Discover how we transport and treat sewage

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Key:

C = Caecilie Hougaard Pedersen

SM = Stuart Moss

ST = Simon Tait

RC = Rachel Cunningham

BM = Brian Moloney

C: Hello. Welcome everybody, welcome back and also welcome to anybody who is joining us for the first time. It is worth noting that if you are joining us for the first time don't forget that you can watch the recordings of all of the previous webinars in the series directly on the website. For today welcome to Discover How We Transport and Treat Sewage. Feel free to introduce yourselves in the chat, who you are, your organisation, where you're joining from so that we can all get to know each other. Before we get started there's just a little bit of housekeeping. So if you have any issues during the webinar feel free to reach out using the chat, our team there is ready to help you and they'll also be sharing lots of relevant materials and links throughout the presentation.

At the end of the webinar, we'll have plenty of time for a live Q&A, so for the Q&A we are using the platform Slido and the platform is already live. So please do use the QR code on the screen or you can use the link that's been posted in the chat to add any questions that you might have. You can add questions during the presentation, or you can also add your questions during the Q&A and we very much hope to get through all of your questions but if there are any left at the end of the webinar that have not been answered feel free to reach out to us via email. If your question is for a particular speaker feel free to add that when you ask your question and otherwise we will open up

your question to the full panel. So without taking away any more time today I will hand you over to Stuart Moss from Isle Utilities who will get us kicked off.

SM: Thanks for the intro, Caecilie. As you heard this week, we are focusing on sewage transportation and treatment. In the previous webinars we discussed the source of water, the treatment process and the distribution of water through a piped network. We discussed that water comes from a variety of sources, is treated and distributed to customers through a network of homes and businesses. We, as customers, then use the water in our house for drinking, cooking, cleaning and outside our house for watering our favourite plants and cleaning the car, some people even fill up their swimming pools. Water is also heavily used in agricultural, irrigation and in industrial processes like food and beverage manufacturing. Once we have used the water it is typically discharged through the drains into the sewer.

The sewer network is primarily gravity fed to large, centralised treatment facilities but sometimes the sewage needs to be pumped which is expensive due to the weight and energy requirements. In the UK the sewage collection system is typically a combined system that also captures rainwater. This is not always the case elsewhere in the world where sewage from toilets and kitchens are kept separate to the rain or stormwater, a separated system. This means that in the UK the sewage arriving at the treatment works is quite dilute, you can imagine your favourite orange cordial as the sewage and the tap water as the rainwater and diluting affects this will have. This presents challenges as they need to ultimately be separated. During heavy rainfall the combined system can get overwhelmed and can sometimes flood. This is exacerbated by blockages in sewers caused by fat, oil and grease that we put down our drains and wet wipes that we flush down the toilet. As a society we really need to stop doing this, it's unacceptable, they are my views and not the views of my employer.

Once the sewage arrives at the treatment plant it goes through a variety of stages. The preliminary treatment can include simple fixed bar screens that capture any large objects like sticks, plastic bottles, footballs and dead animals, yes really! This stage also includes more advanced screening to remove the smaller objects to capture the wet wipes, the nappies, the teabags that are put down the toilet. Yes, teabags! Who puts teabags down the toilet! This stage is followed by grit removal, there is a lot of grit from road surfaces, sand and fines from the beaches and fields and all this needs to be removed. There is value in this grit being recovered and to be used as a useful product, however some further innovation opportunities could present themselves around this. The primary treatment stages include clarification referred to as primary clarification. This is the initial stage whereby the solid, organic matter, your pooh, is separated from the liquid. This is also referred to as 'settling'. The solid that falls to the bottom of these tanks is referred to as sludge or primary sludge, this is regularly pumped out of the bottom of these tanks and can be used as a resource which has lots of calorific value or energy and nutrients which can be used as a fertiliser.

The liquid fraction is taken forward to the secondary treatment process, typically this is an aeration stage where air or pure oxygen is pumped into the basins to fuel bacteria which feed off and break down the organic matter. There are many different setups of aeration but regardless of the setup this is by far the most energy intensive part of the treatment process and also the stage where greenhouse gases like methane and nitrous oxide are emitted into the atmosphere. Around 2% of the whole of the UK's energy demand is for aeration of sewage, it's a huge amount. Lots of work is being done in this area to understand the optimal process conditions to use just as little energy as possible while emitting the least amount of greenhouse gas but still effectively breaking down the organics. Most water and sewage companies will be interested in innovation across this area. We then move into the final settlement or secondary clarification where more sludge is collected from the bottom of these clarifiers. This secondary sludge is also used as an effective resource for energy generation.

There is usually a tertiary treatment stage, this is to remove further components that the water companies are required to, like phosphorous for example, prior to it being discharged into the river. Phosphorous is also a valuable resource but sometimes difficult to recover and therefore there's lots of innovation happening in this area and more to be done. The final effluent or liquid fraction is typically disinfected then returned back into the rivers or recycled as a water source for drinking or irrigation. Water companies are tightly regulated on what they can discharge to protect the environment. I have mentioned primary and secondary sludge, these sludges can be thickened to remove the excess water usually including chemicals and presses to squeeze out the water. The solids can then be digested within an anaerobic digester to produce a gas which can be used locally on site, sold into the National Grid or put through a combined heat and power unit to crate electricity. There are lots of different varieties of treatment processes across the UK, some that use less energy, less chemicals, recover more energy or more nutrients and recover plastic even. We'll hear more about that at the next webinar.

So we have been through the process of how the sewage leaving your toilet ends up treated and back into the river with lots of valuable resources recovered. Now let's hear from our guests. I welcome Simon Tate, Rachel Cunningham and Brian Maloney to just give us some answers to some questions that I have. So I have a series of questions and we're looking forward to your responses. Here goes, question one, what is your name, who do you work for and what is your role?

ST: Hello, my name is Simon Tate. I'm the Professor of Water Engineering at the University of Sheffield. So most of my work involves research, looking at sewer drainage systems, with a small amount of work at rivers. I research myself, supervise people, work with others to try and develop more innovative ways to better manage systems.

RC: Hello everyone, I'm Rachel Cunningham and I work for Thames Water. I'm the R&D manager here for both clean and wastewater networks.

BM: Hi my name is Brian Moloney. I'm the founder and CEO of Storm Harvester and in my role, I provide strategic leadership, I provide the overall management of the business, I liaise directly with the Board and manage the day-to-day operations at Storm Harvester. Storm Harvester is a start-up in the water industry selling alerting and analysis to water companies.

SM: Thanks all, great to have you join us today and great to have a cross section of the sector, academia, water company, technology supplier, brilliant. Question two, tell me the biggest challenges related to sewage transportation and treatment from your perspective.

ST: I think one of the biggest challenges related certainly to a network that transports wastewater to treatment plants is the ability to provide adequate service at all times. So networks have been built over a number of decades so different design rules have been used. There are now more people in the UK, the wastewater generation is higher, climate change makes rainfall more intense. So trying to ensure that these uncontrolled systems can actually manage the increased load up is quite a challenge and the challenge is that there are traditional engineering solutions but they're really quite expensive and carbon intensive. So the challenge that we have is taking the systems that have been built over a number of decades and trying to ensure that there's uniform performance across the networks at a reasonable cost and delivers it in a reasonable timescale.

RC: One of our biggest challenges is blockages and we create over 60,000 blockages every year from the sewer network. About 80% of these are paper and rags or fat, oils and grease. These items are flushed from our homes, offices, restaurants etc but unfortunately, they get stuck on the way and accumulate into a problem. This might be in your backyard causing your house or garden to flood or smell or in a larger sewer which can affect much more people, you may have even heard of fatbergs. They can also rag up on our pumps or build up on our pumps or build up at the inlets to the sewage treatment works causing problems and possibly pollution. The blockages can cause flooding and pollution and clog the sewer networks and even if we get into the sewage treatment woks there can still be a problem, blocking the inlet screens and pumps or if fat gets into our aeration lanes it can cost more in power to clean it up before discharging to the river. However, if we could get it into the solids stream it goes into the digesters we might even actually get some more energy back.

BM: One of the biggest challenges around sewer transportation particularly is the blockages that form within the transportation or the collection network that cause the network to backup and potentially flood where pollution or sewage can come out of a manhole in the network causing a pollution event. These blockages can form anywhere in the network, they usually are pretty unexpected, and the consequences of the blockage can be pretty severe. Within the network blockages mainly form because of sand, soils and grease or wet wipes, a combination of those or other items that should not be in the sewer network finding their way and making their way into the sewer network and they consolidate within the network and cause the sewer pipes to block up. Therefore additional sewage cannot continue down through the pipe network, it

backs up and eventually it pollutes or it comes out into a CSO if there's a CSO in the vicinity of the blockage or else in some instances backs up and comes out of a manhole in the street or somebody's garden or worse again actually backs up through the toilet system of somebody's house potentially. This is a big problem within wastewater networks and it's one that at Storm Harvester we have come up with an innovative solution for.

SM: Well the focus there was quite heavily on the transportation side rather than the treatment side. Perhaps that's a reflection of what's in the national press at the moment. We heard about the challenges related to hydraulic capacity of the network and the issues with blockages and spills. Next question, tell me about an innovative solution you've tried, tested, reviewed to address the challenge that you describe and what were the outcomes?

ST: As I said in my previous answer a great challenge is ensuring the sewer networks have consistent and adequate performance across the whole network. Currently they are built in different decades maybe to different design standards. We're now facing more wastewater because of our population in the UK, also with more intense rainfall events so the wet weather performance is becoming more constrained as well. So one of the things that I've done in my career is to look at innovative sensing solutions so that we can actually understand the character of the network and the performance, the hydraulic performance of the network at particular locations and time. I use this information to develop ability for real time control or local real time control that balances out flood risk and the risk of intermittent discharges across the network so ensuring a more consistent and better performance for both flooding and overflow.

RC: So one innovative solution we have tried is to solve fat blockages with bacterial dosing. It makes sense. Our bodies break down the fat we eat and uses it for energy. We've tried bacterial enzymes in liquid powder and block form straight on to the blockage, upstream, at the pumping station or even through our customers' sink. However, the results have never been a definite success. The civil network has many variables such as flow, mixing, rainfall and the quality for example oxygen levels or bleach, so it's really hard to control. Also, the blockages aren't often just fats, therefore our outcome has been to use it only in very problematic places where we can afford to fully understand and is possible control that environment while the understanding and the science is still developing. So perhaps not a very successful innovation but it's now targeted in the right direction and is a very good example of all the factors that you may encounter and need to consider to ensure the outcome is measurable and in fact on this journey this has often been where the spinoff innovations have occurred such as monitoring the CCTV is improving our pumping station performance.

BM: In order to address the problem of the blockages forming in collection networks of the overall wastewater network Storm Harvester have developed some clever AI based technology that monitors sensors within the network, uses machine learning, hyperlocal rainfall forecast information and basically it works by predicting what the level in the sewer should be. So effectively in an unblocked sewer how should the

sewer be performing, for example during dry weather it predicts the dry weather flow, during wet weather it predicts the increase in flow or level based on the expected increase in flow based on the rainfall amount that is forecasted. So it becomes pretty accurate at identifying typical flows, your actual flow that you expect in the network. If we know what to expect then we can quickly identify if we have an anomalous level flow in the network from what is expected. So essentially, we use machine learning to predict what should happen and then if there're any anomalies from what should happen in the network identified we can flag those up as potential blockages that may be forming within the network. The outcomes of this were we first of all ran a successful trial with Wessex Water where we were able to identify a lot of blockages, within a six-month trial we were able to identify multiple blockages per month.

Evolving on from that we extended that trial into a full network rollout with Wessex Water, and we subsequently now work with eight other water companies in the UK providing our specialist blockage prediction software where they use that to identify where blockages are forming and really early on detect them so that they can get out to unblock them before they result in a pollution event. That's allowing the UK water companies that are using our software to reduce their overall number of blockages significantly.

SM: It was great to hear about those innovations, thank you. The focus again is really around trying to detect and break down the blockages with bacterial or enzymatic dosing, using data within the network to control flood risk and discharge and then data analysis to predict where the blockages may occur before they do so they can be managed. On to the final question, tell me about the key innovation opportunities that you see within this area.

ST: I think the key innovation opportunities that I see my area of work is the use of data. We've probably gone through a period where we have quite a lot of innovative new sensors where water companies are potentially collecting very, very large amounts of data and I think the issue now is actually trying to understand how companies optimise their collection of data. Are they collecting the right data and once they have this data can they actually get some useful knowledge out of it? I think this is quite challenging because I think there has been a recent year where data collection on new sensing or collecting more data is seen as advantageous and now I think we're moving into a new area of trying to understand what we can actually do with these new observations. Can we turn these new observations into some useful information that will allow us to better manage and control our sewer networks to meet the challenges of more intense rainfall or the challenge of trying to have fewer overflows into our receiving waters.

RC: I think there is a big innovation opportunity in this area for both fat oils and grease but also paper and rag. One successful innovation has been sewer depth monitoring to prevent customer flooding. We are currently putting in more sewer depth monitors to detect where and how our blockages occur so we can address them more effectively with a new innovative technique instead of just a push rod or a jetter. Do you have a sensor that's sensor but easy and more reliable? How can we remove these

blockages perhaps more mechanically or even better get them to the right places, away from houses and urban areas and all the traffic. We want to be proactive and clear them before the customer calls and stop it from coming back again, but remember the whole cost, we don't want to use more water or waste more energy plus time needs to be taken for planning and adding people costs in too, think about how easy it is to use at the different sites and maybe scale up across the patch. So I think there is a big challenge here and I hope you can help us address it.

BM: The ability to identify I and I, inflow and infiltration, into wastewater networks I believe is an area that would be a key innovation for the industry. Having studied the EDM data, the sewer level monitor and CSO data for nine of the UK utility customers I can see that a large proportion of the overflows are caused by sites that spill for prolonged periods of time, be that one, two and maybe even three months at a time. Doing some initial investigation on that we have identified that those spillages correlate very closely with ground water levels which indicates to us that it may actually be groundwater that is driving the increased flows in these times and that's what's actually causing the prolonged spillages at these sites. Further investigation and work is required in this area to identify more accurately the causes of the spillages but it does seem like there's a very high correlation between the spillages and the time when groundwater level is rising or is at a high point. It seems that the spillages have a much closer correlation to groundwater levels than they do accumulative rainfall over a 5, 10, 15 or 20 day period.

Being able to identify where infiltration and inflow are entering the network is absolutely key as across the next amp or amps that water utilities engage in plans to reduce their overall spillages with very large capital budgets to do this. If they aren't spending the money in the right areas to solve the actual problems then they will not achieve the results that they are hoping for which are to reduce the overall number of spillages. So the key innovation I see here is an accurate ability to identify sites that have I and I, where is it coming from and then to be able to treat those sites in a specific way knowing that the majority of the flow that's driving the overflows at those locations is actually clean water or groundwater or some culverted stormwater that is increasing its flow at periods of high groundwater level so in essence the water quality at those locations at those times is extremely clean, relatively high quality in comparison to the dry weather flow which is highly concentrated wastewater. So being able to identify and treat these in a different way I believe is one of the key areas of innovation for the industry to move towards the targets that it's setting around reduction in pollution numbers.

SM: Well thank you for all the answers. You can see that there is a desire for cheaper sensors, more analytics and further understanding of the cause of prolonged spillages. I want to thank all our speakers today, Simon, Rachel, Brian much appreciated. To summarise what we've heard the sewage collection system can get overwhelmed due to storm events. Blockages in sewers caused by human activity can cause flooding and unattractive sewage spills. Sensors and analytics are the key to unlock innovation and help solve some of these issues that industry faces. This has been the third in a series

of six webinars as we travel through the water cycle so keep an eye out for the future ones. We will now transition to a Q&A session; I hope you've been thinking through some questions and have been populating them via Slido. I invite all the speakers to come off mute and I hand over to Caecilie to chair the Q&A session. Thanks for your interest and engagement.

C: Great, thank you so much everybody. If I could welcome back to all of our speakers. I can see that the Slido and the Q&A, the questions, are popping in and have been popping throughout the presentation so we'll get started straight away with that. Just a quick note that unfortunately Rachel has had to drop off to join another meeting so if there were any questions popping in directly for Rachel, we'll pick them up and get them shared after this webinar. So we've got Simon and Brian and we are also joined by Karen from Isle Utilities ready to answer questions. So I think we'll jump straight in but please do keep the questions coming into the Slido, into the Q&A. So the first question that we've got coming in is so far the webinar's focus has been on water and wastewater infrastructure, are there innovation opportunities for instance water efficiency devices in the homes, are they relevant for the challenge? So I'll jump straight on to this question and say yes, absolutely they are. The Ofwat Innovation Fund specifically looks around testing new ways of conducting core activities to deliver services to customers and societies that add value. So that is a big kind of innovation area and a focus area for the fund as a whole.

It's also for the discovery challenge and maybe if possible, we can put the innovator handbook in the chat so that people can have a look. In the innovator handbook as well you'll be able to see at the very end of the book mapping from the water sector on kind of innovations that they're particularly interested in and areas that they're really looking to for new ideas and solutions. They are looking at how the sector might better engage with customers to make them feel part of the water cycle, ensuring that they understand their role in reducing demand. They're looking at how to rollout low-cost metering and delivery that can deliver insights on usage for domestic customers. They're also looking at how to better facilitate learning and engagement. So yes, that's a definite yes, that is an area that they are looking for solutions and innovations within. Then also just a note to say that we will actually be looking at this specific topic in the webinar that's coming up on the 28th which is Tuesday next week. We'll be looking at how customers impact the water cycle. So whoever asked that question come back, join us on the 28th so you'll get a lot more insight into that at that point.

I'll jump straight on to the next question. So how feasible are non-tethered robots in wastewater pipes? I think that the University of Sheffield are exploring this so I will ping this one directly over to you, Simon.

ST: Okay thanks Caecilie. Yes, non-tethered robots are technically feasible and at this moment we're building the first prototype that works in a complex laboratory network. Non-tethered roboting has some autonomy, some ability to think for themselves and as that develops then you'll get more and more complex robots that are not tethered to somebody on the surface. So this allows them to effectively live within the network, gather information and then transfer it back to somebody on the surface

either in terms of an operational issue such as a blockage or more of structural defect as well.

C: Excellent, thank you very much. We'll jump straight on to the next question and just in the meantime before I jump on I just want to say that for the audience who are joining us we're just going to pop a quick poll up, you'll see it popping up on your screen, so do take a second to answer that while you're listening to all the answers come in. If I can just check, Simon, could I just ask you to mute your… I'm getting a little bit of background noise from you so if you could just mute, perfect thank you very much. We'll jump straight into the next one. So are there any challenges for portable water and treatment sites that use it for boiler feed water on site with thermal hydrolysis or polymer dilution? Well, that is a tricky question to read out loud, Karen I will ping that your way.

KG: T hanks for that question, it's a really interesting one and I think if I just talk quite generally about this. Any process which requires potable water within the wastewater treatment is a challenge in as much as water companies want to be as water efficient as they possibly can be. So anything that can reduce the potable water demand is going to be beneficial. The same in terms of having the right quality of water in the right place, at the right time. So it isn't necessarily that it needs to be potable water quality in all cases, not necessarily talking about thermal hydrolysis but I think, yeah, any innovation or any thoughts around the right water, right quality in the right place at the right time I think is beneficial.

C: Thank you so much, Karen. Just to say as well that I'll ping the ball over to one of you guys to answer the questions but if anybody else has additional knowledge or insights to share feel free to just kind of unmute and jump in if you do want to jump in on a question. Simon we'll come back to you for the next question here. So can AI be successfully applied for local and decentralised wastewater control, for example CSOs, gates etc and are there potentially any case studies examples that we could share?

ST: Yeah, sure Caecilie. I think AI is particularly suited to local decentralised control. It's quite a [sound distortion 0:33:26] local and decentralised. I've been involved in a large European project where we've developed different types of AI, hardware and software with different partners and apply it in terms of flow control within combined systems and also stormwater systems. In that case it was used to effectively share flood risk across the network so you would reduce flood risk and localities that you want to better protect but that does mean that you have to share the excess flow within the network itself. So yes, AI is a particularly useful type of modelling approach for local and decentralised problems.

C: Thank you. Wondering if anyone knows of any case studies that we might be able to share, the person asking the question is looking to maybe look through some of those.

ST: There are some case studies for the European project, we had a system in Coimbra in Portugal and one in France and one or two other systems throughout the UK

where it's actually been used to adjust flows actually within the network based on localised trained AI systems.

C: That's excellent so I think for whoever asked this question it might be worth following via email. So if you follow up via the inbox for the Ofwat Innovation Fund we can gather some links to some case studies and then we can get them back to you, so just shoot us an email after this webinar. We will jump into the next one, so Karen I'll ping this one your way first but anybody else feel free to jump in. What actions do water companies take when there are pollution incidents from CSOs?

KG: So in terms of the actions that need to be taken it's around looking at what harm has been done, so is there an ecological impact, what impact has this pollution event had? So there's that environmental aspect as well. But in terms of the CSO as well it's they've all got event duration monitors on so you can look at how long the CSO's been discharging for and the flow rates as well. So there's that monitoring information as well. So they take that information back to work out why did the discharge happen if it was outside of storm conditions and do that investigation work as well.

C: There we go, sorry need to unmute myself there again. Thanks so much, Karen. We'll jump straight back to you I think for the next one. I've got Brian also, feel free to jump in, I think you probably have some good insights on this next question as well. So when we're looking at the sewage and wastewater system in the UK where do you see the biggest innovation areas? So we'll ping it over to Karen first but definitely the rest of you feel free to jump in. I know that we covered this slightly in the presentation as well but if you can expand.

KG: Absolutely, thank you. So I think there's lots of different innovation areas that we can potentially explore when it comes to the sewage networks and also wastewater treatments. If I was to pick just a few I would say the big area of innovation where we haven't got all the answers yet is around low carbon treatment. By low carbon I mean wastewater treatment which doesn't emit things like nitrous oxide, which is low energy, so we're not using the energy in the first place and looking at the embodied carbon as well so the amount of concrete that you might use. This is where things like nature-based solutions or NBS or resurge wetlands might come into the mix of things. Other aspects around innovation are decentralised treatment as well. So currently we've got very large wastewater treatment works which are brilliant for scales of economies, but I think in areas like rural areas or smaller communities decentralised treatment in a low carbon, in an energy-efficient… treating all of it, would be a really exciting innovation. I'll hand over to Brian to add his thoughts.

BM: Yeah, thanks, Karen. I think first of all it's a really interesting area for innovation. I think the water industry generally, particularly the wastewater side of water companies has been under-served traditionally by innovation. I think a lot of the innovative solutions have gone to the reticulated water or the drinking water side of the business. Looking at it from a small business point of view in terms of trying to find the biggest problems that the water companies have in order to target innovation in those areas, and I would certainly say one of the biggest challenges the water companies

have are around the number of pollution events that are happening per CSO or per 10,000-kilometre sewer every year. The majority of those pollution events area driven by stormwater, by rainfall events, stormwater entering the sewer network and that is driving overflows and hundreds if not thousands of pollution events in areas and in towns around the UK.

Being able to solve that problem is going to be a huge challenge for the water companies and I agree with Karen around stuff like decentralised treatment, treating your flow differently depending on what is coming through the network. So if it's large stormwater, a large rainfall event, you've got a completely different dilution on your sewage, does that need to be treated the same as the rest of your dry weather flow when that's flowing through the pipe normally on a finer, dry day. We would say no. Are there other solutions like reed beds as you mentioned, Karen, can things like that help to try and get us down to a lower level of pollution. So I think my area of innovation would be trying to reduce to a lower level of pollutions, a lower level of spills from your CSOs and how can we get there and all the innovative solutions that can be applied on that journey.

C: Thank you very much. I think this maybe links a little bit into the next question that came in as well so we'll jump straight on. Why is sewage and other wastewater, so rain and flood water for instance, merged in the UK, I think in the presentation it was mentioned that it's mentioned in the UK and that it's separate in other countries or other areas. So I think this question is relating to that probably, so why is it merged in the UK if it's kept separate in other countries. So Karen, we'll throw this over to you first.

KG: Another good question. So it is merged in the UK but it's also merged in other countries as well and I would say also within the UK we do have combined sewer systems which is the rainwater, the stormwater is mixed with the sewage but we do also have separate systems. So it tends to be in the newer towns and cities that they have a separate system, so the rainwater is kept separate, it doesn't go into the foul sewer but lots of other countries have combined sewers as well. It's quite a historic way of doing things and if you think in the UK some of our infrastructure goes back over a hundred years so it's certainly a system that water companies have inherited over the years.

C: Perfect, thank you very much. So here comes one that specifically I think someone, Brian, had a question for you. What are the biggest challenges in scaling a business on your eureka moment in the water structure?

BM: Yeah, I guess the biggest challenges that we have found were the ones early on. So you've got a concept of a business, you've got a solution and you're building a technology around that. There're a couple of big challenges at the start, building technology, hiring software engineers or building hardware costs money so you've got to get funded. So how can you get some funding, so things like this Innovation Challenge, other forms of grant, we got some Innovate UK funding at the start. That's a huge challenge, it's starting off at the start when you don't have the traction that we

have currently where your name is known and recognised, and you're trusted by the utilities. Before all that comes it's getting in to the utilities and in order to do that two big areas, look at what funding is available, things like this Innovation Challenge, Innovate UK granting, some other local council grants, things like that can help a lot and target innovation through the water companies.

One of our first projects we worked on was through a marketplace challenge for Wessex Water published some challenges that they didn't seek solutions for and we applied to one of the challenges that they had published, we got a three month trial, that extended to six months, we got a full network and now subsequently we've got a five year contract where we're doing blockage prediction for their whole network and starting to do other things for them as well. Likewise I know Anglian have a shop window that they run and all the different utilities will have something similar where they invite innovation and it's trying to get a match on one of those and initially get some traction with the utility and obviously it's a small industry, from there you can branch out and grow if you've got some funding and you've got some traction. It becomes easier at that point.

C: Thank you and I think I'll just draw a parallel exactly to what Brian was just saying there, what he was talking about in getting that initial funding and getting that traction is very much part of what the Water Discovery Challenge is trying to do, it's to kind of capture these ideas at a fairly early stage, provide the funding to make sure that innovators do continue to work but also very much providing the access into the sector, providing the support and the knowledge. We've got the sector mentoring program where you'd be able to work directly with the water companies across England and Wales on the development of your innovation and new solution. So I think it's like the Innovation Challenge and the Discovery so much trying to combine the funding and the insights and knowledge and sector awareness that Brian was also mentioning. So we'll jump to the next one, lots of more questions coming up. I'm conscious that we've got 15 minutes left so Karen we'll ping this one over to you straight away but Simon do feel free to jump in afterwards as well. So what are water companies progressing on the storm overflow discharge product plan? Are we on track to move from combined to separate sewers?

KG: Okay so for anyone on the call who doesn't know what the stormwater discharge reduction plan is this was published by the government in August last year and it looks to get English water companies to address CSO stormwater discharges that are happening kind of outside of the norm. There are three main targets within this, the first is looking at ensuring that stormwater discharges only happen, or they're only permitted where there's evidence of no ecological harm. Also looking at reducing significant harm in terms of pathogens, so the bacteria, the viruses where that stormwater discharges into bathing water. Also looking at reducing the total number of stormwater discharges from the CSOs, combined sewer overflows. There was some work done to look at separating sewers, is that going to be the answer? But the work undertaken by Stantec showed that it would cost around six hundred billion pounds to separate sewers, so flowing from that combined sewer system into entirely separate

systems and that may not be the most cost effective or even environmentally effective answer to the solution.

So in terms of what water companies are doing, that would be for the water companies themselves to answer but there is lots of research going on at the moment to really understand what is the most appropriate response in terms of innovations, in terms of technologies and the approaches to making sure that the water companies meet the requirements of that stormwater discharge reduction plan. But note that only applies in England. Wales and Scotland have their own approaches.

ST: Okay, some views from academia and the stormwater overflow discharge reduction is an absolutely immense task for the water sector. It's a [unclear 0:45:20] target, we've got to appreciate there're probably 15,000 to 18,000 overflows in England. I'd struggle to work out which ones would fail the plan target at the moment but it's probably in the order of 30% to 50%. It really is a really immense task that faces in for many AMPs to come. So I think there're a lot of opportunities here for innovation to drive or to develop solutions that are much, much lower cost both in terms of funding and carbons than we have at the moment. Are we ever going to get to separate systems? I don't think so to be honest because it's just too immense in construction. There are disadvantages to separate systems, they're not the panacea to flood risk and [unclear 0:46:16] materials. One of the issues with separate systems is that they discharge runoffs that goes on our streets into the natural environment, so they're not entirely a clean system.

C: I think that links perfectly into the next question where we've got someone asking in the panellists' opinions so Karen, Simon, Brian do join in as well if you have any answers on that. But in your own opinions is there a cap on water innovation in the UK whilst we do have this combined sewage and rain system? So does it need to be rethought entirely or are there simply innovations that can't be applied until we have a separate system? Simon you are on mute, I think you're answering but you're on mute.

ST: Okay I would actually say it's the other way round. I think because we've a combined system there's a huge range of opportunity for innovation. You've got to deal with the system you have, you can't have a dream that is I would like this system, you've got what you have, you have a climate, we've got our sewer and drainage systems and we've just got to innovate and work our way round that, I think. Because it's combined it's got some, well for academics it's got some really nice and interesting aspects with how you deal with wastewater and rainwater combined, how do you deal with [unclear 0:47:42] change and concentration going to a treatment plant. There is also opportunity to harvest some sort of stormwater or rainwater, you can harvest heat. So potentially lots of benefits from these systems as well as dangers and I think that's the opportunity for innovation that's going to last many years. The nice thing about these systems is they're very large, so if you've got innovation that works it's got a potentially huge impact on society. But it is a sector with not so much money. I worked in the oil and gas industry at the start of my career and that's a different level of resource. To be honest that's the nice part of the innovation challenge in the water sector.

KG: Yeah, and I have to say I think Simon answered that really nicely. There are definite challenges with having a combined system but there are opportunities as well. So I'm just going to echo what Simon said really, it's an exciting kind of problem to have, a terrible problem, but it's an exciting one where I think there's lots of great innovations and solutions potentially out there.

C: Thank you very much. Brian we'll ping this next one over to you, a question has popped in how can data help identify problems and find specific solutions to the sewer network?

BM: Yeah, really good question. Data is absolutely fundamental to identifying and solving some of the big problems that we've been discussing here. If I can speak through the experience of Storm Harvester, particularly first of all around blockages, we take in data from all of the sewer level monitors for all of the event duration monitors, from all of the pumping stations within a network. We process that in an AI model to determine how the network should be performing and then we can identify if it goes out of it's normal operating parameters. So that is an example of using data to identify if a blockage is starting to form. So if you've got a very early formation of a blockage you can get out there, you can remedy it before maybe in a week's time if you haven't fixed it, it would start to build up and build up and eventually ending up in a pollution event. That's a real-life example of how the data is actually improving the functionality and the performance of the network.

Similarly, we have used the same EDM data and additional sewer level monitors to identify where infiltration is coming into the network. So we can match groundwater levels with sewer levels and then when we see the groundwater level increasing and the sewer level also starts to increase then we can say okay there's groundwater infiltration happening at this location and monitoring the data to identify the flow pattern to tell us what exactly is coming in to the sewer. Is it all roofs, is it road and roof or is it infiltration as to brown water or is there may be some underground culverted watercourse accidentally has been discharged into the sewer network and is that driving additional flow and then ultimately that driving pollution event. So I think the data is the key fundamental building block here in order for us to identify and then subsequently solve these problems.

C: Thank you very much. Next one we will ping over to Karen and you, Simon, again, I think. So are water companies experiencing the same issues looking for the same solutions? The question is saying that it seems like solutions therefore should be kind of collectively applied where possible. I think, Brian, you were mentioning that the solutions through Storm Harvesters is currently in operation across eight of the water companies but obviously not all of them. So I think this might be linked into that, that if they are experiencing the same issues are solutions being collectively applied?

K: I'll go first. So absolutely there are some shared challenges across all the different water companies, but there are also some fundamental differences. So there are for example different ways of treating sewage. For secondary treatment you might use trickling filters, you might use activated sludge and there are some other types as

well. So there are those kinds of nuances within the treatment process itself but also there are some catchment… by that I mean the towns and the cities or the area around the sewage treatment works that might have lots of industrial discharges, so there might be lots of factories. It might be all domestic and this could mean different influent concentrations and by that I mean the amounts of different maybe metals or organic chemicals, different strengths of sewage. That means that the treatment processes on site will be slightly different from one site to the next and one water utility to the next but that doesn't mean that there aren't shared challenges. So for example the greenhouse gas emissions, how can they capture them, how can they monitor them, how can they measure them.

Looking at your sewer network as well, how can you understand what's going in there. These are all opportunities for those shared understandings and potentially using very similar solutions, whatever is appropriate but even with a sewer you've got different pipe materials, different diameters, slightly different ground conditions as well. So it's important for them to share knowledge where possible but there isn't necessarily one solution fits all.

ST: Yeah, I think as Karen water companies do have similar problems, but they probably range in their severity in different companies. It would be a good idea if we did apply successful approaches collectively and I think that's the challenge for them because they are different companies and different companies have different people in them and different people make different decisions, I think. So in that sense it is difficult for successful solutions to be applied quickly in different companies. I think eventually it will work its way through the water sector, but it does take time. There are a number of central testing facilities, the government invested about five years ago about £120 million in infrastructural laboratories, so there are 12 large laboratories. Three are in the water sector, so there's one in Sheffield. We've got the National Distributed Water Infrastructure Facility which focuses on pipes, water transport and wastewater transport systems. One at Cranfield looks at processes and one at Newcastle that looks at green infrastructure.

I also know that water companies have their own facilities, large scale facilities for testing, I know Northumbrian Water is in the process of building large drinking water network technologies and a full-scale drinking water network. I know Severn Trent facilities and catchments where they test innovation. So that's just my personal knowledge but I know other companies have… Thames I know has a couple of wastewater sewer networks where they test various innovations on. So companies do have their own testing where they can apply new technologies, but again it's not centrally organised so it is very, very company specific sometimes. Also the water supply network at Northumbria is being built by a consortium of water companies which should mean that there will be an easier route for learning amongst companies rather than the organic way at the moment.

C: Thank you very much. I think we are very slowly coming to the end, I'm conscious that we've just got a couple of minutes left. So we'll jump in to the next question but anybody who has got questions in the Slido we will try and address those

offline and share the answers. If you have a very specific question that you haven't had your answer to today do email it across to us in the inbox and we are in that inbox every day so we will address your questions in writing by email very quickly as well. So if there're any questions that are still unanswered please just email it through, but we'll cover just the very last ones before we close up. So what are the prospects to real progress of addressing the impacts of groundwater infiltration and identifying hotspots effectively. This is diffuse extraction so I think we'll ping that one over to you, Simon.

ST: Okay I think there are elements in assessing groundwater infiltration both in terms of [unclear 0:56:51] analysis of existing data to look for anomalies but also in terms of monitoring and instrumentation. So there is fibre optic-based instrumentation that looks for temperature differences between the wastewater infiltration. There's also electrical based tomography that looks for differences in the soil next to the pipes. So I think twin approaches of data analysis and better understanding of existing data but also new technologies to try and pick up and localise where groundwater infiltration is occurring. The difficult thing with groundwater infiltration is actually identifying the location, you normally can find good evidence that it's there but it's actually being able to find the location and then allow an effective repair to be made that doesn't require maybe 100s of meters of pipe. So it's the location that's very difficult.

C: Thank you so much, Simon. With that note we are now at 1 o'clock so the webinar is coming to a close. I just wanted to finish off saying a massive thank you to all of our speakers, so Simon, Brian, Karen, also Rachel who was unable to join the Q&A but massive thank you for you guys to join today for answering all of the questions that are coming in. We'll be able to take a lot more via email as they come in so anyone in the audience who's got any then ping them our way in the inbox. Also thanks to all of the audience who've been here, who've been engaging and writing in the chat and sharing all of their questions. We've got another webinar coming up on Thursday, same time and two more next week so do check out the link in the chat for all of the entrance support that's available. You can watch all of the reporting on the webinars that have taken place already and you can register for all of the webinars that are coming up over the next five weeks until the entry period will close in early April. So thank you so much for today and we will see you all on Thursday.