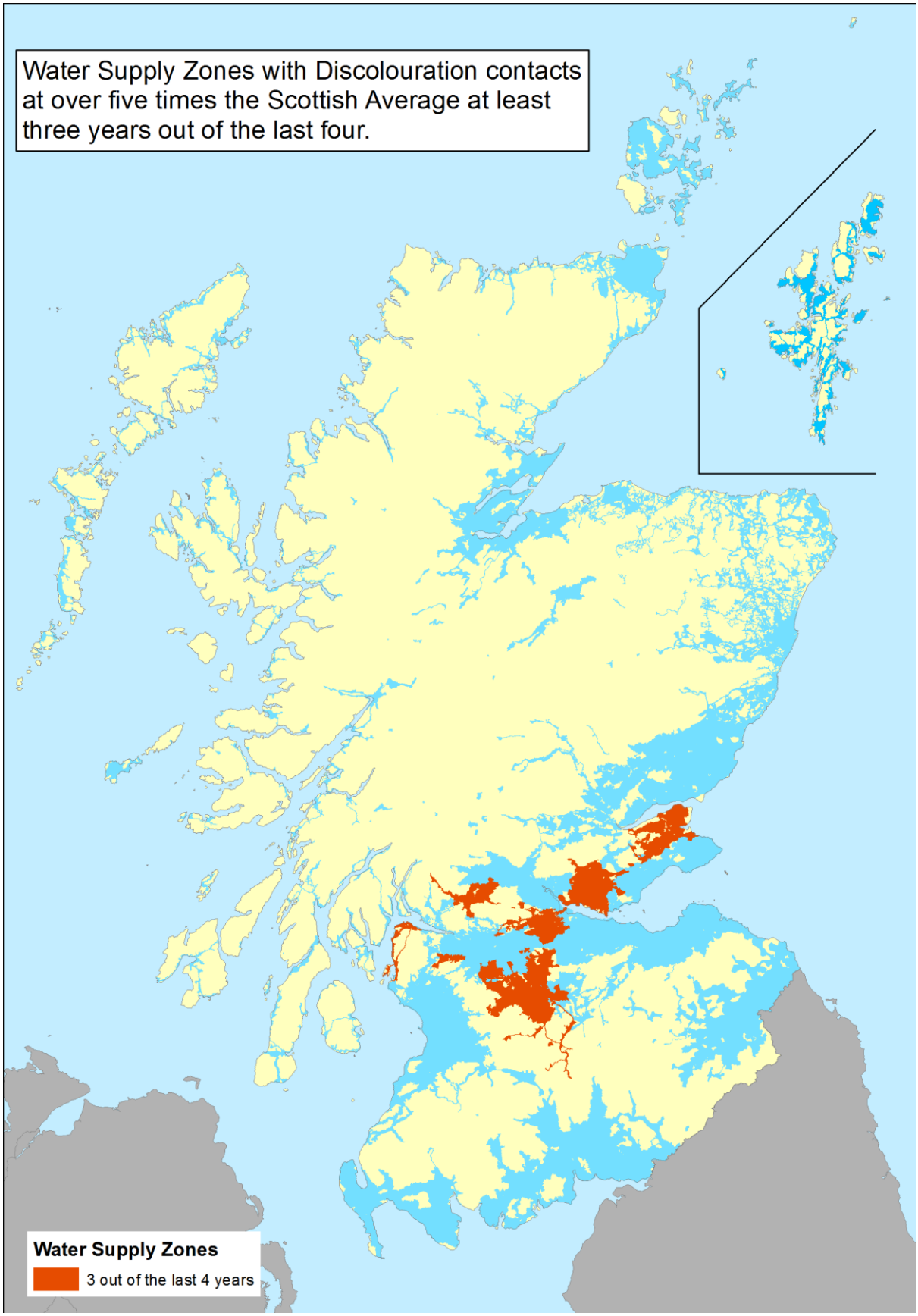

Figure 7 Areas of consistently high volumes of discoloured water contacts

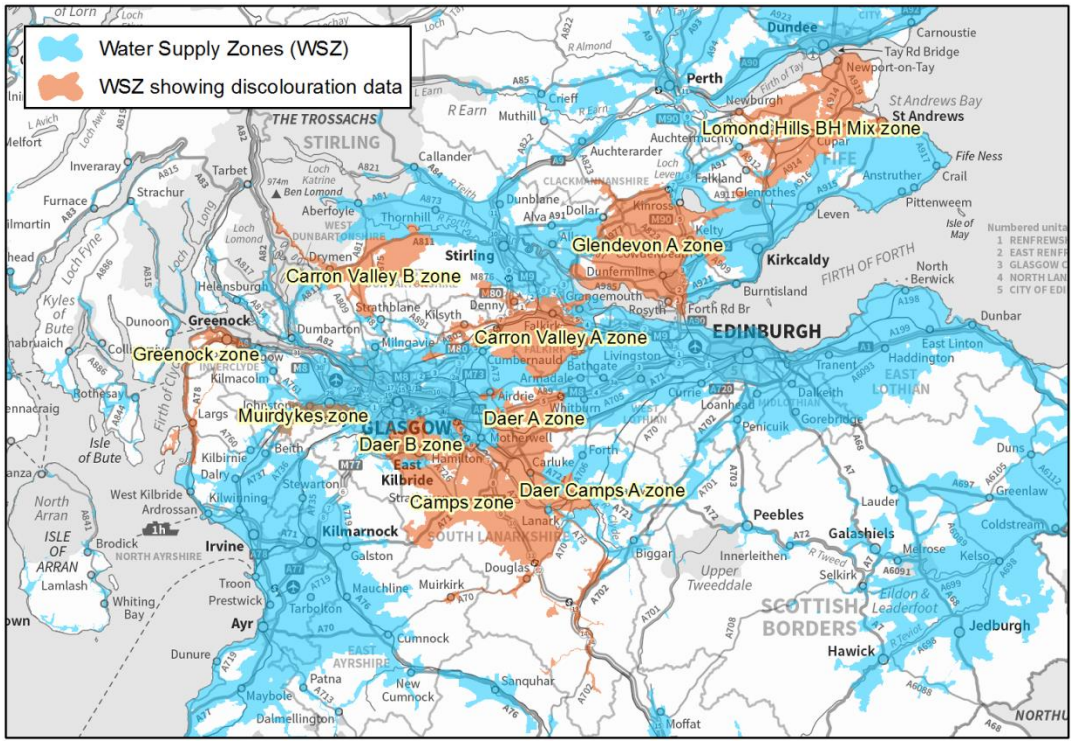

Figure 8 Supply Zones with High Discoloured Water Contacts

Of the ten supply zones highlighted in **Figure 8**, Scottish Water has investment plans for improvements for Muirdykes, Greenock and Carron Valley B water supply zones. DWQR expects Scottish Water to be reviewing the contacts it receives on a regular basis and those areas showing persistently higher than average levels of discoloured water contacts be included in plans for remediation.

The overall contact rate for all categories of consumer contacts in 2015 was 22.5 per 10,000. In geographic terms, the areas where most issues were raised by consumers are shown in **Figure 9**. There are 11 zones where more than 200 contacts were received. This has reduced from 16 zones in 2014 and the chart shows the supply zones ranked by contact rate. The general preponderance of discoloration and aerated water is readily illustrated but three zones stand out as being less typical.

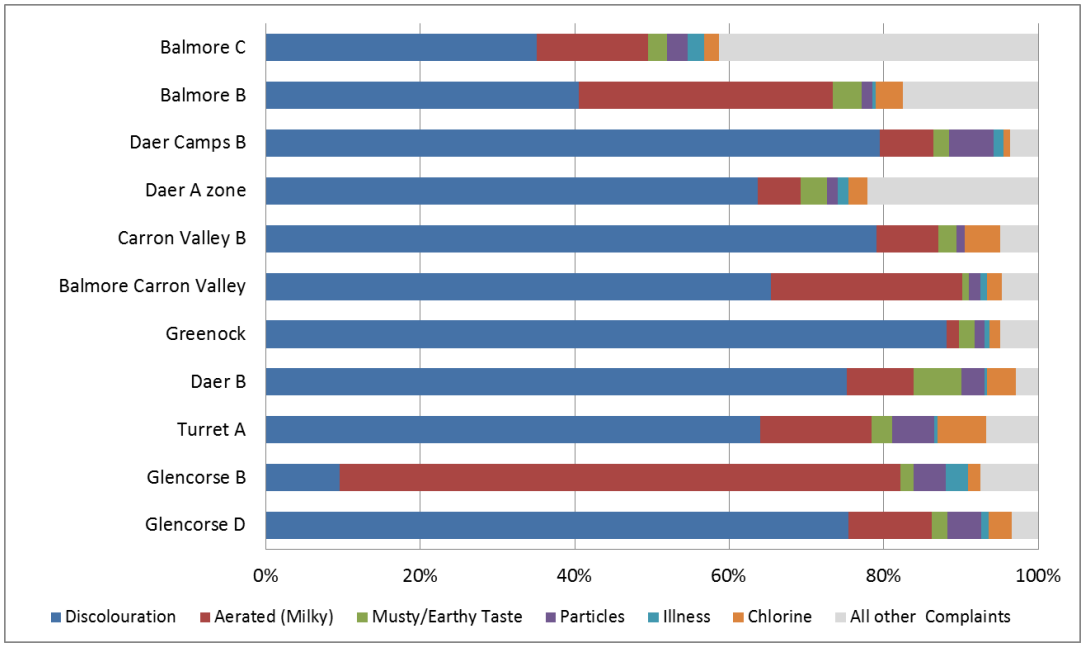

Figure 9 Water Supply Zones With Most Water Quality Complaints

Balmore C Supply Zone, in Lanarkshire, had over three times the overall contact rate across Scotland, generating over 77 contacts per 10,000 population. Four hundred and ninety three contacts were made over the year but a serious water quality incident occurring in the Motherwell area in June and into July, generated the majority of those. These ranged through solvent or fuel type tastes, metallic tastes and TCP or chemical type tastes. These normally are of low occurrence, or none and are collected within the 'other complaint' category. Over 90% of the 204 contacts in this 'other complaint' category and over 70% of the 173 discoloured water contacts were associated with the incident. DWQR has investigated this incident and submitted a report to the Procurator Fiscal.

Balmore B supply zone again shows an unusual proportion of discoloured water to aerated water contacts. Overall, 432 contacts were recorded in this zone in the year with 175 being discoloured water and 142 aerated. Significant numbers of these were generated by the same Motherwell incident, as water was transferred from this zone into the adjacent Balmore C zone to restore water quality there. The valving operations and increased flows causing disturbance of mains deposits. Solvent or fuel type tastes also featured significantly within the other complaints category.

Daer A zone was similarly affected by the Motherwell incident. The overall number of contacts in this zone over the year was 289. Glencorse B zone shows a very untypical record of contacts with 175 of the overall 241 contacts being for aerated, or milky water. Over 92% of these contacts were received over a seven day period and they were attributed to an error occurring in the program code for a pressure reducing valve located in the Alnwickhill area of Edinburgh. A re-write of the code was required to return stability to the system.

Consumer Contacts to DWQR

Scottish Water has a responsibility to investigate water quality complaints and supply issues, and the DWQR guides 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 a formal complaint with Scottish Water, the DWQR can carry out an investigation of the issues.

The DWQR is committed to ensuring consumer complaints are properly investigated and has an agreement with the Scottish Public Services Ombudsman (SPSO) on the arrangements and processes required to provide a fair and transparent assessment of water quality complaints.

Table 2 Consumer Contacts Received by DWQR

Contact Category	Number of Contacts				
	2015	2014	2013	2012	2011
Appearance					
Discoloured Water	3	6	6	8	18
Aerated (Milky) Water	0	1	2	3	2
Particles in Water	0	1	2	2	5
Organisms in Water	0	1	0	0	0
Taste and Odour					
Chlorine	2	9	5	19	19
Metallic	1	0	2	2	3
Solvent/Fuel Taste/Smell	1	0	0	0	0
Musty/Earthy	0	0	2	0	2
TCP/Chemical Taste/Smell	0	0	1	1	2
Other contact about Water Quality					
Illness due to Water	2	2	2	1	8
Other Contact	6	3	10	10	5
Total Public Water Supply Water Quality contacts	**15**	**23**	**32**	**46**	**64**
Public water supply issues & requests for information	8	23	27	42	56
Private water supply issues	23	16	12	7	16
General Enquiries to DWQR	32	37	21	37	17
Total Consumer Contacts to DWQR	**78**	**99**	**92**	**132**	**153**

Table 2 shows the various categories of consumer contacts received by the DWQR in 2015. Overall, 55 contacts were received in relation to the public water supply. Whilst the number of general queries to DWQR remains similar to previous years, the number of contacts on water quality issues has again dropped. The key factor in the reduction is clearer guidance

to consumers to make use of Scottish Water's formal complaints process to allow the company the opportunity to properly investigate and resolve issues.

DWQR carried out formal investigations of two complaints against Scottish Water in 2015. Both of these concerned complaints of taste and odour in the water.

Case 1 - A complaint that Scottish Water had allegedly supplied water which caused offensive odour on tableware and crockery and was the cause of ill health. Further, that they had failed to provide satisfactory explanation or information regarding the supply. The Consumer had made a number of complaints over a 10 month period requiring samples to be taken at intervals over this time. In the course of the investigation it became apparent that a tap in the garden of the property remained on an old private water supply and it was feared that there may be cross contamination taking place. Subsequently it was found that they were not interlinked but the Byelaws inspections carried out in the house, found a combination water heater had been installed with an improper cross connection to the heating system. DWQR considered this to have been a significant route for possible back-syphonage to occur and cause contamination of the domestic water supply. Although there was no indication in the analysis of sample results of this happening, it is possible there may have been undetected episodic occurrence. The consumer quickly rectified the plumbing fault. DWQR found that Scottish Water carried out appropriate investigation of the taste complaint, provided accurate information in their assessment of sample results, made appropriate interpretation of the supply system and to have provided appropriate water quality advice. DWQR was satisfied that Scottish Water had demonstrated the public water supply met the required standards and was safe to drink. It was considered however that they had failed to carry through arrangements at agreed times leading to an unnecessary prolonging of the complaint investigations, failed to provide timely confirmation of sample results and failed to fully address relevant questions in a formal complaint. DWQR made three recommendations in this case.

Case 2 – A complaint that Scottish Water had allegedly supplied water which had an offensive taste and odour and had failed to resolve consumer's concerns that water is unsafe. The consumer had complained to Scottish Water on a number of occasions and Scottish Water responded by discussing the issue and sending a representative to the property to investigate on several occasions. Samples of water were taken twice and bottled water was supplied as a temporary measure. From the samples taken, measured chlorine concentrations were not excessive and there is no evidence of anything in the water that could give rise to an unpleasant taste and odour complaint or cause health concerns. A series of flushing exercises were undertaken, over which period the consumer continued to report unpleasant taste. DWQR reviewed the actions taken and responses provided by Scottish Water. These appeared to be reasonable and consistent with expectations for the investigation of a taste and odour complaint. Evidence of correspondence demonstrates that the company had taken the complaint seriously.

The full determinations are published on the DWQR website www.dwqr.scot

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 or issues which attract significant media interest.

Each event is reviewed and classified into one of five categories: not significant, minor, significant, serious or major. Those events categorised into one of the latter three categories are classed as incidents requiring further detailed investigation by DWQR. Where further information is required a full report may be requested from Scottish Water. It should be noted that where a full report is not requested, this does not suggest in any way that the incident is less serious. During 2015 DWQR raised significant concerns with Scottish Water regarding the timescales for the submission of an incident report. DWQR expects Scottish Water to provide an Incident Report within 28 days of a request, this timescale was not met for the majority of reports during 2015. Scottish Water had amended its internal process in order to improve the quality of incident reports following previous concerns raised by DWQR and this change had impacted on timely delivery of reports. Scottish Water has assured DWQR that improvements to the timescales will be implemented and this is being actively monitored along with the timescale for submission of Event Outcome reports.

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

In 2015 746 events were notified to DWQR, the majority of which were not significant, however 35 were classified as Incidents and **Table 3** shows the numbers of these and the Scottish Water operating areas that they occurred in. A summary of these incidents is available on our website www.dwqr.scot. The number of incidents in 2015 represents an improvement on 2014 when 53 drinking water quality incidents occurred. DWQR expects Scottish Water to be taking steps to improve its identification and control of risks and reduce the number of such incidents, any drinking water quality incident has the potential to have a lasting impact on consumer's confidence in their supply.

Table 3 Event Classification 2015

	Not significant	Minor	Significant	Serious	Major
North	185	38	11	4	0
East	162	45	6	1	0
West	131	20	6	0	0
South	110	19	2	4	1
Total	**588**	**122**	**25**	**9**	**1**

The one incident that was classified as major involved a contamination incident in the Carfin area of North Lanarkshire. A report has been submitted to the Procurator Fiscal, therefore it is not possible to describe the circumstances of this incident in detail in this report.

The reasons for the determination of an event as an incident are shown in **Figure 9.**

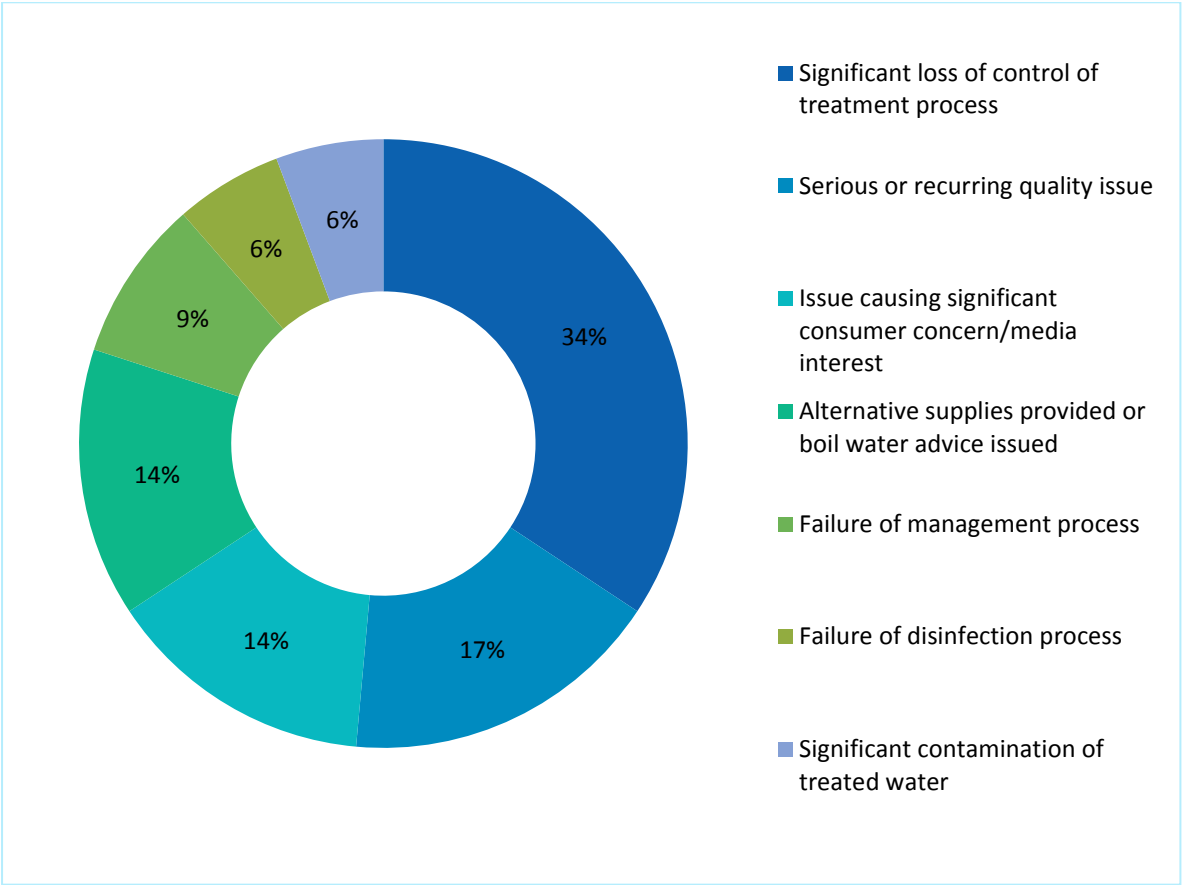

Figure 9 Reasons for Determination of an Incident

The majority of incidents were caused by a failure of or loss of control of a critical treatment process, most commonly the coagulation and clarification process. The reasons for these failures vary, but are often associated with a sequence of events which include failure of critical alarm generation or incorrect alarm settings; lack of monitoring at key points within the process; inappropriate alarm response; critical standby equipment awaiting repair. DWQR has also investigated a number of incidents which highlighted failings of adherence to procedures in place to safeguard drinking water quality. It is essential that Scottish Water learn from these incidents and build this into their risk assessment process, ensuring that lessons learnt are shared across operating areas and remedial action is not restricted to the affected location.

Several incidents are worthy of highlighting as they present significant learning points for Scottish Water and these are discussed in more detail below.

Balmichael WTW – Treatment failure – November 2015

An untreated water turbidity alarm was generated at Balmichael water treatment works (WTW), on arrival at site the operator found the works shutdown due to high untreated water turbidity and faults indicated on the ultrafiltration membrane modules. A backwash of the membranes was initiated and alarms reset. However the membranes started rotating through a sequence of repeated backwashing, generating further alarms and the operator was unable to restart the works.

Balmichael WTW membrane treatment units

By this time the storage tank at the works was at a low level, with the downstream service reservoirs empty. At this point the membrane treatment process was bypassed to keep a supply of water to the 2500 properties served by the works. This decision was not escalated, as is required by Scottish Water's internal procedures. Membrane treatment was re-established the following day.

Unfiltered water entered distribution for a total of 29 hours during the incident. No microbiological failures or *Cryptosporidium* detections were recorded during the sampling, however four elevated metal samples were recorded at the treatment works (manganese and iron). One consumer contact was received directly by operational staff during the incident, and bottled water was provided as requested.

Scottish Water reacted quickly to the initial alarm, however, the actions taken after this point were wholly inadequate and demonstrate obvious procedural failings within Scottish Water

that must be addressed. Scottish Water identified one action for improvement and DWQR made one recommendation for action.

The reason for the increase in source water turbidity is still under investigation and it may be that additional treatment will be necessary to mitigate against this risk in the future.

Acharacle WTW – Loss of supply and turbidity failure – December 2015

A mains power failure occurred at Acharacle WTW but no alarm for power failure was received by Scottish Water's Intelligent Control Centre (ICC), though a PLC Watchdog alarm was received. When power was restored to site, the works did not restart and as no power failure alarm had been received staff were not dispatched to validate the status of the works.

Scottish Water were alerted to the issue the following day when consumers began to report low pressure and no water. Production at the treatment works was restarted and communications re-established between the site PLC and the telemetry outstation. The network and the storage tank recovered quickly and water was restored by early afternoon that day. In response to the event, a water sample was taken which exceeded the turbidity standard.

DWQR is satisfied that on discovery of the lack of water, Scottish Water took appropriate action to restart the works to recover supply. However it is unacceptable that the lack of supply was communicated to Scottish Water by consumers, rather than via internal checks and monitors in place to safeguard against such a possibility. Scottish Water identified nine actions for improvements and DWQR made no further recommendations for action.

Aultbea WTW – pH failure – October 2015

On 20th October 2015 the routine task of topping up the limestone chips in the limestone contact tank to correct the pH was carried out at Aultbea WTW. This involved draining the contactors and added a mix of limestone and a proprietary pH correcting substance to each contactor. Each contactor was flushed before returning them to service. The Intelligent Control Centre (ICC) were aware of this activity and that this would raise the pH, so did not report the initial alarms received that day.

Contactor vessel

Over the next three days, Scottish Water staff were on site regularly to attend to various tasks and adjust the blend of the water passing through the limestone contactors as both treated and final water pH values continued to stay above Scottish Water's action limits. Further alarms were generated at ICC on three occasions and passed to operational staff, but not escalated.

On 23rd October the public health team (PHT) received a failure notification of a result of pH>10 in a sample taken from Aultbea WTW. They observed that the pH had been outwith action levels for 4 days, and immediately escalated the incident. A 'Do not drink/cook' notice was issued along with bottled water to all affected properties and actions were instigated to bring the pH down by tankering in water, flushing downstream service reservoirs and taking increased samples to ensure compliance. Of eight samples taken at consumers' taps, three results were above the prescribed value or concentration (PCV) of pH 9.5.

By 25th October laboratory samples showed that the water quality had returned to normal, and after discussion with NHS Highland the 'Do not drink/cook' notice was withdrawn and all clear notices delivered to all customers by the evening that day.

No water quality complaints were received before the 'Do not drink/cook' notice was issued and 23 contacts received while the notice was in place. No microbiological failures were recorded from the network or consumers' taps. DWQR's investigation has concluded that the operational procedures for recharge of the limestone contactors were inadequate and the staff involved did not have the appropriate training. This was further exacerbated by failure to follow escalation procedures.

Back Tolsta WTW – Failure of coagulation process – January 2015

Operational staff were called to Back Tolsta WTW to investigate a works shutdown due to a low chlorine level. Their investigation found that the aluminium dosing pump had stopped dosing which caused a loss of coagulation at the works. The coagulation loss caused water with high turbidity to pass through the filters and the water to have a high pH. This high pH then caused the aluminium floc to re-dissolve and pass into supply resulting in aluminium levels above the prescribed concentration or value (PCV) entering distribution for a period of over 2 ½ hours. No customer contacts were received.

This incident highlights a sequence of failures of critical equipment and alarms. No alarm was generated from the aluminium dose flow monitor due to configuration issues with the power supply and MCC. The changes to coagulation pH were not flagged due to a blocked sample line to the monitor preventing the proper analysis of the coagulated water and consequent generation of an appropriate alarm. Perhaps most crucially of all, filtered water monitors for both aluminium and turbidity which should register, alarm and cause plant shutdown failed to do so. This occurred because the alarm points had been incorrectly set,

at 1600µg/l instead of 160µg/l for aluminium and 2.0NTU instead of 0.2NTU for turbidity. These were manually input.

DWQR is satisfied that when alerted to the event, Scottish Water staff worked well to resolve the problem and rectify the issues. However, this incident demonstrates a serious lack of appropriate controls and monitoring by Scottish Water.

Daer Camps B Water Supply Zone – Discoloured water – June 2015

Compartment 1 of Tannochside Service Reservoir (SR) was isolated and removed from service on the 25th of May 2015 to repair the inlet ball valve and carry out a routine clean. On the 1st June, the operation to begin refilling the tank commenced. Shortly after this, the Contact Centre began receiving calls from consumers seeking information on the water supply or reporting discoloured water. Initially, these contacts were from an area supplied off the water main providing the inlet flow to the SR but later, the same problems were reported from areas supplied from Tannochside. Just after 11:00pm in the evening, the Control Centre (ICC) received a low-level alarm from Dechmont SR, the tank higher in the system providing the water to Tannochside and a Network Service Operator (NSO) was called out to investigate. This investigation showed that Tannochside had not filled to any appreciable level due to a scour valve remaining in a fully open position. The NSO closed the inlet to the tank to allow the system to recover and closed the scour valve.

By this point, Scottish Water had received 60 consumer contacts regarding the condition of the water. Some localised flushing and site water quality checks were carried out in the affected areas the following day and although consumer contacts were reducing, the total number had risen to 88 by the end of the day. On 3rd June, the inlet valve to the empty Tannochside compartment was opened to again commence filling and this continued without further event until it was full and the automatic level control valve closed off the flow as normal. Water quality sampling in the areas affected by the discoloration were taken on 2nd June and these showed there to be two failures of the aluminium standard and four failures of manganese There were a total of 95 customer contacts for this incident.

DWQR has determined that this discoloration incident was caused by the significant, uncontrolled flow generated in the inlet main to Tannochside SR. In opening the inlet valve, a flow of up to 90 l/s occurred over an extended time period, which lead to disturbance of pipeline deposits being carried forward into the direct distribution system and also into the 'live' compartment of Tannochside SR. Normal maximum daily flow would be of the order 50 l/s. DWQR considers the disregard demonstrated to the magnitude and effect of the inlet flow to be a significant failure of operational procedures designed and in place to safeguard water quality. The issue of the open scour valve at Tannochside also demonstrates a lack of rigour in checking the system following the commencement of filling. This caused a significant loss of water from the system with the further consequence of excessive draw-down on the stored water at Dechmont SR requiring a call out of standby staff.

DWQR considers this to have been an entirely avoidable incident. Scottish Water has Distribution Operation and Maintenance Strategy (DOMS) procedures and a check, actuate, listen, and monitor (C.A.L.M) initiative in place to ensure the water supply and service to consumers remains unaffected by maintenance works. It is clear the guidance these provide was not followed.

The issue of the open scour valve is an unfortunate consequence of different 'direction of closing' of valves being prevalent across the country. This is a result of historical preference of SW's predecessor organisations and it is incumbent on Scottish Water to ensure the correct direction is shown on valve records. In this case, the wrong direction had been ascribed to the valve and the NSO believed it was therefore closed when it was not. Scottish Water has informed DWQR that this error has been rectified in the valve records and is also clearly marked on site.

The incident reveals a number of shortcomings: awareness of flow rates generated by valve operations and the impact on water quality; role of the ICC in monitoring and alerting to unexpected asset status or performance following maintenance interventions i.e. the failure of Tannochside SR to fill as expected and the inordinately high inlet flow rate following flow control valve repair works; communications between Operations teams and ICC on alarm suppression (and cessation of suppression) for maintenance activities.

Black Esk Water Supply Zone – Contamination Event – August 2015

During the investigation of consumer complaints of discoloured water in the rural area near Amisfield, North of Dumfries, Scottish Water identified a cross connection between a private, farm water supply and the public supply. Recognising this to be a potential for introducing contamination back into the public supply, the connection to the mains was immediately isolated and flushing was carried out in the surrounding area. A notice of restrictions on water use – a don't drink, cook or wash notice, was delivered to properties in the area and water sampling was carried out from the mains supply. Further sampling over a wider area was also arranged. When the initial indications from the first samples became available the next day, they showed there to be significant microbiological contamination in the water, one of which ultimately confirmed as 1400 Coliforms, 900 *E. coli* and 210 *Enterococci* per 100ml. Measures to apply direct disinfection of the water mains were taken together with a further programme of targeted flushing. The later samples and all those taken following the additional disinfection measures, showed the supply to be clear of any contamination. With confirmation of all samples being clear, the restrictions on use were removed. Overall, Scottish Water received 23 contacts from consumers reporting discoloration or having other concerns linked to the investigation and remedial measures.

An initial visit by the Scottish Water Byelaws team and discussion with the Farmer resulted in a request from the Farmer for the connection to the public water mains to be permanently

removed and this was achieved on 4 September. A full Byelaws inspection of the premises identified a number of contraventions of the Byelaws.

DWQR was satisfied that the likely cause of the contamination of the public water supply was the cross connection with the pumped private water supply. Samples from two properties connected to the mains in the immediate area showed a significant level of contamination in their supply and in consideration of source, pump and pipework arrangements of the private supply, these were such that it could readily permit this type of event to occur. Once the connection to the main was isolated and remedial actions taken, there were no further indications of any other contamination in the mains supply. In addition, as no further complaints arose from consumers, this provided confidence that the backflow conditions were the likely cause of the discoloration of the public supply.

Where properties are connected to the public water mains, responsibility for compliance with the Scottish Water Byelaws lies firmly with property owners. Where there are dual supplies from both the public water mains and private sources, these owners must ensure their apparatus and pipework arrangements are such that there is no possibility of backflow into the mains. DWQR considers compliance with the Byelaws to be essential to minimising the risk of contamination of drinking water and supports the measures taken by Scottish Water to resolve this event and their consideration of a case for prosecution.

3 AUDIT AND INSPECTION

An important part of DWQR's scrutiny role is to audit and inspect activities undertaken by Scottish Water. DWQR may 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. DWQR also audits the completion of investment projects. Typically site visits will be undertaken prior to DWQR signing 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 are 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 among Scottish Water staff
- It enables verification of the delivery of investment work
- DWQR can build an awareness of common trends, risks or deficiencies across Scotland and use these to inform future policy and guidance.

Sites to be inspected are selected 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, DWQR has inspected the procurement of services affecting water quality and actions to complete DWQR recommendations.

DWQR uses standardised inspection templates to ensure consistency between inspectors, 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 in order to drive consistency and spread best practice.

A distribution operations audit

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 when these are observed. 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 2015, DWQR completed twelve inspections of WTW. As always, Scottish Water staff operated their plants with a high degree of professionalism and pride 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.

The greatest number of recommendations were centred around process control, especially in terms of the ability of the process to continue to operate under certain circumstances, and the monitoring of water quality parameters.

Chemical dosing equipment

Most sites visited were maintained and operated to a high standard, but notable issues that DWQR identified included:

- The requirement at a treatment works for further assessment and improvement of disinfection;
- 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;
- Process control issues and the need for development of procedures for response to process alarms

Table 4 Water Treatment Works Audited during 2015

Location	Date	Reason for Audit	No. of Recommendations
Ascog WTW (Bute)	January 2015	Risk based	3
Clatto WTW (Angus)	February 2015	Risk based	3
Ballygrant WTW (Islay)	February 2015	Incident	9
Torra WTW (Islay)	February 2015	Incident	13
Forehill WTW (Aberdeenshire)	March 2015	Risk based	2
Black Esk WTW (Dumfries & Galloway)	June 2015	Risk based	8
Marchbank WTW (Edinburgh)	July 2015	Risk based	5
Tobermory WTW (Mull)	September 2015	Risk based	0
Craignure WTW (Mull)	September 2015	Incident	2
Carron Valley WTW (Falkirk)	November 2015	Risk based	7
Rosebery WTW (Midlothian)	November 2015	Incident	3
Unst WTW (Shetland)	November 2015	Risk based	5

Storage and Distribution

Eleven distribution audits were undertaken in 2015. Recommendations included removing sources of ingress via holes and vegetation, and improving the integrity of sample points.

A service reservoir inspection in the West of Scotland

Table 5 Distribution Systems Audits 2015

Location	Date	Reason for Audit	No. of Recommendations
Larkfield SR (Greenock)	January 2015	Risk based	3
Flatt Farm SR (Largs)	January 2015	Risk based	1
Portnahaven SR (Islay)	February 2015	Risk based	0
Bruichladdich SR (Islay)	February 2015	Risk based	1
Lintrathen RSZ (Kirriemuir)	February 2015	Risk based	3
Fortrose SR (Black Isle)	February 2015	Risk based	3
Glenlia SR (Foyers)	February 2015	Risk based	2
Mannofield RSZ (Aberdeen)	April 2015	Risk based	4
Bunessan Forestry SR (Mull)	September 2015	Risk based	0
Fionnphort SR (Mull)	September 2015	Risk based	1
Whalsay SR (Shetland)	November 2015	Risk based	0

Services

Scottish Water has two UKAS accredited laboratories which undertake all sample examination and analysis for Scottish Water and private contractors. Both of these sites were audited during 2015.

DWQR also audited Scottish Water's customer complaints procedure during 2015, where individual recorded calls were scrutinised to ensure that water quality complaints are dealt with correctly and efficiently. Thirteen recommendations were made following the audit. Many of these recommendations involved the quality of advice given by call handlers to consumers regarding water quality, including refreshing scripts and training. Other recommendations included the need to provide clearer information on the appointment system and for staff attending appointments with consumers to record more detailed information.

Table 6 Audit of Services

Location	Date	No. of Recommendations
Juniper House Laboratory (Edinburgh)	August 2015	2
Scrutiny of Customer Complaints	August 2015	13
Henderson Drive Laboratory (Inverness)	December 2015	3

Investment

Scottish Water has been directed by Scottish Ministers to achieve a number of different objectives to improve and protect drinking water quality during the period 1 April 2010 to 31 March 2015. 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. Scottish Water self-certify improvements where the solution is either mains rehabilitation or the maining out of a treatment works from an already compliant existing works. A number of treatment and mains rehabilitation project outputs are late, for a number of reasons including access, design review, and requirements for additional treatment beyond the original project scope. The OMG are monitoring progress with these projects closely.

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. No outputs were due to be delivered during 2015 as most projects are at feasibility study and option selection stage.

DWQR 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.

Eight site visits were undertaken during 2015 and these are detailed in **Table 7**.

Table 7 Investment site visits undertaken during 2015

Location	Solution	Reason for Audit
Innerleithen WTW	New membrane treatment process	Sign Off
Killylour	Phosphate dosing to supply the Terregles water supply zone	Sign off
Craignure	New membrane treatment process	Sign off
Broadford	Disinfection control improvements	Post sign off review
Torrin	Main out from Broadford	Self certification review
Staffin	New membrane treatment process	Late project – progress review
Kilmuir	New membrane treatment process	Late project – progress review
Kilmaluig	New membrane treatment process	Late project – progress review

In addition to the sites presented for sign off listed in **Table 7**, a further 10 project outputs achieved Regulatory sign off, these are shown in **Table 8.**

Table 8 Projects achieving Regulatory sign off without site visit

Location	Solution	Sign Off
Elgol	Main out from Broadford WTW	Scottish Water – self certification
Strollamus	Main out from Broadford WTW	Scottish Water – self certification
Tarskavaig	Main out from Teangue WTW	Scottish Water – self certification
North Ronaldsay	New borehole and replacement turbidity monitoring	DWQR
Eredine	Upgrade of existing process and adoption by SW	Scottish Water – self certification
Strathyre	Enhanced chlorine control system and replacement chlorine monitors	DWQR
Tweedsmuir	Main out from Rosebery WTW	Scottish Water – self certification
Kenmore boreholes	Turbidity monitors and diversion to waste facility	DWQR (site visit undertaken in 2014)
Kaim	Phosphate dosing	DWQR
Foula	New membrane treatment process, new contact tank and limestone contactor	DWQR

The majority of projects submitted to DWQR for sign off required additional information or further action to be taken by Scottish Water before the output was finally signed off. Additional requirements have included:

- Calibration of turbidity monitors
- Provision of additional *Cryptosporidium* data
- Amendment to SCADA to show membrane pressure decay test history
- Additional operating procedures

ANNEX A SUMMARY OF IMPROVEMENT PROGRAMMES

Scottish Water has been directed by Scottish Ministers to undertake a number of different projects to improve and protect drinking water quality across Scotland during the period of 1 April 2010 to 31 March 2015. These projects include water treatment works improvements; water mains rehabilitation; studies assessing future rehabilitation requirements; surveys to confirm numbers of lead communication pipes; replacement of lead communication pipes and installation of backflow protection devices. Scottish Water's progress with this investment is monitored by the Scottish Government Outputs Monitoring Group, and DWQR is a member of this group. The Outputs Monitoring Group provides Scottish Ministers with a quarterly report of progress.

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. No outputs were due to be delivered during 2015 as most projects are at feasibility study and option selection stage.

The summary table below shows the water treatment works improvement schemes which were signed off as complete during 2015.

Location	Driver	Solution
Broadford	Disinfection Index	Disinfection control improvements
Craignure	*Cryptosporidium*	New membrane treatment process
Elgol	*Cryptosporidium*	Main out from Broadford WTW
Eredine	Type B supplies	Upgrade of existing process and adoption by SW
Foula	*Cryptosporidium*	New membrane treatment process, new contact tank and limestone contactor
Innerleithen WTW	*Cryptosporidium*	New membrane treatment process
Kaim	Lead	Phosphate dosing
Kenmore boreholes	*Cryptosporidium*	Turbidity monitors and diversion to waste facility

Location	Driver	Solution
Kirbister	Flood mitigation	Removal of a road bridge, water course widening, bank height increase
North Ronaldsay	*Cryptosporidium*	New borehole and replacement turbidity monitoring
Strathyre	Disinfection Index	Enhanced chlorine control system and replacement chlorine monitors
Strollamus	*Cryptosporidium*	Main out from Broadford WTW
Tarskavaig	*Cryptosporidium*	Main out from Teangue WTW
Terregles	Lead	Phosphate dosing to supply the Terregles water supply zone
Torrin	*Cryptosporidium*	Main out from Broadford WTW
Tweedsmuir	*Cryptosporidium*	Main out from Rosebery WTW

ANNEX B INFORMATION LETTERS ISSUED DURING 2015

Information Letter number	Title
2015-1	Changes to DWQR Operations Team Staff and DWQR websites
2015-2	*Cryptosporidium* Analysis
2015-3	Regulation 33 Approval of Products and Substances

Copies of these letters are available on the DWQR website:
www.dwqr.scot

ANNEX C 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

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, 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 2015, there were six on-going Undertakings:

Muirdykes water treatment works and supply zones - Manganese

Bradan water treatment works and supply zones - THMs

Amlaird water treatment works and supply zones - THMs

Craignure water treatment works – *Cryptosporidium*

Tullich water treatment works - *Cryptosporidium*

Tullich water treatment works - THMs

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 2015, there were two active Enforcement Notices:

Invercannie water treatment works - *Cryptosporidium*

Burncrooks water treatment works - Plumbosolvency control

ANNEX D 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 Alnwickhill B 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 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 Mean Zonal Compliance 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 significantly deteriorate 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, 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 mean zonal compliance 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 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.

Distribution Maintenance Index

The Distribution Maintenance Index (DMI) is the same as the Operational Performance Index (TIM) used in previous DWQR reports. It is used to reflect the performance of the distribution system for a zone or collection of zones, and is simply the arithmetic mean of the MZCs for turbidity, manganese and iron for the zone.

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 10 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

Published for the Drinking Water Quality Regulator for Scotland, August 2016