the Rain Gauge

by Chris Moss

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It all starts with rain

Pretend it's snowing, an increasingly rare event on the south of Vancouver Island. Snow, however, is just another form of rainfall. It stays on the ground as a reservoir of moisture and slowly melts to recharge the watersheds and the aquifers under them. An aquifer is just Nature's water storage system but important so more in this later. Rainfall on the south of Vancouver Island is becoming increasingly rare during our summers. Climate change is pushing our rainfall into shorter periods of time. It is becoming a season of rain or drizzle followed by a season of dry weather. This is not good for the watersheds or the aquifers. Rain, falling in short strong bursts, does not have time to sink slowly into the land. The land can become dry to the point that water does not sink into the dry surface and instead runs off rapidly. The first good rain we had last fall was welcome after a summer of drought. But digging down three inches into the garden, the soil it was still dry dust. Potatoes did not grow to their full size due to lack of deep watering.

Everything we depend on has been based on the belief that we have plentiful water in our region. The Leech River watershed and the Sooke Lake watershed provide water to Sooke Lake and from there to all of the Greater Victoria Region population. From North Saanich down to Victoria, across to Colwood, Langford and Sooke this one reservoir provides all of the piped drinking water. This water is used for drinking and cooking. However, it is wasted for watering lawns, power washing driveways, and a thousand other uses that do not require potable drinking water quality. Sooke Lake is a remarkable water supply but it is still dependant on rainwater and snowfall to fill the lake. The water level in the lake is usually at its lowest point in the September to October months, falling to 30% of its total volume. Then the rains come and fill the reservoir back to full. The average rainfall for the period of September 1 to December 18 2022 was only 49% of the average (average 1914 – 2021: 677.6mm) In the same period in 2022 we got only half that (334.1mm) and as of mid December 2022 we got only 19% of our normal average (average 1914 – 2021 293.8mm verses 2022 actual rainfall of 55.2mm). This data comes from the weekly water watch from the CRD website. Without the slow even rainfall that we have been used to getting in the fall, the entire region from Sooke through Otter Point, Shirley, and Jordan River to Port Renfrew and the Rural Resource Lands could face lower water aquifers and drying wells. An intense rain over a short period will not refresh the aquifers as evenly as longer rain periods have done in the past. Surface water moves too quickly down the small streams and rivers. On the way it scours the stream beds and erodes the natural terrain, destroying fish and animal habitat. Large scale forest harvesting has added to the inability of the land to slow down and save this water on the land and to allow it to sink into aquifers.

What can we do when our wells dry out? Hauling drinking water is costly and drilling a deeper well can be much more costly. The new well may or may not yield water, or it may be only a temporary solution.

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It all starts with water

Life as we comprehend it could not exist without water. Everything with an organic base depends on water. Humans are mostly water, on average we are 60% water. Without water our bodies dehydrate, which is why we tell people to drink lots of fluids during hot weather or during an illness when the body is losing fluids rapidly. Without water acting as the main ingredient of the primordial soup where life began, life as we know it could not have developed on what was a very hostile rock planet some 3.7 billion years ago at the bottom of a shallow body of water. Water has some interesting properties. It can be a frozen solid or a liquid or a gas. When it freezes it expands and it floats on water. If it became dense, as other solids do, it would sink to the bottom of the ocean and our planet would have a perpetually frozen ocean floor. Water evaporates into a gas if you put energy into it by heating it or leaving it in the sun. Liquid water can be distilled from its gas form by cooling it. When condensed water falls from the sky we call it rain or snow. If it remains suspended in the air we call it a cloud, a mist or a fog. It is so common to our lives that we take it for granted if we have it, and despair if we don't.

In 2017 the Capital Regional District issued a report called "Climate Projections for the Capital Regional District". It is filled with maps based on existing data from 1971 to 2000 and projections for 2041 to 2070. Where we have had a 1971-2000 snowpack of 3 meters on our south island mountains, by 2050, the report predicts that there will be zero snowpack on our mountains. While the report deals mostly with changes in temperature and precipitation it also has a section on other impacts in our region. Changes to the climate will affect our human health, wastewater and sewage management, water supply, tourism, recreation, transportation network, ecosystems and species, buildings and energy systems, and food and agriculture. It all starts with water.

Greater rainfall in a shorter period might be good if you are a lake reservoir. Sooke Lake might accommodate a sudden influx of water in spite of the increased turbulence. But if you are a watershed the increased short duration rain will not have time to infiltrate the soil and much of the surface water will be shed into streams and rivers and therefore not sink into the underground aquifers. That's bad news if you draw your water from a well. Also bad news if you are a salmon. Water shortages are a real concern as our summers get dryer and longer - stretching into mid to late September. The CRD releases water into the Sooke River to compensate for the lack of water needed by migrating salmon, but all other spawning areas are on their own. If the salmon can't get up to their spawning grounds for lack of water then they cannot lay eggs and the spawning run in that river can be damaged or lost. Just recently it was reported that a run of Chinook salmon has fallen below the level of reproduction in one of the northern BC rivers. If we lose that run, that part of the natural diversity, then we may also damage or lose the bears and eagles that depend on the salmon, and the streams and ecosystems that depend on the natural fertilisers that the decaying salmon provide. Indigenous use and western use of this resource will change. Protecting the watersheds and keeping the rain where it falls is essential to the health of diversity in our region, and it all starts with water.

Stewardship

The CRD region is comprised of over 300 watersheds which are over 100 hectares in size, as well as numerous smaller named and un-named watersheds. A watershed is the area of land which drains water into a creek, stream or river system. Some are large like the watershed for Sooke Lake. Some are very small. As you head up the coast past King Creek, Tugwell, Muir, Kirby to the smaller ones which are not even named but sit like narrow fingers on the edge of the land. During rainfall events all of these watersheds catch and drain water and send it downhill, usually to the ocean. If the rain comes quickly the water will overwhelm the ability of the ground to soak in and hold onto that water. Water will flow rapidly over the surface eroding the topsoil and sending it quickly to the ocean.

Natural dams and lakes act as buffers to this quick diversion of water, slowing down and holding it on the land. Artificial dams and reservoirs found at Sooke Lake and Goldstream also stop and hold the water for later use. They can also prevent sudden flooding events. On the other hand, if they are filled to 100% at the time of the rainfall, the excess water will flow over the dam and down to the ocean. The watershed for the CRD drinking water at Sooke Lake is the only watershed in Canada which bans all entry to the watershed land area. It is therefore well protected from outside contamination. No other area on the south island is so protected. In general we must watch carefully where we place developments such as roads, housing and farming so that contamination of surface water is avoided.

Salt Spring Island has a well developed team of volunteers that monitor the watersheds and streams of their community. They also have a community well monitoring program of which this column will talk in the future. Peninsula Streams and Shorelines Stewardship Programs have been operating since 2002 in 13 of the watersheds in Greater Victoria. Their volunteers work with anglers to monitor and improve the watershed and stream systems all over the GVRD. From their webpage: “The objectives of these collaborative partnerships are to : educate the public about the importance of watershed resources, to facilitate communication and cooperation in watershed management and to provide volunteers with the training required to protect and restore aquatic and riparian habitat.”. In addition “Our dedicated stewards are also the “eyes and ears” of local watershed conservation , monitoring stream conditions, counting salmon and alerting authorities when there are problems with local streams.”

To my knowledge the CRD west of Sooke does not have a coordinated Volunteer group like this to monitor the many streams and watersheds that exist on our coast. Baseline information is important on all watershed areas, not just on fishery streams. This data will show us the changes being made by the climate. When does the stream stop flowing in the summer? When does it start in the fall? What is the impact on water flow, habitat and animals? What is the health of the stream? The answers to these and many other questions will help us to manage the use of watersheds and keep them in healthy operation during the coming decades. We need to enlist residents to become watershed stewards. Adopt a local watershed to monitor. If we have volunteers we can get funding to train them to access the health of watersheds and over time we will build a database of information to help us keep watch on the health of our land.

Aquifers

Watersheds receive and guide precipitation across the land and they slow and filter the water that infiltrates into the ground. Under the ground the water filters through the soils and rocks until it meets an impervious layer of rock or clay. At that point the ground above starts to fill and saturate with water. This is an aquifer layer from which many of our wells draw water. The aquifers can straddle many watersheds, for example, our house is on the Tugwell Creek watershed but on the Muir creek aquifer down under the ground. There are many aquifers on the south island. The largest is the 606 aquifer which is a solid basalt formation that underlies us from Colwood, Mechosin, East Sooke, Sooke, up to and including the Sooke hills and across in a large arc to north of Jordan River. This is the dark rock you see on the side of the road with small dribbles of water sometimes trickling down them. Water is contained in these fissures that crack through the rock. If you drill a well into this rock you have to drill through a fissure of water to find your supply. If you miss them your well is dry no matter how deep you drill. Water supply is usually poor and the supply is vulnerable to contamination as the thin fissures don't filter out the contaminants. The contamination can spread though connected fissures.

On top of the 606 aquifer are sometimes found other layers of aquifers. This occurs when the gravel till from the last ice age has been pushed over the bedrock. These are different aquifers that accept water much more readily and are usually shallow and good producing wells if they are not overused. As the glaciers advanced and retreated sometimes a second layer of gravel will be deposited over the first layer, separated by a less permeable layer of glacial silt. Then you have two shallow aquifers over the 606 aquifer. This occurs in the Otter Point area north of Kemp Lake where the aquifer 604 lays on top of the Sooke River Aquifer 599 and both of them are on top of the 606 bedrock aquifer. All of this information can be found on the BC Groundwater and Aquifer Map website. If you drill a well in this area you might find water less than twenty feet under the surface. If you kept drilling another thirty feet you might punch through to the second aquifer and if you drill deeply more than two hundred feet you would likely be into the bedrock of aquifer 606.

There are two provincial observation wells on Phillips Road, a shallow well into aquifer 599 (Sooke River) and a deep well into aquifer 606. It takes ten years of monitoring before the data can be shown to follow any long term trends such as falling water levels in the well. The problem with using this data is that in the 606 aquifer (solid rock with tiny water fissures) you can drill two deep wells a hundred meters apart and one will hit a fissure and have water and the other will not hit any fissures and turn out as a dry well. A better use of money would be to require new wells to include a "drop pipe" in the well. The drop pipe is used to send down a well water "tape" which measures the depth of the water in the well. One tape can be used throughout the neighbourhood area to measure every well with a drop pipe installed. Tapes cost about $1500 and a drop pipe about the same plus installation by a professional well technician. Certainly this would be less expensive that drilling even one well for official observation use. This way we can see the seasonal variations immediately in our own wells and in the neighbourhood area wells. By sharing this information we can better ration the use of water and forward the data to the government for longer term use.

The water cycle

If you boil water in a covered pot you will see the water turn to steam and then condense on the inside of the pot lid. In a nutshell this is the "water cycle" that encircles the Earth. Liquid water is evaporated by the warmer air and the sunlight into a gas of water vapour. The amount of water vapour in the air can be measured and becomes what we call the "relative humidity". There is a limit on the amount of water that any given air can hold as vapour. When the humidity reaches toward 100 percent the water vapour cannot be absorbed and it starts to condense back into liquid. The temperature of the air mass also affects the amount of water vapour that it can hold. Generally warmer air can hold a greater amount of water vapour. Hot summer nights can be extremely humid and feel wet and sticky due to the warm air holding its maximum water vapour. If the local climate pushes that humid air mass up the side of a mountain the air cools as it rises in the atmosphere and the water vapour condenses into cloud formations. But clouds have a limit as well and if you watch them develop you can see the colour of clouds gradually darken as they struggle to keep that water vapour in the air. Finally the vapour will turn back into liquid and fall as rain onto the ground below.

Many areas which have available water, from surface water and/or vegetation, and hot daytime temperatures will experience daily rainfall as the local cycle evaporates water in the morning and condenses that vapour into rain the afternoon. While some cycles can feel like they are local, the same water cycle operates globally. The sun is the energy that, as the earth turns, heats up one side then the other side of the earth every twenty-four hours. The swirling atmosphere heats and rises, it absorbs tonnes of water vapour as it does, lifting it high above the ground. Cooler air sweeps in to replace the warm rising air. The earth is turning under both air masses and as the warm air cools it spins clockwise in the northern hemisphere as a high pressure dome and wind is created in the air mass. This occurs multiple times every day all around the earth and our local weather is made up of these spinning high and low pressure systems. But this is just "weather", it is not climate, nor climate change which is measured over a longer period of time. What man has done is to "mess" with the normal composition of the atmosphere. Using fossil fuels to pollute the air with excess carbon dioxide allows the envelope of air around the earth to retain more heat. More heat allows the air to evaporate more moisture and retain it as water vapour. This heat leads to melting of glaciers and permafrost, as well as droughts, and to arid land with reduced ability to support life. Meanwhile the turning earth and swirling air masses can travel around the earth and drop that much larger amount of water as torrents of sudden rainfall which can result in flooding. The water cycle is no longer a regular cycle that can be predicted. Droughts and floods have been warned about for the last seventy years. Only now are people worldwide beginning to understand firsthand the effects of human made climate change.

The 2017 CRD report "Climate Projections for the Capital Regional District" shows clearly the effect of human made climate change on our south island region. By 2050 : no snow pack on the hills , at least two "tropical nights" per year when the temperature stays above 20 degrees Celsius, an increase in rainfall over a shorter winter season as the water cycle pushes water laden air off the Pacific Ocean, dry summers or drought until at least mid September and no frost days. All of these predictions are coming true.

Fish and wildlife

While humans tend to think about themselves as occupying some sort of special place on earth we are really just another animal which depends on the sustenance which the earth provides. All the animals in our ecosphere depend on water for survival. Migrating populations have taken 10,000 years of stability to adapt their species to the climate. Humans have changed that climate forever in the last 200 years and fish and animals are having a tough time trying to adapt on short notice. The return of the salmon along British Columbia's coast is one of the largest migrations on the planet. For thousands of years it has provided food for bears, eagles, humans and the forest ecosystem. Salmon wait for the fresh water surges in the fall from the rivers to signal them to swim upstream to their spawning beds. The warming oceans can make them more susceptible to disease. The reduced flow in rivers can keep them circling near shore as they wait for the fresh water to flow into the ocean. Longer, dryer summers will delay the spawning process and low water levels upstream can spell disaster for an entire spawning year. For thousands of years the fall rains have come at a predictable time, but humans have changed that predictability in less than a hundred years. The salmon will have to adapt quickly if they are to survive. If they cannot, we lose more than just fish. The salmon feed thousands of animals during their return to Vancouver Island. Whales, seals, wolves, bears and eagles all depend on the regular return of the salmon. Sport fishing, commercial fishing, and tourism fishing will have to stop if stocks fall too far too fast. The carcasses of dead salmon fertilize the banks of their spawning rivers and help to build a robust and diverse habitat.

Bears are being impacted by warming temperatures as well. Bears "hibernate" when there is not sufficient food stock for them. But with warming temperatures, no snow packs, and perhaps no berries due to heat kill and no fish, the bears will remain active all year round in the southern island looking for food. If the bear and cougar populations dwindle, the deer population may explode. Bird and insect migrations are already being disrupted by the changing weather patterns. The subtle clues that signal to birds that it is time to migrate have been disrupted by climate change. Areas that were once too cold for summer habitat are now moving north. The birds are following the temperatures and the food. Animals that have never been seen in our far north, like beavers, are starting to inhabit areas further north than what has been historically known. Some tundra lakes have disappeared and some have grown in size as permafrost melts. This will throw bird populations off their traditional wintering areas. Local birds may choose not to migrate at all as warming conditions continue. Some animals will not adapt and will die off while others will flourish. Drying summers will encourage more reptiles like snakes and lizards to inhabit our area. Those that depend on lots of rain and moisture, however, will have a tougher time surviving.

Watching over our watersheds and creeks and streams and rivers will help us to monitor the overall health of our biodiversity on the south island. It will create a data base of information to predict changes to the natural water flows. Rain and precipitation are crucial to the health of our animals and our forests. Once again the quality and persistence of our lives is based on water.

Wells

There are more than one thousand wells in the CRD and Greater Victoria area. From Swartz Bay to Port Renfrew they supply thousands of homes with clean, potable water for drinking and farming. Most of the wells up the Saanich peninsula have been replaced with City piped water from Sooke Lake. This has allowed their aquifers to replenish over time. In areas without piped water, multiple wells cause a drawdown of water each time they are used. Since 2016 all domestic wells should be registered in the BC well data base which operates out of Front Counter BC with the nearest office in Nanaimo. Wells that are considered commercial wells, such as businesses, farms, stratas, river run, and bed and breakfast operations are required to be licenced. Domestic single house well registration is free and there are no charges for your ground water, whereas licensed wells will pay a user fee for the commercial use of ground water. The province and local districts use this registration data when developers want permits to build houses and drill a well for each house. If your district/municipality knows that you have a well in place they will consider the viability of granting any further building permits that may interfere with your well. If your well in not registered and no one knows about it, you may find that new subdivision wells have affected or dried out your existing well. There is no legal recourse if this happens – you are just out of water.

Once again, take a look at the BC Wells and Aquifer Map web site. It shows all of the known registered and licensed wells in the province. It gives you a very clear idea of how many British Columbians depend on wells for their water. As you drill down on the map to the south Vancouver Island area you will see exactly where the wells are located, lot by lot. Going further you can find the complete record of each well, drill date, depth, flow rate and more.

Each well has a static water level. This level is the point at which the water pressure pushing the water up the well is balanced by the air pressure weighing down on the water. Provincial monitoring wells measure the fluctuations in the static water level. As the aquifer dries out there is less water pressure and the level drops. When the aquifer is replenished from surface rains, the level goes up. Using domestic wells as monitoring wells makes it more difficult to see the long term changes, since every time you take water out of the well you will do so faster than the well fills up again. So this “drawdown” is a temporary and local change in a single well. Over time, however, it is still useful to measure domestic wells and “sort out” the daily drawdown to see the longer term data and thus to see the yearly fluctuations in the aquifer. The CRD and Front Counter BC both have a wealth of information on all topics related to wells on their websites.

My wife had a great analogy for the effect of climate change on aquifers and wells. She said, “Pretend that you like to have two cups of coffee at a leisurely breakfast. Your cup is like the aquifer. The rain that falls, symbolized by your coffee, comes in a shorter period of time because of climate change. So the coffee cup fills up with two cups of coffee at the same time. The second cup spills over the brim and is lost. You end up with one cup of coffee.” The same is true of wells and aquifers. We might get the same amount of rain per year, but we are getting it in shorter and shorter periods of time. Once the aquifer is full the rest of the rainfall is lost and cannot be retained by the aquifer. Then, over a long dry period that aquifer is not refilled. Building rain swales, or retention ponds, will capture that excess water and slow it down so that it is able to infiltrate slowly into the ground. It would be like putting a bowl under your coffee cup to catch the excess coffee, and now you can enjoy that second cup.

Rainwater harvesting is a growing industry in the south island and for those whose wells have gone dry, it is a necessity to catch that extra rainfall when they can.

Rainwater harvesting

Rain fall catchment tanks come in all sizes and can be placed close to gutters to catch the rain from your metal roof. Asphalt roofs are made with petroleum products and the water coming off such a roof is not drinkable, but could be used for watering your lawn or washing your car. Underground cisterns are usually made of cement and expensive compared to above ground storage. An average house with four occupants will use about 5000 gallons of water per year, if you are careful. Two 3000 gallon above ground tanks will cost you a total of about 7000 dollars for both tanks. These can fill quickly during the heavy rains that we expect to get in our shorter winter rain season. The excess rainfall can be diverted into landscaped ponds, swales, rain gardens or open air ditches. Really anywhere where the rain can be retained and allowed to infiltrate into your ground but not too much too close to a building with a basement in case the footings drains are overwhelmed. The land in the Sooke Industrial Park in Otter Point did not produce viable wells. Every business that occupies this area knows that there is no well water and that they will have to either catch their own rain, as the CRD office does, or pay for hauled water. Close to the Park is a house that was the first approved building permit without a drilled well that we know. It functions solely on rainwater catchment. This may open more land for development and housing as all previous permits require that the builder "prove" water sufficient for running the home. This means that a builder must buy the land, drill a well, and if the well finds water, then the building permit can go forward. Drilling a well and finding no water is an expensive way to find out that you cannot build on your property.

Rainfall catchment can be built into the house design. As with a well you would need piping into the building and filtering and a UV light system to ensure the purity of the water. The advantage of this system is that if your tank should run dry you can have it filled easily (but not necessarily cheaply depending on your location on the south island) with additional potable water. Using a traditional well, which may run dry at some point, you would have to then buy and install a tank and feed the water into your house and/or retrofit the rainwater system to your house.

A 3000 gallon tank taking rain from the metal roof of a small house or double garage will fill in one week of moderate rain. It can last from June to September to water lawns and gardens every other day for about 40 minutes per watering. If the infeed piping is installed to potable water standards so that if the well dries you have an easier and less expensive time of retrofitting the tank to the house water system. Many people have the black tanks standing in their yards, others have built framing around the tank to support trellises and espaliered fruit trees. I have even seen one with a "look out" area built above the tank.

Tanks can be filled by gravity or by a small pump in a small tank pushing the water up to the larger tank. They can also be emptied by gravity or by an in-tank pump which will give you regular garden hose pressure or more for all your watering needs. There is some upkeep on tanks such as emptying the filter(s), cleaning your gutters (metal gutter guards to keep out leaves and debris are a must have) and the inside of the tank should be cleaned out once a year for potable water. When it does need cleaning, ask around for advice from someone with experience or hire a professional. Never go down into the tank due to potential bad air issues.

All in all, rainwater catchment will become a common sight in new housing developments the value of water and its price continues to rise.

Development

Development in this area will continue and we have to think about the changes that climate change is making on the industry. Concerning water resources, we know that the CRD will not be building more piped in water past Sooke in the near future. The existing Kemp Lake water system was added to the CRD system recently and residents paid for the CRD line to service their area.They are paying a lot more for their water than Sooke residents as the cost of the line, which averages one million dollars per kilometer, plus the pipes needed to take it from the street to each house is being borne by the users. In Otter Point and areas north and west from there, the population is too small to make further extensions to the CRD system viable. So we have wells, stream water or rain harvesting or hauled water. New developments have to prove to CRD that a well is in place for each lot developed and that water flow on each well meets the minimum requirements for development, however if all the wells in a development are pulling water in the middle of the summer, there is no predicting of who loses water and who doesn't. Wells can be checked any time of year, so builders may tend to test their wells in the early spring when aquifers are at the peak amounts and then apply for building permits. Part of the permit process is to check for other wells in the area and determine if additional wells will affect the older wells. Of course if a well is not registered and a new building permit with a well is approved, the older well owner may find their water supply is severely reduced or emptied by newer registered wells. If this happens to you and your unregistered well, there is no legal recourse for you and you will end up having to find another way to get your water. Hauling water cost varies from 200 to 800 dollars a delivery depending on where you live. The local water hauling business in Sooke doubled its fleet of tanker trucks last year and plans to double it again in the coming year.

In nature only ten percent of rain ends up as runoff. Over a paved parking lot, seventy percent of the rain ends up as runoff and is lost to the ground water. Developments therefore should be required to use permeable pavers, grass, gravel or some other permeable medium. The sometimes huge and expensive infrastructure built into commercial areas to handle "waste water" can be drastically reduced by planning for rain water retention on site. Put the water into tanks for watering in the summer, install rain gardens and swales which can rapidly fill up and hold water for infiltration or put in a system where the captured water can be used in the building as non-potable water. Vegetation such as gardens and trees will cool the area and provide shade and fresh air. It is much more costly to retrofit rain systems than it is to plan them into the original build. True, the cost of the original build will go up, meaning less profit for the builder or a higher cost to the buyer. Developers will build to established codes and bylaws, therefore it is the responsibility of municipalities and districts to see the bigger picture of climate change and (if needed) force developers to put adaptations for climate change into their plans. One development in Otter Point met all current rules on water and wells, and yet by the time that all the homes were built the wells were drying up. As each new well came on line it starting taking the water from the neighbour's well. As one person described it, "You can only put so many straws in a milkshake before no one gets anything". Now almost all of that housing development relies on hauling water. Developers need to build for the future and consider the use of water at every step of the process. South facing metal roofs for rain water harvesting and solar panels is a good start.

Building codes

With the new challenges of climate change we are living through we must change our attitude to the first requirement of life – water.

Bylaws are one of the ways we can change behaviours but they are perceived as more of a "stick" than a "carrot" to most people. Still, strong bylaws, enforced over a period of time become the norm. Remember the introduction of seatbelts in cars? "Can't be done" "Nobody will use them". Today, nobody thinks twice about putting on a seat belt. It will be the same with building bylaws. Required building codes at the provincial level are often lagging behind the local requirements that residents support. Many BC municipalities are speeding ahead on their own and asking for standards above those currently in force. We have seen this with the provincial Step Code where one Council says "Step 3 by 2023" and another right beside it says "Step 5 by 2023" and the province says "Step 5 by 2027". The developers have said "Can't be done" "Nobody will use them" but it is being done where it is the requirement

It should not be seen as a surprise that building permits require adequate water. Having your roof be a metal roof increases the initial cost but a metal roof will last far longer that a shingled roof, longer in fact than the building it covers and it can be totally recycled if the building is torn down. A metal roof will not burn, it will not shed pollution into our shared environment every time it rains. It can support solar panels better than a shingled roof. It can be used to collect potable water year round. Having a south or southwest facing sloped metal roof should be a natural requirement for almost all buildings. The prevailing rains tend to come from the southwest and solar power collection is enhanced at the same time. Requirements for rain water collection should be added to all building codes and bylaws for new construction. Built into the design, and enforced by local bylaws, these water saving ideas will become the norm for "green" construction.

Those lucky enough to have water piped into their homes now face watering restrictions and often lower water pressure on a yearly basis. Letting your lawn go brown in the summer is the norm. But if your home was built with a rain collection tank (say 3000 gallons) you could keep your garden and lawn green all year and benefit the environment by letting that water soak in during the hot summers when the ground needs it the most. It cools the air, provides resistance to wild fire, provides moisture for insects and animals and recharges the aquifer under your feet.

Local government has to construct and maintain very expensive underground infrastructure to deal with "waste water". How many hundreds of thousands of tax dollars could be saved if we just decided to keep that water on the land for as long as possible instead of trying to flush it away as quickly as possible?

Conclusions

Over the last nine installments we have taken a cursory glance at the importance of water to our lives.

Between now and 2050 our experience with water will become more stressful as water increases its value to our community.

The Introduction: Started with snow falling outside and looked at the ever warming conditions on the south island.

It all starts with water: Sought to explain why water is such a fundamental part of life.

Watersheds: An introduction to the natural collection of rainfall.

Aquifers: An introduction to the hidden world of underground water.

Water cycle: How the world recycles its' water resources.

Fish and wildlife: The effect of water shortages on flora, fauna and fungi.

Wells: What threats are there for well users now and in the future?

Rainwater harvesting: Mitigating the changes that climate will make.

Development: If we build, how can we ensure water?

Building codes: Enforcing attitudinal changes for the good of all.

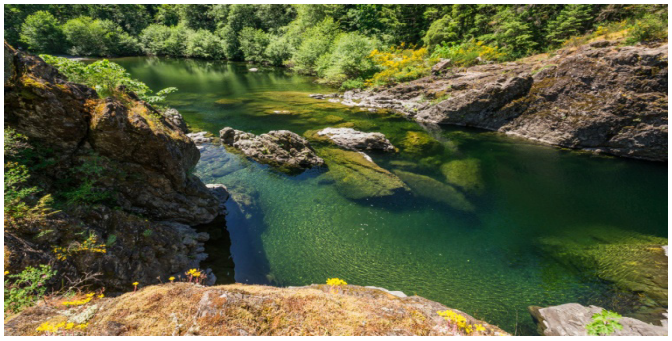
All of these topics feed back to the need to better use our water resources. I have sought to keep all the figures and statistics out of these articles. The global picture is more important and a change of understanding of our local area water is what I wish to accomplish. There are more intense and detailed arguments why we have to think about water. Food security comes to mind- how do we feed our community without locally grown produce? The southern island was built on subsistence farming. Growing your own food is a hedge on climbing prices and for that to happen we need water. Greywater pipe systems are in the building codes now and are intended to reuse water that has been used once already in a household context. Composting toilets are also in the building codes and offer a substantial savings in water use.

More stream watcher volunteers are needed to map the health of hundreds of small watersheds, creeks and streams on our west coast. Domestic well monitoring groups are needed to figure out the health – drawdown and refill and water quality – of wells on our several local aquifers.

Contact 606 Water Group on line if you wish more information or want to join our small group of interested residents. 606watergroup@gmail.com

There are seventeen watersheds which feed through the Sooke District. The flow of every one of them has been altered by the infrastructure of storm water drains. Many of these watersheds encompass land well outside of the District of Sooke and water infiltrates through the ground until it gets to a point where development dictates that this water should be diverted and flow through drains to the ocean. This is the way almost all urban areas deal with natural water flow. Some areas however are taking steps to return natural drainage areas to nature. In Saanich and Oak Bay, the Bowker Creek daylighting project has been running for more than ten years. Bowker Creek was put through a large culvert through most of its length from Mt. Tolmie to the ocean. It remains locked below Shelbourne St. but as soon as it emerges again residents have been re-establishing a natural water course. When I lived by Royal Jubilee Hospital we had a flood when Bowker Creek, funnelled by infrastructure into a narrow underpass into Oak Bay and it backed up and flooded the area houses. Since that time the creek has been opened up and allowed to flow at its own rate. The project boasts a small return of salmon to the creek, the first seen in decades.

As we build more homes and businesses in Sooke we must be careful not the make the mistake of overlooking the benefits of natural infiltration from our watersheds. Natural water in the soil increases the ability to resist fires and drought. Less piped water and well water need be used in watering the land. Whenever possible, planners need to let water remain on the land to fulfill its natural work of feeding the watershed and all of the flora and fauna that share our land.



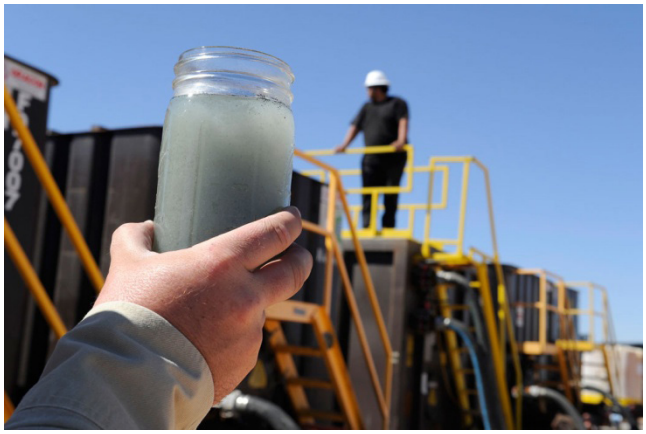
This article will discuss the use of drop pipes in wells.

A “drop pipe” is a pipe that is installed into a well which allows the owner to measure the static water level in the well and to monitor that level throughout the year. The Provincial Government of BC operates and monitors a system of observation wells throughout BC. In the Sooke area however there are only two observation wells. A shallow one going into the Sooke River 599 Aquifer and a deep one going in to the 606 Aquifer. Both wells are located on Phillips Road. The problem however is that these wells in no way give any information to well owners whose wells go into any of the other underground aquifers in Sooke. The 606 Aquifer is fractured basalt rock and a well only gets any water if it happens to be drilled through one of the small fractures in the rock.

For those with wells in Sooke and for most of those who live outside of the CRD piped water system there is no way to tell how your well is holding up through the summer unless you measure the height of the water yourself. The way to do this involves having a drop pipe installed into your well and using a water tape to drop down the well. The cost of retrofitting a pipe will vary depending on the depth of your well. I had mine done this winter (about 250 feet deep) and it cost us about $1200. The water tape cost us another $1200. One tape however can be used in any number of wells with disinfecting between wells. The District of Sooke and the Juan de Fuca District have the ability by bylaw to require that all new wells be drilled with the installation of a drop pipe. The cost, of course, will be passed on to the user of the well. But without the ability to measure the water level, neither the District nor the homeowner has any idea if there is sufficient water in the well to last through our warming summers. Peace of mind knowing that you have 100 feet of water in the pipe is priceless, and knowing that the water is running out will help you decide if you will have to buy hauled water and a cistern plumbed into your home if the well goes dry. One group, the 606 Water Group, advocates for the requirement of down pipes in new wells and for citizen local area well monitoring. Only one tape need be bought that the whole neighbourhood would share to measure the water in their wells. In this way homeowners and government will be kept informed about the status of wells and potential conservations measures that can be taken.

Here we are heading into another long hot summer. In the North East of BC there has been a level 4 or 5 drought all winter. The chief Hydrologist for the area has issued a warning that water will be in short supply this summer. Conservation may not be enough to allow fracking for natural gas to continue at full speed. What might be the possible outcomes if this were to come to pass? Fracking uses thousands of gallons of water, mixed with toxic chemicals and sand to force out natural gas from wells. That water cannot be reused by people, animals, or Agriculture as it poisons the well water and aquifers which it touches. Some of it can be recycled by the industry but not in the volumes they require. If water restrictions are imposed will they affect everyone equally? We can choose to reduce and conserve our use of water on an individual level. Fossil Fuels giants can also choose to reduce and conserve water in their production. That would likely lead to much higher cost for natural gas. Perhaps they would consider running the pipelines at a much reduced volume. At some point the profit levels would be reduced to the point that some companies might be shut down and the pipelines go dry. That would be extreme, yet at some point we know that the fossil fuel industry will get to that point once they have squeezed every drop they can from the earth. As they have in Alberta, an no doubt other jurisdictions, fossil fuel companies will walk away looking for better returns and leave an ecological disaster behind them.

If more rain is not forthcoming in this area of BC we should expect water restriction at a high level. People and towns can do their part but so should industry. It would be left to fossil fuel executives to decide either to cut their profits and reduce drilling or to allow clean water to used by people, animals and agriculture. What do you think they will do?



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We are sliding into the wettest part of the year here on southern Vancouver Island. Now is the time that our watersheds and aquifers recharge themselves with water. Recently we had short “atmospheric river” come through and give us 2 inches of rainfall. Sounds like a lot, right? How surprised we were to go out into the garden for winter cleanup after the rain and find that the moisture had only penetrated 3 to 4 inches into the soil. This brings to mind several thoughts. Two inches of rain is not nearly enough to make up for the lack of rainfall throughout the summer. It also shows us how much soil can absorb water. If two inches of rain can be absorbed in just four inches of soil then think of how much water in total can be absorbed into the soil. In fact the world’s soil is the largest reservoir of our water. It can hold eight times the volume of water as is contained in ALL the rivers on Earth.

Four inches of absorption would keep many plants alive, but many other plants and trees have root systems that spread downward many feet into the earth. They must wait for the moisture to be drawn downward through the soil before they get the full benefit of water to their roots. Last of all the aquifers must wait for that downward percolation to reach them before any recharge is realized. If two inch of rain soaks in four inches and two more inches of rain soaks down to eight inches the you can see that an aquifer that lays a hundred feet underground will have to wait a very long time to receive and store the rainfall. Aquifer recharge can take months or years to occur, some can take centuries.

The damage from continued low rainfall is occurring now, but we may not realise it for decades as underground water supply is reduced by the use of humans and is not being recharged by rainwater.

Even now, in the middle of our “wet” season it is important to continue to conserve our use of water and let the aquifers recharge.

For the past ten months we have been logging our well in Otter Point. To do that we had to have a "drop pipe" installed into the existing well. Then we had to buy a well tape with a sounder on the end which we have dropped down the well every Monday morning since February 2024. The well pipe installers asked "Why?". Our concern was that we have never known how close we are to running out of water. We did, briefly, run out of water late one summer after our neighbours invited seventeen relatives for a family weekend, followed by a series of showers on the day that that all left. For a brief period of time the drawdown on their well (which is deeper that ours and about 300 meters away) caused a drawdown in our well and the water stopped. A day later it was back, but the knowledge that it ran dry stays with you forever. We do not have unlimited water. This prompted our investment in the well logging tape.

This year 2024, we were extremely happy to see that the static water lever in the well was fairly stable. Static water level is the level of equilibrium between the air pressure pushing down and the water pressure pushing up in the well. That level dropped less than a meter over the course of the summer and edged up again when the rain came back in November.

The aquifer on which we sit is very good. The Muir creek aquifer is predominantly gravels which have lots of space within them and which recharge quickly when it rains. Also we are fortunate in that there are relatively few wells currently sunk into this shallow aquifer. Deeper drilled wells go into the 606 Aquifer which is a cracked basalt rock. It is a poor producer of water and recharges very slowly as the rain must first permeate through the overlying gravel and soil and then find fissures in the rock to seep through. This also makes this type of Aquifer very vulnerable to pollution. It will take a long time to seep through the cracks in the rocks but once it does you cannot get rid of the pollution in any meaningful way. You water is fowled and may not ever recover.

Next time we will talk about the other options you have to log your well.

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The District of Sooke and the CRD Juan de Fuca electoral region are both considering the impact of more housing in response to edicts from the Provincial Government. In the JdF EA this means 202 new homes in the next five years and more than 1200 new homes in the next twenty years.

When it comes to water there will be impacts on both the piped water CRD system and the domestic wells and aquifers where piped water is not available. It may not be possible to provide water for all of these new housing developments. More demand on piped water may reduce the water pressure during peak times. Greater demand is usually met with great charges for a scare commodity, and piped water users can expect greater metering and charges, perhaps "two tier" charges as we now get on our BC Hydro bills. But there is a way to avoid excessive water rates over the long term and reduce the demand on the CRD pipe water system at the same time. Municipalities and Districts have the option of requiring items within a building permit. For example, if new housing (in its many forms) were required to have metal roofing and rainwater harvesting systems then the major expense of water consumption in the summer months would be greatly reduced for the home owner.

When I look at the asphalt roofing on many houses in Sooke, I wonder why such a roofing material is being used in our climate. It is not ideal. You spend money to put the roof on and then spend money for the next twenty years spraying it with toxic herbicides to stop moss from growing on it. You spend time and money cleaning the washed-off grit, oils and glues out of your eavestroughs every year. You cannot use the water that comes off your roof because it contains petrochemicals and glues, and those chemicals from thousands of roofs are washed into the ocean every year.

A metal roof will cost twice to three times as much as an asphalt roof, but the long term benefits are many. There is no chemical leaching from metal, they are "slick" surfaced and clean themselves, they will last for the life of the house, say seventy years, without having to be replaced. Reroofing your house once with another shingle roof will be the same total cost as the initial cost of a metal roof.

From a metal roof you can collect rainwater and use it for whatever you need outside your home and the "cost" of that water is zero once you have the tank(s) and piping– rainwater is free.

Oh, and did I mention one big advantage? Metal roofs are fireproof.

All it would take is a change to building permits to provide a way to build houses with a reliable source of free water, and reduce the maintenance cost on your roof for the life of your home. It would also lessen the overland water during heavy rain events as well as provide a source of water during droughts. Maybe we should be asking why such obvious benefits are not being required.

18

In our temperate climate it is not unusual to see clouds in the trees. Many times these clouds do not appear to be part of any other weather system. They seem to appear spontaneously in the forested areas of our region. They are the result of the transpiration of trees pushing water vapour into the air which then condenses into clouds. But there is more going on than just a simple mini "water cycle". The complexities of cloud formation in forests globally has only recently been studied using years of data from satellites. In 2021 the Journal Nature Communications (1) published an extensive review of cloud formation in forests and their effect on global climate.

"Forests play a key role in humanity's current challenge to mitigate climate change thanks to their capacity to sequester carbon. Preserving and expanding forest cover is considered essential to enhance this carbon sink. However, changing the forest cover can further affect the climate system through biophysical effects. One such effect that is seldom studied is how afforestation can alter the cloud regime, which can potentially have repercussions on the hydrological cycle, the surface radiation budget and on planetary albedo itself. Here we provide a global scale assessment of this effect derived from satellite remote sensing observations. We show that for 67% of sampled areas across the world, afforestation would increase low level cloud cover, which should have a cooling effect on the planet. We further reveal a dependency of this effect on forest type, notably in Europe where needleleaf forests generate more clouds than broadleaf forests."

Low level forest clouds reflect the sun's energy, thereby lowering temperature. The clouds retain moisture and return it to the forested area. In non-forested areas the moisture is drawn directly upwards and if there is enough moisture this can form higher level clouds. However, high level clouds like cumulus and thunderclouds usually dissipate as soon as the sun's warmth fades. They can flatten and form a layer of status cloud that traps heat and reflects it down to the ground and increases night time temperatures.

"The fact that Earth's vegetation cover can affect rainfall has been known for a long time. The Amazon forest generates about half of its own rainfall by recycling moisture lost through evaporation."

During the B.C. heat dome of 2021 the Island town of Tofino nearly ran out of water. The Mayor explained that it was only through the existence of trees on Muir's Island (because they had been saved from logging) that captured wet moist air and fog blowing in from the ocean every day and dropped it to the ground and into the Tofino water catchment system, that the town avoided a total shutdown of its water system.

We must be aware of the changes we make when we reduce or level the forest around us. If we upset the balance we will find ourselves in a hotter dryer climate, with a loss of bio-diversity, and drought very quickly.

1 *Duveiller, Filipponi, Ceglar, Bojanowski, Alkama, Cescatti, Alessandro. 2021 Revealing the widespread potential of forests to increase low level cloud cover. Nature Communications*

When we had our rain water harvest tank of 3000 gallons installed we dug a small area to receive the excess water once the tank was full. The first year it happily flooded the small field downhill. The next spring we had a swale dug to hold up to 6000 gallons of runoff from the roof. Since that time the rainwater fills the swale each winter and slowly allows the water to seep into the surrounding land, forests and aquifer underneath. This water supply lasts until the rainfall reduces in the Spring.

This year on January 20th, I noticed that the pond is now half empty, waiting for new rains to fall. If they do, great, if not we might be heading for another dry summer earlier than we thought. Fortunately we had good rainfall late last year which filled up the Sooke Lake reservoir to 94.9 % to date. This is just about at the minimum amount required by the CRD water system to supply all the water they need to meet local demand for the year. You can watch the water levels at Sooke Lake online simply by typing Sooke Lake water level, in your browser. https://www.crd.bc.ca/docs/default-source/water-pdf/sooke-reservoir/storage-summary.pdf?sfvrsn=bd2991c9_960 The site offers a weekly update and yearly summaries which clearly show the annual charge and discharge of water volumes from the dam. So 2025 looks like it will fall within the normal parameters for water storage. The next site you might want to look at is the BC Drought Information Portal. This site will give you the current conditions in areas of BC and a useful chart to compare regions. https://droughtportal.gov.bc.ca/

This is very useful site to explore. Here you will find links to BC stream flow maps, Precipitation Conditions Map, Groundwater Conditions Map, 30-day Low Streamflow Forecast, Snow Basin Indicies Map, and a really interesting national Map at the Canadian Drought Monitor website.

The BC site also contains Angling Closure Information Bulletins, Temporary Protection Orders, BC Energy Regulator Directives, and Local Water Restrictions.

On National site, the Canadian Drought Monitor, you will find monthly drought conditions across Canada (Jan 2025 there is an extreme drought in Northern Canada for example) as well as historical data and drought forecasts. It contains links to the US Drought Monitor, the North American Drought and the Mexican Drought monitors.

The Groundwater maps on the BC Drought Information Portal are based on Provincial observation wells, and Sooke has two at the top of Phillips Road into Aquifer 599, which is the Sooke River shallow aquifer, and into Aquifer 606, the deep aquifer, and the map shows that in Jan. 2025 that we are below normal in the level of groundwater we should have for this time of year. The Precipitation maps for our area show a disturbing trend this year. Most Vancouver Island rainfall is substantially less than the medium level for this time of year.

From DEC 25 to JAN 23 (2025) Victoria had 70 mm less rain that normal. Port Alberni had 159mm less than normal. Sooke will fall somewhere between those two values. It all currently indicates a dry winter, the lack of rainfall, the lower than water groundwater levels and even my small swale is half empty in the middle of January. These are continuing reasons to remember to conserve water year round and to never take it for granted that the recharge of water, whether in the ground, our wells, our reservoir will occur over the winter months.

20

Here is our word for the day "sublimation". This is defined as the conversion between the solid and the gaseous phases of matter, with no intermediate liquid stage. The opposite of sublimation is "deposition", where water vapor changes directly into ice—such a snowflakes and frost. As I look out on my deck I notice that the snow on the glass table is decreasing but there is no water on the table. The snow is evaporating more or less directly into the air. Tim Smedley in his book "*The Last Drop – Solving the World's Water Crisis"* mentions this process in reference to the mountains of the Cascadia Range in the western United States. So, not only are snow packs declining, but also they are evaporating at a greater rate.

Climate change is altering the way snow enters the water cycle. Less melt water will lead to dry streambeds earlier in the year. Less water will enter the "interflow" level under the ground. The interflow water soaks down to an impermeable layer and starts to fill the spaces underground. At some point it will "level off" into what we call the water table, that point where we find water if we dig far enough into the soil. If you use a domestic well system you know exactly where the water table is in reference to your water pump down the well. If you measure or "log" your well you can easily guess if your water is going to run out as the water table around the well drops down over the summer. You become very aware of your water use when you log your well and start to see the water table dropping.

You cannot fill a well up with hauled water. It simply disperses into the ground. If your well goes dry you must find another way to bring water to your home. For an increasing number of people in the Sooke, East Sooke, Otter Point, Shirley and Jordan River areas, this usually means buying water or having it hauled to your house from Sooke. To use it, however, is a different story. Some people will haul their own water and use it directly from their small pickup truck tanks. Others have opted to install a large cistern tank and have it professional plumbed into their homes. Both can be expensive propositions, especially if they are used to "free" water from their wells.

Rainwater is in abundance during our winter months, even if the rain comes down in shorter but heavier periods. If you can harvest that rain into a large cistern plumbed into your house water system with the same filtration and UV light that you would use for a well water system, then you have a free supply of water to get you through the summer. Well, not free if you include the costs of the tank, plumbing and permits to make it all happen. However, as the cost of buying and hauling water will only increase over time, the cost of such a system will pay for itself. If building codes required rainwater harvesting, every house could possibly be self-sufficient in water and not have to have drilled wells or expensive hauled water to last through the year.

21

We have always marvelled at the return of the Pacific Salmon to the rivers on Vancouver Island. Both Indigenous and Settler communities have made use of this great natural resource. It is one of the biggest annual migrations on the planet and it occurs all up and down the west coast of North America.

Often we hear of the salmon in the Sooke basin waiting for the right amount of fresh water and temperature to begin the journey up the Sooke River to spawn. Is it my imagination that the fish have had to wait longer and longer for the right conditions to occur? Is there something else happening due to climate change that is changing their behavior?

I listened to a webinar recently from the UVIC research group POLIS (A Greek word meaning Community). One of the researchers gave a detailed review of his ongoing Doctoral work on the health of BC salmon stocks based on the availability of water resources in the province. Salmon like cold water for example and in one study he found that in a lake with two water sources, watershed runoff on one side and glacial run off on the other, fish would choose the cooler side of the lake. Which is fine except we are losing all of our glaciers due to a warming climate and the reduction in cool clean water will affect the health of the fish stock. In general, he found that salmon migrations and river returns are moving northward up the BC coast.

The boom and bust rainfall cycles we have seen in the past few years are now expected to continue and intensify as climate change runs out of control. Rain, perhaps more than average amounts, in the winter followed by longer dry periods in the summer. Eventually we may have only two seasons, wet and dry.

The last set of data that the scientist from UVIC presented was on stream flows on Southern Vancouver Island to the year 2100. He extrapolated his data to four endpoints based on the estimated increase in global temperature from 1.5 degrees Celsius to about 4.5 degrees Celsius. He noted that the most recent data collected was showing that we were already moving toward the most extreme end of the model. By the year 2100 he said it was most likely that all the streams on Southern Vancouver Island will be dry for the summer period. This would make it impossible for the fry salmon and riparian life dependent on the stream to survive. It would require waiting until late early November for the rivers to receive the winter rainfall – enough to enable spawning to take place. Salmon will have to adapt to the new cycle, and if they cannot, salmon stocks will likely collapse. Already the CRD provides the Sooke River with additional water to aid the salmon to return. We don't know if that will be enough in the future to maintain the spawn and bring the salmon up river.

The shock of this information is even greater when he told us that a 1.5 degrees Celsius rise by 2100 will result in dry creeks and streams and what rivers are left will have drastically reduced water flow. At the most extreme level of temperature rise he estimated that these conditions will occur by 2075 or earlier. The child born this year will only be 50 years old when this future becomes a reality.

Water really is Life – Chris Moss

22

Understanding the way water moves through the ground is the topic of this article. We will investigate the meaning of "porosity" and "permeability".

To try to explain these terms I turn to an old but trusted book called *"Landscape Processes, An Introduction to Geomorphology"* by Darrel and Valerie Weyman (1977). Going back to your understanding of the water cycle – water goes up, condenses, and comes down. What it lands on when it comes down is vital to a watershed. If it lands on vegetation it will be intercepted and some of it will then evaporate back to the atmosphere. Some rain however will drip down into the vegetation and some will trickle down further to the surface of the soil. Soils vary greatly, leaves, roots, rocks, humus, sand, but within these soils are empty spaces which the rainwater will occupy. This process is called "infiltration" and the rate of infiltration is determined by the size and shape of the spaces and the amount of water already in those spaces.

So here is your first definition – The total volume of air spaces in a soil is the soil "porosity". Generally speaking, the porosity increases as the average size of articles in the soil decreases. This occurs because of the way in which smaller particles pack themselves together to create a larger number of spaces for water to occupy. One way to understand this idea is to use a filter paper in a funnel. Fill the funnel with small gravel and pour 10 ml (tablespoon) of water through it and into a cup. Virtually all of the water will stream through the gravel. Then replace the gravel with sand (much smaller particles and a different packing between the grains), again pour the same amount of water through the sand and see what happens. The water you poured onto the sand might not even make it through to the other side. It has been stopped by the much higher porosity (empty air spaces) of the sand and retained.

The reason is that water infiltration depends less on the total amount of porosity than on the size of the air spaces because water is attracted to the smaller particles and moves more slowly. Here comes the second definition – The rate at which water moves through the air spaces in the soil is called the "permeability" of the soil. The permeability increases therefore as the porosity decreases. The larger gravel (large air spaces) in our experiment would therefore have a high level of permeability (water moves quickly through) but it has a low porosity (little water is retained in the gravel). Conversely the sand (many small spaces) in our experiment did not let water drain through as quickly so it has a lower level of permeability while at the same time it retained a lot of water so it has a high porosity.

Our water is pulled by gravity through the soil and deeper and deeper into the ground. As the weight of the overlying ground compacts the soils under it, the soils become less permeable to the water. Water may be deflected horizontally and start an "interflow" along the top of this non-permeable layer of ground. Water may also stop at this non-permeable layer and completely fill up all the spaces. As more water is pulled down the level of the filled spaces will push upward filling the spaces above it. Now the ground has become "saturated" with water filling all available voids. The part of the rock which has become saturated is now called the "ground-water zone" and the upper surface of the ground-water zone is called the water table. Above the water table the rock is unsaturated and water can still percolate through until it reaches the saturated rock.

Drilling a well means that you must drill until you have entered the saturated rock below the water table. It is important to know what type of aquifer you are drilling into for your well. A gravel aquifer on top of a less permeable layer will fill up with rainwater quickly and provide a lot of water, however, as you now know gravel is highly permeable and that captured water can rapidly drain away from your well. It will all depend at what depth your water table is situated and on the stability of that level over time.

23

Last time we talked about the meaning of the terms “porosity” and “permeability”. As you’ll remember, porosity is the total volume of spaces in a substance like soil and rock. It is how much water can be stored. While permeability is the rate at which water can move through a substance like soil and rock.

When you are building a road bed you will notice that a large amount of time is spent dumping and grading vast amounts of gravel. The same is true of building requirements.The outside walls of buildings are filled with gravel. Now you know why. Gravel has low porosity and high permeability thus it drains water away from the building walls faster than other materials. Outside underground drains and weeping drains are required to set into a bed of gravel to ensure proper drainage. You don’t want your drains to be sitting in a saturated location. With road construction you want your road to be solid and firm but also non-saturated from surrounding water sources. If a stream crosses your path you would direct it into a culvert under the road to separate the water from your road bed. We know that when the water table rises even gravel can become saturated with water if it has no way to drain out. So you will frequently see drainage ports on the sides of roads to do just that. If the water cannot escape and the ground becomes saturated then you have a significant risk of underground collapse. The gravel roadbed can suddenly wash away from under the paved surface and leave it hanging in mid-air.

Our changing rainfall patterns due in part to global climate change challenge the methods of construction of roadways. Culverts that met codes years ago may no longer be sufficient to drain through the sudden large downpours of rain that we are seeing more frequently. When the drain becomes overwhelmed with runoff and cannot separate the water from the roadbed the water will back up and saturate the ground on either side of the culvert. Sometimes you will see a culvert where the gravel has washed out around the sides and once this happens the culvert piping is in danger of breaking or collapsing. Once the water has filled all of the space in the gravel you have a perfect case for a slide of rock and gravel from underneath the paved road, washing out on the downstream side. Radio reports after a heavy rain support this when they talk about the number of slides and washouts on a highway route. Road builders are trying to decrease this event. But larger culverts are expensive and not the only way to handle this type of event.

Next time you driving on Highway 14 take look at the sidings of the newest roadways. We know from our other discussions that an open stream bed can expand the volume of water it carries much more than an enclosed pipe. We know that gravel or similar substrate with a high permeability will effectively drain away water. Therefore, an open stream bed can drain away water much faster when a ”gully washer” incident occurs. On the side of the road look for open “stream beds” of large rocks and gravel being utilised to keep water from pooling up and saturating the road bed. The high permeability of these gravel stream beds will keep the water away from the road.