Episode 81

Rainwater Harvesting From Your House

The show notes: www.houseplanninghelp.com/81

Intro: Our interview today is with Cath Hassell from ech2o Consultants. We've spoken to her before on the podcast (episode 36) so you can go back into the archive and learn about saving water. At the time she overloaded me with so much great information that I had to stop her before we even got onto the topic of rainwater harvesting. That's why we're welcoming her back today.

And I started by asking what is rainwater harvesting . . . but she didn't want to start there! Typical Cath. Instead she wanted to answer why we might be thinking about rainwater harvesting for our houses.

Cath: Rainwater harvesting is one way of stopping rainwater getting into our drains and sewers, and that's a really important thing to do. And what we want to do is we want to keep as much rain as we can falling, that falls on our buildings, kept within in effect the curtilage of the building. So we save it somehow outside, and rainwater harvesting is one way of doing that.

And obviously today I'm going to be talking about rainwater harvesting but I just wanted to put it into that context because that is just really, really important. If your building is in the city and you're going into a combined sewer then we get issues of when it's raining too much, everything goes to the sewage treatment plant, there isn't space in the sewage treatment plant to process that waste water and so it has to spill out of what we call combined sewer overflows straight into the local rivers or seas. And if it's in separate drainage then it will run, it doesn't have to go to sewage treatment plant obviously because it doesn't have sewage in it, but it will still have dirt in it, it's still going to be running off and it's going to go into rivers and potentially causing flooding in rivers. So the idea is we want to keep rainwater where it falls as much as possible.

Ben: Does that mean that everyone should be rainwater harvesting in some capacity?

Cath: Yeah, in effect. Ideally everyone should be disconnecting their stormwater system, so in effect their gutters and their downpipes, they should be disconnecting that from their drains.

Rainwater harvesting is quite a complicated way of doing that, you know because you sort of asked me right at the beginning, what is rainwater harvesting and really how we talk about it in the industry is it's collecting rainwater that falls on the roof of the building, usually only on the roof because that's the cleanest water, keeping that water, storing it outside and then using it either back in the building, for WC flush, urinal flush, general cleaning purposes, washing machines, or using it outside the building for gardening.

That's a complicated system. That costs a lot of money. But what you could do is you can just disconnect your downpipe from the drainage system. You could run it into what's called "rain gardens" which are just little areas of garden that can cope with sometimes being inundated with water. So have planting in it that can cope with being inundated with water and you can even just run it into a bed or you can run it in little swales, but just try to disconnect it from your stormwater drains.

And that can be done in a retrofit situation as well. And that's actually simple to do, whereas rainwater harvesting, you know, it's not just about water butts. It's about saving a lot of water, therefore you generally tend to have underground tanks to store the water in.

You store the water underground for two main reasons really. It's heavy so you don't want to store it high up on the top of a roof, and once it's stored underground it's cool, it's dark, so you don't have issues of it becoming too warm with potential for bacteria.

You can also once you start storing rainwater you start to realise, oh gosh actually where we're going to be putting in 2m³ or 3m³ of storage, that's quite a lot of space that's going to take up if you're just going to try and put it on the outside of a building, so that's why you put it underground. But then as soon as you start putting it underground then you get the associated costs, so like in a new build, okay that's fine you're in a new build you're already going to have earth moving equipment, so a little extra to dig a big hole somewhere to put your tank in is one thing. But in a retrofit situation, a) have you got access to the back of the house to put in, which is where usually most of your rainwater falls. If you're a terrace half of the roof is going out the front, half the roof and say maybe your extension is going out at the back so you're not collecting from the whole roof.

So there's a lot of different things to look at. The other thing with rainwater is that it's classified in the UK as fit for non-potable and non-bathing purposes. So I already mentioned at the beginning flushing loos, flushing urinals, washing machines, but not dishwashers, general cleaning as in floor cleaning, stuff like that. But it's not classified as fit for purpose for bathing or drinking.

So what that means is that again in a retrofit situation if you consider a toilet block in say a school, your cold water supply comes in, it goes to flush the toilets, it goes to flush the urinals, but also it just tees off and goes to the wash hand basins. So we could easily put in rainwater but we can't use the same pipework because it goes to the wash hand basins.

You think about in a standard bathroom in your house, your cold water comes in, it goes to the loo, it goes to the cold inlet on the shower, it goes to the cold tap on the bath, it goes to the cold tap on the wash hand basin, but we can't use that pipework if we're going to put rainwater in it. So we have to then run separate pipework throughout the house from that rainwater to the toilets, to the urinals if it's a non-domestic building.

Lots of people think, oh yeah brilliant it'll be really simple to do. It's not that simple. And because of how rainwater is classified, in the UK the rainwater is classified as water that is called fluid category 5. And fluid category 5 is rainwater, grey water or water that's been swept up off the floor of abattoirs or water that's been contaminated with nuclear waste! [Cath laughs.]

Ben: What?!

Cath: Yes, seriously, that's the analysis of fluid category 5 water! And that's basically because of the potential for pathogens in it. There's no pathogens in nuclear waste water but that's got the other potential sorts that'll kill you!

Now what's kind of so crazy about this is you know people all over the world drink rainwater and don't come to any harm. So it's not dirty water. Yes it's not as clean as mains water, yes we're very used to drinking mains water in this country and I'm not suggesting everyone starts going round and drinks rainwater, but it's crazy that it's been classified in that way. But because it's been classified in that way it means that your backup water cannot simply be a little valve that just changes.

So if we've got rainwater we'll just feed it to the WC systems but if we haven't got rainwater we'll just turn a couple of valves and then we'll just use mains water. You're not allowed to do that. You have to have what's called a type AA or type AB air gap which means that all your mains backup has to go into your rainwater harvesting store tank, underground tank, to your store of rainwater with an air gap and then has to be pumped again. You cannot just use mains water to swap it over.

Ben: What do you mean by this air gap?

Cath: There are different types of air gap. But basically what an air gap does is it ensures that there's no way that water can back siphon into pipework.

So I think the easiest way to explain about an air gap is that if you think of taps on a wash hand basin or on a bath, the end of the tap, or the spout of the tap, ends above the spill-over level of the wash hand basin. So if we filled the wash hand basin up with water that water would start to spill over onto the floor before the spouts of the taps dipped into that. And that's an air gap.

And in the olden days we used to have what we called globe taps on Victorian baths and they were actually inside the bath. Very very brilliant looking taps. You know I mean I've actually pulled taps out like that on jobs. Beautiful taps but they then were banned under the water regulations because you could fill the bath up with water, you could then bath in it so the water would now be dirty because you'd bathed in it, and then the globe taps, the spouts, would be dipping in the water. And then if, there's lots of ifs in this, but then if we ended up with a break in the main supply which then meant that there wasn't any pressure in the mains, air pressure can potentially force that water, that dirty water, back up into the mains and then into the next door's house and then they could drink your bathwater that you've used.

So to get by that we have air gaps, so you know there's still possibilities of ways to do it but really we have air gaps so there are other ways we sort of prevent that happening as well, like what we call double check valves. First of all single check valves and then double check valves in case the first check valve failed, but basically because of the way that they've classified rainwater as fluid category 5 we cannot use single check valves, we cannot even use double check valves. We have to have this air gap situation.

And as soon as you have an air gap what happens is that you've lost the mains pressure. Obviously if you're collecting rainwater harvesting to flush toilets you have to be able to flush the toilets if there's no rainwater, therefore you use mains water to do that. What then happens is that you bring the mains water back in into your tank, it loses its pressure then it has to be pumped. So okay you can get around that and that's by if you then have in effect a header cistern, so you'd pump the rainwater to a header cistern first and then feed the WCs or urinals by gravity but then that's extra complication and normally we would want to just pump directly to point of use.

Ben: That's actually something that I've thought of during this, that pumping presumably is bad if it can be avoided. I know you said that we couldn't have a tank up in the loft or in a high space in the roof so is it okay then, you've put it down in the ground just to pump it all back up again?

Cath: Obviously there's a carbon cost to pumping because we are pumping and we're using electricity to do that, therefore what you want to look at is what is the overall cost.

Now to provide mains water into our building, because of economies of scale and we're taking it from the mains, we're using 0.6 kilowatt-hours of electrical energy and that's actually including cleaning that water, taking it from the reservoir, cleaning it then pumping it into our buildings. So if we're using more than 0.6 kWh, and that's per every cubic metre of mains water, so if we're using more than 0.6 kWh of pumping energy to pump our rainwater into the building into our appliances, then in terms of straightforward carbon against carbon it's less efficient.

So there are ways around that, reducing the carbon load of the pump, so again if you pumped to a header cistern you would pump to something with in effect fast fill ball valve, is probably the best way to explain it. Delayed action we'd probably call it, delayed action ball valve.

Ben: That means nothing to me.

Cath: No, it means nothing to you, I'm just hoping that your listeners are going to be plumbers, [Ben and Cath laugh] and they're all going "delayed action ball valve Cath, glad you brought that up"!!

If we look at delayed action ball valves or what we have torbeck ball valves. The old fashioned ball valves, which probably a lot of your

listeners will know, so it's got like an orange ball on one end and a long brass valve, they fill up slowly slowly slowly. Slowly cutting off the inlet and what happens if you're pumping water into there is as it begins to slowly fill up it gets to a point where the pump thinks it's full because it's pumping in quite hard. So the pump shuts off because it thinks it's finished its work and then the ball valve arm opens a little bit and the pump thinks I've got to pump again, so it comes on jumps on pumps again and then it goes oh no satisfied, oh no it's open again. And we get what's called pump hunting.

So to get past that you just have little torbeck type valves if you are just going into a standard toilet cistern. They've just got a little white plastic float which is really really small. So what happens is the water comes in really really fast and then it's only right at the end it just shuts off the ball valve inlet. So that's a type of delayed action ball valve.

Ben: How actually did we get onto this from talking about the carbon of the pumps?! Did we answer that fully do you think?

Cath: I think we did! I think that was an excellent little detour into the technicalities of how you prevent pump hunting!

But no, but seriously Ben I am answering that question because what I'm just trying to say is that if we don't take all of these considerations into account when we're designing the rainwater harvesting system we end up with a system that in terms of pure energy used, in terms of pure carbon because we are looking at pumping energy electricity from the rainwater harvesting pump, compared to pumping of energy electricity for the mains, so we are comparing like with like.

So I'm just trying to explain ways that we can in effect optimise the performance of the pump if you've got it in a rainwater harvesting system.

But the other thing I would say is that there hasn't really, or there's been very little work done, and I don't really know enough of any work that I could just now quote to you that has actually gone by taking rainwater out of the stormwater stream we are preventing pumping in the sewers, we're preventing CSOs. That work hasn't been done. And it would be great to see that work done and to be honest it wouldn't even matter if it was done in Germany, as long as it was done somewhere. That would be really useful in terms of the arguments of the good things about rainwater harvesting because currently there's a lot of work that's being done that shows that

rainwater harvesting does have a very high carbon load and therefore it's often used as an argument to say that we shouldn't do it. And like I said right at the beginning we actually need to consider much wider things about why we should be using rainwater and taking it out of the stormwater stream.

Ben: Let's have a think about the actual design then. So does this affect our building or do we just accept that we've designed our building and then we'll use whatever we have in that design?

Cath: No, it does affect the design of the building. So let's say if it's a new build, if you're going to, if you've got a green roof on your building and I love green roofs, I think there's some really fantastic positive things about green roofs, but I would say that if you've got a green roof on your building I would not collect rainwater for use back in the building. The reason being is that you will get discoloured water and then what will happen is that unless the owner of that building a) knows that's going to happen, and b) is quite happy with that, you will get people going the toilet is really dirty, the water in the toilet is really dirty because everyone's got white toilet pans. And then they'll start putting extra disinfectant down, bleach down, trying to clear away that dirt.

So if you think about your building when you design it, let's talk about a large building, let's talk about a school building for example and it's got an extension say that's got a green roof so hasn't got a green roof everywhere because the cost of the green roof is sort of greater than your standard roof. So what happens at that point is that you just say okay, well we won't collect from that area of the roof. We'll just collect from this area of the roof. That's really easy to design in. You just design it in with your gutters and your downpipes and then you just don't collect from that part of the green roof. So that's very very simple. It needs a bit of thinking about but it's very simple.

Ben: Is there ever a case where you get too much water or can your overflow in the garden, this soakaway, always take it?

Cath: Yeah, I mean the point is you don't size the rainwater harvesting system, or the rainwater harvesting storage area, so the rainwater harvesting tank, to try to cope with all of the rainfall runout. You size that. There's a calculation that you do, I could tell you the calculation if you wanted?

Ben: How many seconds does it take?!

Cath: Not long! [Cath laughs.]

Ben: Go on then! Go on, let's have this!

Cath. Okay! So you take square metre of your roof area that you're collecting from, multiplied by the yearly amount of rainfall in millimetres, multiplied by what we call the drainage factor, and the drainage factor depends on what type of roof it is and it goes from 0.5 for a green roof up to 0.9 really for a metal pre-formed roof, and multiplied by filter efficiency. And so that gives us a figure in litres for the year. You then divide that by 1000. That gives you cubic metres and then you know okay this is how many cubic metres of water I can get from my rainwater harvesting a year, and then what a lot of...

Ben: The optimum, that is the most I will ever be able to...?

Cath: Is that the most you will be able to get? No, because it's not the most you'll be able to get because rainfall is an average. So let's say London for example. So London gets on average, depending on which website you look up, between 600 and 650mm of rainfall a year. On average, and that's 30 year averages. So some years it will probably only get 500, on a really wet year it could get 800. But that gives you an idea on an average year, which never happens of course, this is how many cubic metres of water you'll be able to get.

The storage, we only store 5% of those cubic metres of water. We don't go okay so I'm going to be able to get let's say 80m³ of water a year, fantastic, so I'm going to put in storage capacity of 80m³. No, because rainwater in the UK falls pretty much all through the year and we put in 5% of storage. 5% of storage is in effect 3 weeks in the year. And so it sort of says that you know it's just about trying to optimise the storage. Sometimes your tank will be too full, sometimes your tank will be empty.

But your question right at the beginning was if it's too full Ben, and the thing is about if it's too full it just runs to the sewers so you just connect it to the drainage system at that point. But what in effect you've got is you've had an attenuation of say 3000 litres if you've put in a 3 cubed tank, or if you've put in a 2 cubed tank you've got an attenuation of 2000 litres before it then goes into the stormwater drains.

Ben: And are you having to work out what your needs are? Does that determine the size of the tank?

Cath: If you're just doing a small domestic situation you would just really work it out on storage capacity, following that a 5% of your total yearly yield. It's always the storage that costs more. That's the largest cost because you know it's not just about dropping the tank into the ground, you have to backfill it with concrete, or you know if you're lucky and you're in an area you can maybe backfill it with pea shingle, but normally you have to backfill it with concrete so that's expensive.

So if it's a large building then what you would do is you would actually say well, okay this is how much rainwater we've got but actually we're getting more rainwater from the building than we need so the supply of rainwater is greater than our demand therefore we can reduce the storage. If I'm designing one for a school I'll do the sort of the headline calc...

Ben: You've mentioned schools a number of times. That must be because a lot of your work is for schools?!

Cath: It's true! A lot of work is for schools! Is that my chance to do another little plug about the...?

Ben: Go on then, because I'm not sure at what stage you'll be in the campaign by then but you're doing your Kickstarter thing and it's come up so yeah, tell us about the book!

Cath: Okay, brilliant! Yeah, so basically we do do a lot of work with schools. We never used to work with the infants because I'm so nerdy about water as you may have seen, that if some little child puts their hand up and goes "so how does the toilet work" then I just sort of blind them with lots and lots of information about how a toilet works which is kind of okay if you're talking to like 8 year olds and up. We've got a brilliant little see-through toilet system that we show them how the toilet system works and everything, but it doesn't work with the little kids. And I was sort of sitting in front of kids and thinking if I just had a book then I wouldn't be able to like branch out, I could just have to read the book, this is how the toilet system works!

Ben: Do you quote the formula to them? "And this is the formula!"

Cath: [Cath laughs.] No, no formulas in the book! However that's a really good point for the follow up book, Ben!

Ben: No, no! And your Kickstarter campaign, what we'll do whenever it goes live we'll link to it and make sure it gets some plugs because I

have a feeling this interview will go out before then, but good luck on that. I'm sure we'll all rally behind you.

Let's just quickly start to wrap up, because amazingly we're running out of time already. Rainwater harvesting, I'm sure there's a lot more detail in there. Let's just quickly talk about the tank. Does it have to be made of anything in particular if we're worried about our carbon footprint?

Cath: Some people who are listening to this, so Judith Thornton, Judith Thornton she works at CAT, she's also an AECB member. And Judith did one of those life cycle analyses of rainwater harvesting tanks, GRP (Glass Reinforced Polyester) against polyethylene tanks and basically the poly tanks came out far far better. When I first started rainwater harvesting, which was back in 1998, there were concrete tanks around, concrete rings, concentric rings, but to be honest now you're looking at GRP or poly and really now most of the tanks, most of the smaller tanks are poly and most of the larger tanks are GRP. But if you're seriously looking at it in terms of what's better in terms of the overall carbon footprint, poly tanks are better.

Ben: And does all of this connect into the house okay or again is there a whole lot of gubbins that we need to make sure when we're constructing our house that we sort out?

Cath: In terms of connecting it to the house that's pretty simple. So your downpipes are going to run into a drain anyway. Your drain is going to run out into the street into the sewer. All that happens is that if you've got rainwater harvesting in between the drain and the sewer in the street at some point, you've got a tank. So the rainwater comes into that tank. When that tank fills up it just runs out from the overflow of the tank and continues on its way into the street. And then you drop a pump into that. The electricity supply for that pump and then obviously the water from that pump are just housed in a duct, same duct, that duct runs back into the building and then you've got to think about the mains backup which I was talking about all the way back when, and that mains backup goes through a type AA air gap.

Ben: I know a bit more about that now!

Cath: [Cath laughs.] And just drops into another duct and that duct will then run back into the tank, or if you aren't pumping direct, what we call direct point of use, but you're pumping to a header cistern,

you're mains backup goes into the header cistern but still through an air gap.

Ben: Finally, just is there any part of this without going into massive depth that we have missed? I'm sure there's lots that we're not going to be able to touch, but is there anything that is essential?

Cath: I don't think so. I would, what I often say to my clients is that if you've got a large requirement for garden watering use rainwater for that. Don't try and bring rainwater, if it's in a domestic situation, don't look at bringing rainwater back into the building because of all the issues of your extra pipework that you've got to put in because of the fact that because of the type AA air gap where any mains backup to flush your toilet, to use on your washing machine is going to have to be pumped, I always say collect it use it for the garden.

If you run out of rainwater in the garden, you just have another tap which is an outside tap and that tap is fed directly from the mains and you just use that if you ever run out of rainwater for the garden.

The one thing if you're collecting for rainwater for the garden in effect you then use a different calc in terms of your storage, because what you're saying is I want to collect as much of the rainwater as I can during the non-growing months, so across the winter season, so that I've got as much rainwater as I can possibly have for the spring and summer when I'll be using it a lot.

Ben: That makes sense. Cath, once again thank you.

Cath: No worries Ben. Pleasure.