FWR NEWSLETTER
. . . from the Foundation for Water Research
www.fwr.org
Issue 3, August 2015

Welcome to the summer issue of the FWR Newsletter

In our spring newsletter we reported on the conference *Managing Cryptosporidium – Sharing Wisdom*. This time our lead article looks at how the challenge of this is being met by Dŵr Cymru Welsh Water. I am most grateful to Carol Weatherley for her fascinating account of how the water company manages this risk.

The Chiltern Chalk Streams project is now in its 17th year. It is a partnership which aims to 'conserve and enhance all major chalk streams in the Chilterns AONB'. They held a forum in June to present their work over the past year, plans for the future, and a field visit to the River Chess. Read my account of the day on page 6.

In *Wastewater Matters* Tim Evans explores the interesting topic of 'unintended consequences' in relation to misconnections, and decreasing per capita water consumption which, although good news for the pressure on water resources, can lead to other difficulties.

For information on events and news highlights please go to our website *www.fwr.org*. You can also contact us via email *(office@fwr.org.uk)* or telephone (01628 891589).

Maxine Forshaw - Editor

THIS ISSUE

CRYPTOSPORIDIUM
The approach to the challenge in Wales

Upland reservoir in North Wales (courtesy Dŵr Cymru Welsh Water)

Carol Weatherley
Public Health Manager, Dŵr Cymru Welsh Water.

Cryptosporidium **is a protozoan parasite that has been isolated from a surprisingly wide range of animals including mammals, birds, fish and reptiles. It causes a gastrointestinal illness known as cryptosporidiosis, regarded as a disease mainly of young animals and is very widespread in livestock, especially in calves.**

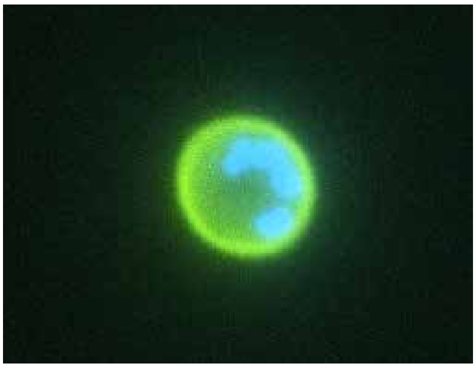
In humans, young children under five years of age represent a significant proportion of cases overall. Cryptosporidiosis is an unpleasant, though generally self-limiting illness characterised by profuse, watery diarrhoea lasting several days. In some individuals such as the immuno-suppressed, the illness can be severe and potentially life-threatening, particularly as currently available drug treatments are not very effective and a vaccine has yet to be developed.

Cryptosporidium is transmitted by the faecal-oral route, with person-to-person contact or contact with infected animals identified as the main cause of disease cases. However, transmission through routes such as the consumption of contaminated water or food is also significant and has been a major cause of outbreaks in the UK.

The organism is perfectly adapted for an indirect route of transmission:

- It is shed in the faeces of an infected host in a dormant, infective state called an oocyst. The oocysts are shed in extremely large numbers with up to 10^{10} oocysts excreted on a daily basis.
- The oocysts are highly environmentally resistant and are able to survive for many months outside the host, eg in moist soil and water.
- Very few oocysts, possibly single numbers, are needed to cause an infection.

Given these attributes it is unsurprising that *Cryptosporidium* has presented major difficulties for water companies. However, it is their resistance to chlorine at levels traditionally used for the disinfection of drinking water that has presented by far the greatest challenge. Water companies have responded by adopting the multiple barrier approach to water treatment as the best means of securing a safe drinking water supply. Drinking water safety plans (DWSP), recommended by the World Health Organisation in 2004 as a process for managing the risks associated with drinking water production and supply, are key to identifying where a barrier or risk management process is needed to prevent *Cryptosporidium* compromising the safety of drinking water.



A Cryptosporidium oocyst (courtesy Dŵr Cymru Welsh Water)

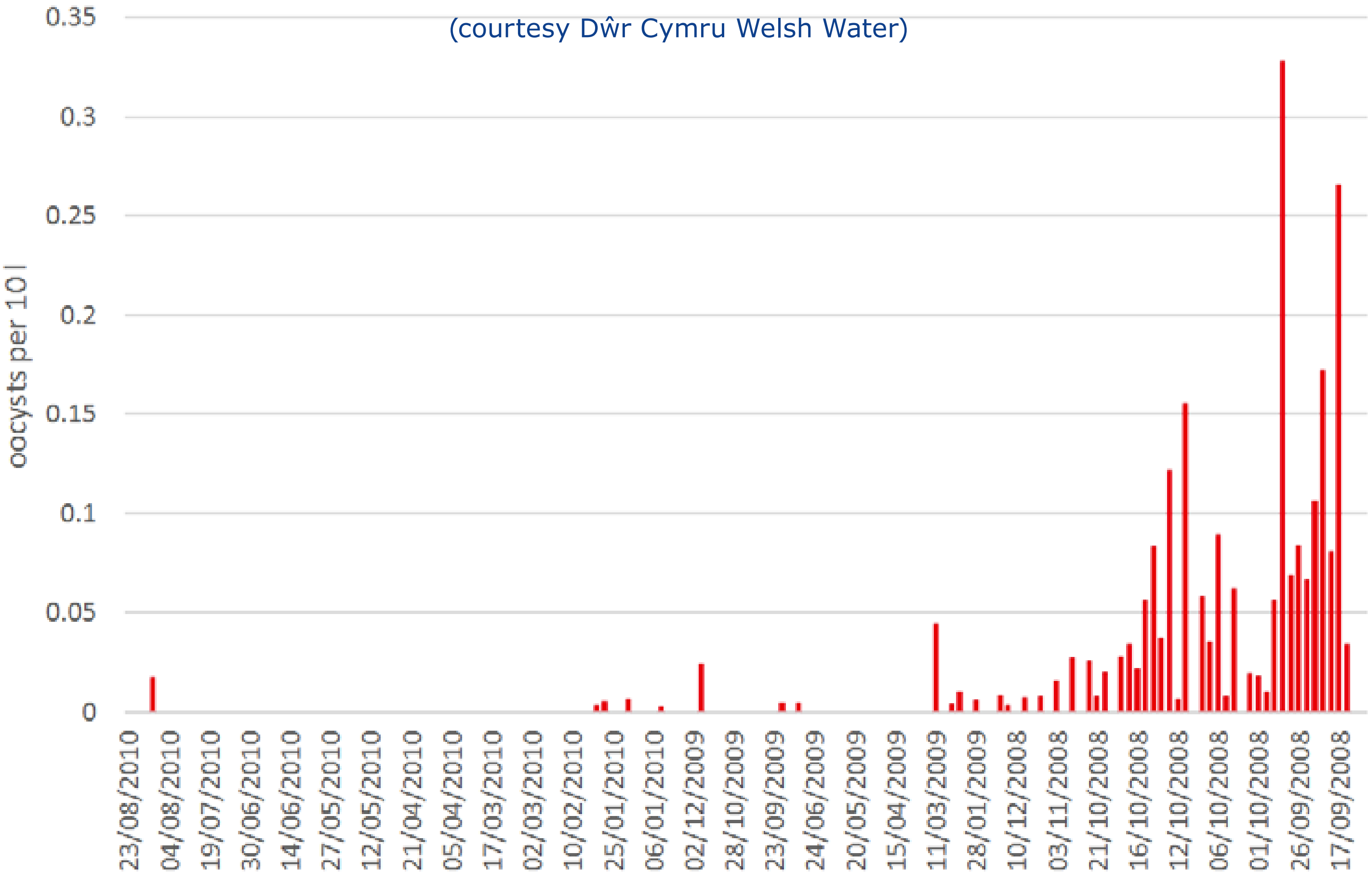
Cryptosporidium risk is almost entirely associated with the nature of the catchment surrounding the source water. Given the widespread occurrence of animal infections, the diversity of animal hosts and the robustness of oocysts, it can be predicted that *Cryptosporidium* will be almost ubiquitous in an environment affected by faeces. Catchment interventions such as removing livestock from grazing near water sources has been shown to have some positive benefit in controlling the input of oocysts.

However, where there are significant numbers of wildlife there is evidence that they can also contribute large numbers of oocysts, but the species are less likely to be pathogenic for humans than those found in livestock. Out of approximately 24 currently recognised species, just two species, *C.hominis* and *C. parvum*, account for the majority of human cases; *C.hominis* only infects humans while *C.parvum* has a wider range of animal hosts including man. *C. parvum* is very prevalent in young livestock so is frequently associated with zoonotic (animal to human) infections and detected in water sources close to livestock grazing.

The majority of Dŵr Cymru Welsh Water (DCWW) source waters are from lowland or upland reservoirs where the latter, in particular, tend to be geographically isolated in unpopulated areas, so unaffected by human sewage inputs. An extensive source water monitoring programme has been undertaken for many years and it is in the water of these upland reservoirs that some unexpected trends in oocyst concentrations have been observed.

At a large source water reservoir in a mountainous region in North Wales, where oocyst levels are usually low and attributed to the correspondingly low density of sheep in the catchment, a large spike in oocyst numbers in the source water occurred. This

Fig 1. The number of oocysts in the source water (per 10 litres)



spike continued for a few days then rapidly declined and has not recurred in subsequent years (Figure 1).

Despite extensive investigations, no obvious cause for the sudden increase was found; the rainfall in the days preceding the sampling was not particularly unusual, there were no dead wildlife or livestock evident in the area and there was no change in livestock activity. In addition, no obvious change was observed in source water quality (eg turbidity) which might have indicated conditions were unusual. It is this particular incident, which occurred in 2008, that led to a more conservative approach being taken to assessing and controlling the risk from *Cryptosporidium*.

So, in 2009 UV light treatment was installed at a number of water treatment works (WTW), predominantly groundwater sites. UV light renders oocysts non-infective through disrupting the structure of the DNA. The benefit of this investment was realised in 2012 when, at a spring source in North Wales, after years of monitoring indicated oocyst levels were generally low and intermittent, there was a sudden, elevated but short duration spike of oocysts (approximately 11 oocysts per 10 litres) that again had no obvious link to any change in the catchment. In this instance it was demonstrated that the UV dose applied was sufficient to inactivate the oocysts and subsequently it was shown that the species was *C. ubiquitum* that usually derives from sheep (which were present in the catchment).

Incidents such as this indicate the unpredictability of oocyst presence in water and that, unless a catchment and the potential pathways for *Cryptosporidium* intrusion into the water are fully understood, there is the risk that oocyst numbers may surprise you and it is best to take a precautious approach to treating the water.

In DCWW, as well as source water monitoring, an extensive final water monitoring programme for *Cryptosporidium* is undertaken. WTWs are subject to monitoring based on an assessment of the perceived risk associated with the catchment and the potential risk associated with the treatment process. This monitoring serves to verify the risk assessment and demonstrates that water in supply is safe to drink. In common with other UK water companies, surface water sources are treated by chemical coagulation followed by filtration which removes particles, inorganic and organic chemical contaminants to produce water that is suitable for chemical disinfection.

When *Cryptosporidium* oocysts, which are an oval shape ranging from 4 to 6 µm in diameter, are suspended in water they essentially behave as particles and so are effectively removed by coagulation and filtration. A well-designed, well-operated process should remove over 99% of oocysts. Therefore, it is to be expected that should the process be challenged with extremely high numbers of oocysts there may be occasions when an oocyst breaks through into the final water.

It is worth pointing out at this stage that the current standard method for the detection

A vole captured at the study site of an upland reservoir (courtesy University of Liverpool)

of oocysts in water does not distinguish between different species – it merely provides an overall count of oocysts. Therefore, it is probable that an oocyst isolate in water will not necessarily be a human pathogen. In common with other water companies, DCWW do see the occasional single oocyst in a final water sample at some WTWs supplied by surface water. On investigation there is invariably no obvious reason for this detection with process performance and indicative water quality parameters such as turbidity being satisfactory.

Turbidity is generally accepted to be currently the best surrogate for the potential presence of oocysts. Approximately three years ago the company water treatment strategy was reviewed and improved to address both the regulatory requirement *(Ref 1)* that the turbidity of water presented for disinfection should not exceed 1 NTU (nephelometric turbidity units) and to ensure that process performance was optimised. The strategy imposes rigorous standards for turbidity at each stage of the treatment process:

Turbidity at post clarification stage:

- 99th percentile <2.5 NTU
- 95th percentile: <1.5 NTU

Turbidity at post filtration stage:

- 99th percentile < 0.25 NTU
- 95th percentile < 0.1 NTU
- No sample to exceed a turbidity of 1.0 NTU

The turbidity data are taken from the online instrumentation situated at each process stage, and for every WTW there is a weekly review of turbidity trends and a monthly review of performance against strategy requirements by the regional team. Where a WTW does not meet the strategy requirements, the root cause is identified and, where feasible, operational interventions are carried out to improve performance and the effect is then monitored over the following month. Where infrastructure investment is needed to make an improvement, this is also identified and prioritised. It is hoped that this refinement of the assessment and optimisation of treatment performance and the specifically targeted investment will result in there being very few, if any, unexplained oocysts in final waters.

Lastly, DCWW are funding a study with University of Liverpool Veterinary School and the Cryptosporidium Reference Unit (CRU) to look at the relative contribution of sheep and small mammals to the *Cryptosporidium* oocysts detected in an upland reservoir water (cover image). It is hoped that using the latest genetic techniques, CRU will be able to match unusual species and genotypes to specific host species. This study will provide a better understanding of sources of *Cryptosporidium* in this and similar catchments, and help determine which management interventions are likely to be the most effective at reducing oocyst numbers in water.

Reference 1: The Water Supply (Water Quality) Regulations 2010 Wales

WASTEWATER MATTERS: Unintended Consequences

Tim Evans
FWR Wastewater Section Co-ordinator

I WILL ADDRESS THIS THEME FIRSTLY in relation to decreasing per capita water consumption (PCWC) and secondly, to misconnections.

Water resources are under pressure in many parts of the world. The combined effects of climate change and population growth will exacerbate the problem. For example, London's population is expected to grow from 8.6 to 10 million in 2029 and weather extremes (drought and rain) will be more frequent. Water abstraction, treatment and distribution use energy and hence have a large cost and carbon footprint. Some 4% of the UK's phosphate use (non-renewable, non-substitutable) is used for dosing potable water to control plumbosolvency and meet the limit for lead in drinking water at the customer's tap.

To conserve water resources and the associated energy and carbon costs of putting water into supply, customers are urged to decrease the amount of water they use. Additionally, manufacturers strive to decrease the amount of water their appliances use and greywater recycling is developing greater practicability. What could possibly be wrong with that? Well, nothing – except that the price of success is that there is less water to flush the sewers and re-suspend sediment. Wastewater meanders around sediment accumulations and more sediment is deposited. Deep inside the deposits conditions can become anaerobic, hydrogen sulphide can be generated which may lead to corrosion and odour issues. Deposits that accumulate unchecked can reduce flow to such an extent that when the sewer surcharges there is sewer flooding. In combined sewers, when sediments are flushed by summer storms, the shock load can cause a works to fail its consent and if the flow were to discharge through a CSO (Combined Sewer Overflow), the sediment would increase the load on the receiving water.

I first heard about the unintended consequence of success in driving down PCWC in connection with Berlin, where PCWC had been reduced to about 100 litres per capita per day and sediment was building up in the sewers. The solution was to rediscover something from the early days of sewerage: sewer flushing. Apparently, Marcus Vipsanius Agrippa (63–12 BC) visited the Cloaca Maxima in Rome and was one of the first to apply flushing to maintain this vital infrastructure; subsequently it was utilized around the Empire *(Ref 1)*. Sewerage was largely forgotten after the decline of the Roman Empire, with the exception of some visionaries, until the mid-19th century. 1850–1940 was the golden age of sewer flushing, with scientific investigations, rational approaches, standardisation and commercial developments; then it seemed to be forgotten again. Presumably, water profligacy (increased PCWC) combined with sewer maintenance gangs ('flushers') obviated the need for hydraulic flushers and reservoirs.

Schematic of a HydroFlush siphonic chamber (courtesy Hydrok UK)

HydroFlush Mini (courtesy Hydrok UK)

Companies such as Steinhardt (Germany) and Hydrok UK (Cornwall) now offer hydraulic flushing devices to suit a range of sewer diameters. Engineered sewer flushing can also move FOG (fats, oils and greases) deposits along before they grow to disruptive sizes, beloved by headline writers as 'fatbergs'. Siphonic HydroFlush can be used for pipelines up to 400 mm diameter in both foul and surface water systems. It can be fitted into manhole chambers and fed with a controlled water supply to flush at predetermined times and/or from a surface water gully or with filtered wastewater.

HydroFlush Mini is a programmable, hydraulically powered gate suitable for sewers 400 to 1200 mm diameter: it holds flow behind the gate, which is raised at programmed intervals to release a surge that re-suspends solids both downstream and upstream of the gate.

HydroSelf is another flushing gate system – for sewers and tanks up to 5000 mm. They can be used particularly in attenuation tank systems where, by design, solids are encouraged to settle. Attenuation sewers often discharge slowly, not permitting solids to be re-suspended, which is a reason why cleaning methods should be considered at the design stage.

Encouraging water frugality has many benefits and will become a necessity in

water-stressed localities. However, it will also require attention to be focussed on moving the solids through the sewer system instead of relying on the serendipity of people emptying baths, rainfall events, etc.

I mentioned that dosing phosphate into the water supply accounts for 4% of the UK's phosphate imports – and then there is the cost of removing it from wastewater. Blown-in-place epoxy lining along lead pipes would eliminate the need for this phosphate dosing; it would seal leaks and be a more assured control of lead in drinking water than dosing, but apparently the copper concentration in domestic wastewater could increase (another unintended consequence) because phosphate dosing also suppresses cuprosolvency – whether it would be sufficient to have an environmental impact is an open question.

People who connect dirty water into surface water drains probably do so in ignorance of the damage this can cause, ie the unintended consequence of their action. CIWEM's policy position statement on misconnections notes that property owners and plumbers are frequently unaware if a property is connected to combined or separate drainage, and recommends that every water bill should state the type of drainage. In my view this would not be difficult but it has not been done yet. Thames Water and Severn Trent Water estimate that an average of 2.3% of properties have some sort of misconnection.

Optical brighteners are used in many products including toilet paper, laundry detergents and shampoos. They enhance whites and brighten colours so they are good for 'fingerprinting' misconnected discharges into surface waters but inevitably they are intermittent, so an inexpensive passive sampler that could be deployed for a few days would be ideal. They show up under ultraviolet (UV) light. Cotton is a good 'receiving agent' for optical brighteners. Prof David Lerner and Dr Dave Chandler had the bright idea of using tampons as samplers because they are made from natural, untreated cotton *(Ref 2)*.

When a tampon was dipped for five seconds into a solution containing 0.01ml of detergent per litre of water (300 times more dilute than would be expected in a surface water pipe), the optical brighteners could be identified immediately and continued to be visible for the next 30 days. The technique was then trialled in the field by suspending tampons for 3 days in 16 surface water outlets running into watercourses in Sheffield. Nine of the tampons glowed under UV light, confirming the presence of optical brighteners and therefore sewage pollution in 56% of the supposedly surface water drains.

With the help of Yorkshire Water, the team followed the pipe network back from four of the nine polluted outlets, dipping in a tampon at each manhole to see where the sewage was entering the system. They were able to isolate the sections of each network where the sewage originated, narrowing down the households that would need to be inspected in more detail. A visual inspection in one area immediately revealed a house where both a sink and soil stack were connected to the wrong sewer.

Left: http://www.bbc.co.uk/newsbeat/article/32129590/glow-in-the-dark-tampons-could-help-make-our-rivers-cleaner (Photo courtesy BBC)

Neat job but clearly a misconnection into roof drainage

Lerner says that most misconnected households are unaware they are discharging their wastewater into the wrong system and, once it has been identified, immediately rectify the problem. Local authorities have the power to complete the work and charge it back to the householder, but in practice this power is rarely used.

We need not be the victims of these unintended consequences provided we use emerging knowledge proactively. Reducing PCWC will decrease self-cleansing of sewers so hydraulic flushing needs to be deployed once more. Most people do not want to misconnect their drainage (foul into surface or surface into foul) but they need to know which drain is which to prevent the unintended consequence of their ignorance.

Ref (1) J.-L. Bertrand-Krajewski (2008) Flushing urban sewers until the beginning of the 20th century. http://tinyurl.com/okg3x2x
Ref (2) Chandler, D M and Lerner, D N (2015) A low cost method to detect polluted surface water outfalls and misconnected drainage. Water and Environment Journal Vol. 29 (2), 202–206

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Chilterns Chalk Streams

Annual Forum

Maxine Forshaw
Foundation for Water Research

THIS, THE 17TH ANNUAL FORUM OF THE PROJECT, was held at Latimer Park near Chesham on 9th July which turned out to be a perfect summer's day – ideal for strolling along the River Chess, otherwise known as site visits!

The Chilterns Chalk Streams project (CCSP) began in 1997, kick-started due to the issue with low flows at the time. It is a partnership led by the Chilterns Conservation Board, covering nine chalk streams from the Ver in the north-east to the Ewelme Stream in the western Chilterns.

Allen Beechey (Chilterns Chalk Streams project officer) gave a flavour of what has been happening over the past 12 months or so, including the very wet period from late 2013 to March 2014 which saw the Assenden Stream running in the Stonor valley for six months, but which also resulted in sewage issues at various places affecting, for example, the River Chess and the Hughenden Stream. On the Wye, at Desborough Park, 420m of stream habitat has been re-naturalised, a partnership project with Revive the Wye, Wycombe District Council and the Wild Trout Trust. Habitat enhancement was also carried out on the Ver. Riverfly monitoring is a way of determining the health of a river and keeping a check on it – CCSP have recently set up a riverfly training hub for the Chilterns, Hertfordshire and Middlesex area and over 50 new riverfly monitors were trained over the past year. Another important initiative is Trout in the Classroom which is a great way to teach children about fish and their habitats. Looking ahead to this year, CCSP are involved in habitat enhancement at Funges Meadow (alongside the Wye in High Wycombe), this site also being perfect for educational purposes. In addition, there will be water vole surveys and fencing projects.

Using fencing as a river habitat management tool was discussed by Karen Davies (Chilterns Farm Advice project). Reasons to fence, and the effect of doing so (both positive and negative) were covered.

The River Chess Association (chair Paul Jennings) has been active since 2009, addressing issues on the river, eg low flows, the effects of weirs and impoundments, pollution from sewage treatment works, road and agricultural runoff, and misconnections. The group have undertaken habitat enhancement on various reaches and have tackled the invasive plant Himalayan balsam.

River Chess near Latimer Park, Chesham

This was a very enjoyable day learning about, and seeing the effects of, enhancement features such as fencing and woody debris on this beautiful stretch of the Chess, one of our very valuable chalk streams.

(Images courtesy Maxine Forshaw)

Draft River Basin Management Plans

FOLLOWING THE PUBLIC CONSULTATION EARLIER THIS YEAR the Environment Agency has now produced a summary response document:

https://consult.environment-agency.gov.uk/portal/ho/wfd/draft_plans/consult.

The consultation on the update to the draft river basin management plans (RBMPs) was the third and final stage of public consultation in the 2nd cycle of river basin planning. The EA received 486 responses from a range of groups and organisations, such as water and energy companies, charities, non-governmental organisations, wildlife groups, industrial organisations, local government and individuals.

The views and opinions expressed were wide-ranging and are being used to help shape the updated RBMPs and make decisions on how the water environment is managed, protected and improved.

In the autumn the EA will produce a further document, describing how the main points raised in the consultation have influenced the updated RBMPs and will continue to influence work over the next six years and beyond. In December 2015 the RBMPs will be submitted to government.

FWR/Cranfield Course for Water Professionals on Water Quality Planning & Regulation

Chris Chubb
Environmental Policy Consultant

PRODUCING AND DELIVERING FWR'S BOOK *Regulation for Water Quality – How to Safeguard the Water Environment,* together with discussions with the water sector and the Environment Agency, identified the need for postgraduate and professional training in water quality planning and regulation. In response, FWR and Cranfield University developed a course using the book as the basis for a wider introduction to the principles and practice of water planning and regulation. It focussed on delivering improved environmental water quality, use of the Water Framework Directive (WFD) approach, and achievement of greater compliance with permits. The course is accredited by CIWEM.

FWR & Cranfield course. Caption: Field trip to Silsoe research farm (courtesy Martin Griffiths)

The first course was held on 27–29 April 2015 at Cranfield University. Sixteen students attended, from the Environment Agency, water and energy utility companies, plus two independents from Brussels and China. The course was led by Dr Martin Griffiths, assisted by Chris Chubb and Dr Tony Warn, with further teaching support on diffuse pollution issues from Cranfield staff members, led by Dr Bob Grabowski.

Day 1: UK and EU regulatory principles and law; EU Directives.

Day 2: Environmental permitting and water quality planning, including monitoring and modelling.

Day 3: focussed on diffuse pollution issues and included a field trip to Cranfield University's Silsoe research farm for demonstrations of field techniques important in assessing some of the agricultural contributions to diffuse pollution. Case studies on reservoir catchment protection and successful SuDS retrofits were also covered.

Feedback from all attendees was highly positive. We hope that this will assist in raising the profile of water regulation through greater understanding of the underlying principles. Thanks go to Cranfield University and FWR for jointly underwriting the course.

The course will run again on 28–30 September 2015. Places will be limited so please book early!

http://www.cranfield.ac.uk/courses/training/water-quality-planning-and-regulation.html

Beale Boat Show 5–7 June 2015

Neil Tytler, FWR

For the first time, FWR hosted a stand at this year's Beale Boat and Outdoor Show at Beale Park near Goring. The show focused on families with an interest in boating and there were a large number of both traditional and modern boat builders who had static and on-the-water examples of their crafts.

Ice Block Challenge (courtesy Neil Tytler)

FWR shared their stand with WaterAid and sponsored a novel fund-raising activity where visitors were invited to guess how long a 140 kg solid block of ice would take to melt. People were able to choose, for a £1 donation, a one minute time slot over the whole three days with the prize for the winner being donated by Datchet Watersports. A pleasing total of £175 was raised for WaterAid.

Institute of Water Conference 8–10 July 2015

Neil Tytler

FWR was pleased once again to support the Institute of Water's annual conference and exhibition held this year in Cambridge. The conference started with two one-hour 'Meet the Leader' sessions providing delegates with a unique opportunity to meet and chat to water industry CEOs in an informal setting.

Saint-Gobain 350th anniversary (courtesy Neil Tytler)

The afternoon continued with the Institute's AGM where Heidi Mottram of Northumbrian Water Group passed the president's chain of office to Peter Simpson of Anglian Water. The evening culminated with punting on the River Cam where delegates enjoyed being taken along the famous Cambridge College Backs.

Thursday was the first full conference day with the theme for the morning being 'The Challenges' facing the industry and the afternoon 'Focus on Innovation'. The evening started with a Pimms reception, giving delegates a chance to meet the exhibitors which was followed by the ever-popular Saint-Gobain mystery evening. This year S-G celebrated their 350th anniversary, taking over the AirSpace hanger at the Imperial War Museum, Duxford. Using a quiz as the incentive, people could tour the exhibits, including the Lancaster, Spitfire, Concorde and Vulcan, to find answers to questions on aviation. All proceeds went to WaterAid.

Friday's themes were 'Focus on Collaboration' and 'Focus on Transformation'. Throughout the conference delegates were able to view and vote on which of the STREAM projects they believed to be the best. [STREAM is the Industrial Doctorate Centre for water sector sponsored research.] The conference concluded with the president's dinner held in the Hall at King's College with Ed Stafford, explorer and TV presenter, being our host for the evening.

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An update on the activities of the FWR

Caryll Stephen
Chief Executive of the Foundation for Water Research

With the generally good summer weather now upon us, FWR has been out and about at various exhibitions and shows, with more planned before the onset of autumn.

The FWR/Cranfield course on 'Regulation for Water Quality' was well attended and we have already received bookings for the next course in September. As reported in our last newsletter we were pleased to receive an award of £23k from Defra for project work and partnership hosting of the South Chilterns catchment. Work on this continues apace and further news will be given in the future.

Two further ROCKs have been published including our latest David Newsome Award ROCK on 'Smart Meters'. Concerning this award, topics have been invited for the 2015/16 publication and, due to the holiday season, the deadline for this has been extended (see below).

Meantime, all that remains is for me to say enjoy the rest of the summer and a very big 'thank-you' as ever to all who have contributed to this issue.

David Newsome award for postgraduates (2015)

The deadline for submissions has been extended to the end of September 2015. See previous issue of the newsletter for details. Initial inquiries to Debbie Ruck at *debbieruck@fwr.org.uk*

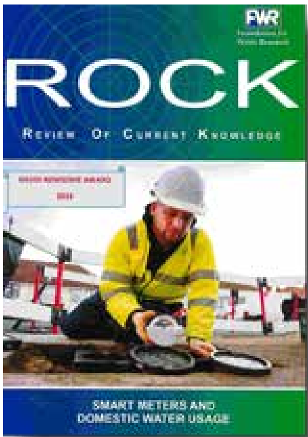
New FWR Publications

Copies of these reports are available from the Foundation, for £15 each, less 20% to FWR members.

Smart Meters and Domestic Water Usage

FR/R0023 May 2015

As global demand for water increases, the metering of domestic water usage and the application of 'smart' or 'intelligent' meter technologies is increasingly viewed as being central to reducing the demand for water and facilitating more effective water management.



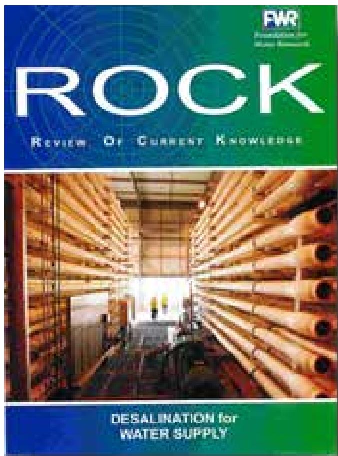
It is argued that smart meters encourage more equitable allocation of water through the application of the 'user-pays' principle. This results in the water user paying for what they actually consume, whilst seeking to associate usage and cost in order to provide a fairer and more sustainable management solution.

This review aims to provide a coherent and integrated understanding of how water metering, through smart meters in particular, can affect domestic demand for water. It also considers the influence of additional factors that can shape the effectiveness of metering technologies. The contextual and governance focus of the review, whilst centred on the UK, draws upon research and information which is more global in scope.

Desalination for Water Supply

FR/R0013 Revised June 2015 (3rd Edition)

The over-exploitation of existing fresh water supplies is becoming a problem in many parts of the world. Water shortages are forecast to increase, especially in urban areas where the demand for water is growing. Even in the UK potential problems with water shortages are starting to appear. In many areas desalination is being considered as a possible solution to the problem. In 2010 Thames Water opened the first desalination plant in the UK for the supply of drinking water.



'Desalination' is the term used to describe a group of processes which reduce the salt content of brackish and sea waters to turn them into a drinkable supply. There are approximately 23,000 desalination plants in more than 150 countries treating 85,000 m3/d with over half of these located in the Middle East; the number is continually growing, around 560 new plants being contracted in 2013–14.
All desalination processes use chemical engineering technology in which a stream of saline water is fed to the process equipment. Energy is applied and two outlet streams are produced – a stream of desalinated (fresh) water and a stream of concentrated brine which must be disposed of. This review describes the most commonly used processes for desalination. It also provides an historical perspective, information on trends in the application of desalination, costs and how salinity affects the palatability of water supplies.

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