The Yellow Quill Story: Part 1, The Boil Water Advisory Years

This is the second installment on a series of safe drinking water articles in the Tribune. Dr. Peterson, a scientist, is one of the founders of the Safe Drinking Water Foundation.

By Dr. Hans Peterson

My Introduction to Yellow Quill

In 1999 everybody knew that Yellow Quill First Nation had bad tap water. Actually, bad, was an understatement. They say that truth is oftentimes stranger than fiction and the water was so bad it was hard to believe how bad it was. The first time I heard about Yellow Quill was in the spring of 1999. A rookie environmental health officer working for Saskatoon Tribal Council, Carla Plotnikoff, had tracked me down and wanted to tell me about Yellow Quill. I listened.

"Yellow Quill is a community 260 kilometers northeast of Saskatoon and I fear for the health of its community members because the tap water is so bad," Carla said at the time. Carla went on to describe conditions that I had only associated with developing countries.

I was skeptical. I had been instrumental in forming the Safe Drinking Water Foundation (SDWF) (www.safewater.org) two years earlier and we had an international board of directors with drinking water interests in developing countries, in such far-flung locations that they included Southeast Asia and Mongolia. I, myself, had toured rural China and Thailand looking for drinking water issues that needed correcting. But Canada? I must admit I knew nothing about First Nations communities or issues. But, how bad could it be?

My plate was already overflowing so I told Carla maybe later in the summer or fall. Carla was not the kind of person who took "no" for an answer and pleaded with any water scientist she could find hoping that they would help her with Yellow Quill's plight. No one could. So, she came back to me time and time again. Being the Executive Director of the SDWF I started to feel some guilt for not helping Carla.

I also realized that this would be a weekly event, Carla phoning or knocking on my door, so I decided to go with her to Yellow Quill and check out what was happening. We drove to Yellow Quill on the morning of June 19, 1999, and we arrived at the Yellow Quill Band office just before noon. The water operator and band councillors were in a meeting. We ate our sandwiches in the car and then one by one people emerged from the band office.

We talked to the three band councillors who demanded an end to the by then 4-year boil water advisory. The councillors were: Verna Cachene, Leonard Pasanipiness and Gilbert Kewistep.

We followed the water operator, the late Robert Neapetung, and the engineering company representatives down to the water treatment plant. Robert explained that it was necessary to open the door of the water treatment plant and wait 5 to 10 minutes before going inside as the smell was so bad. The smell was hydrogen sulphide, which smells like rotten eggs. When Robert thought it was okay to go into the plant it still smelled bad.

Carla Plotnikoff in 2015.

The late Robert Neapetung was the water treatment plant operator at Yellow Quill First Nation in 1999.

Carla and I got the tour of the water treatment plant. It was small. Hydrogen sulphide is a poisonous gas and it reacts with metal parts forming metal sulphides which are black in colour. The control system for the plant (it is called a PLC or a Programmable Logic Controller) had not worked properly for years. Robert explained how he operated the plant without the PLC working. He used an electrical wire with bare ends; he short-circuited the PLC by placing one end in one area and the other end in another area of the faulty PLC. This way he was able to backwash the filter and also run the filter. Sparks were flying but nobody got electrocuted.

A closer look at the chemicals that Robert used immediately made me very concerned. The first chemical added to the water was Elimin-ox. This is a chemical that Nalco Chemicals sells to remove oxygen from the water in *boiler plants*. It contains a chemical that is a known carcinogen. The next day I phoned Nalco in Ontario and they were petrified to learn that this chemical was used in a water treatment plant. After I found this out I phoned Carla to tell the operator to immediately stop using the chemical. She did. The only explanation for using this product at Yellow Quill that I can think of is that somewhere between the band office and Nalco communication was faulty.

We then took a sample of the raw water coming into the water treatment plant. Not only did it look unbelievably bad, it reeked of rotten eggs and algae. That same evening I filled a bottle with water straight out of the South Saskatchewan River by Saskatoon. Both bottles are in the photo shown in column 4. Yellow Quill's raw water (left) and Saskatoon's raw water (right).

Now, which one would you like to treat if you were Yellow Quill's water treatment plant operator?

Saskatoon's Water Versus Yellow Quill's

The City of Saskatoon uses a long string of processes lasting about 2 hours to complete. At Yellow Quill the water treatment process took about 5 minutes and in that time Robert was expected to produce safe drinking water from a water source that was more than 10 times poorer than the City of Saskatoon's. To accomplish this Robert needed to be a magician, not a water treatment plant operator.

Saskatoon's distributed water contains, on average, 25 particles per mL. Yellow Quill had distributed water that sometimes had more than *40,000 particles* per mL. Put another way, if you drank a glass of Yellow Quill tap water you would ingest several million particles per glass! The particles would be made up of dead algae, bacteria, protozoa, and viruses. Not a pleasant thought. But, if this did not deter you from drinking Yellow Quill tap water, the strong smell of chlorine and dead organisms likely would.

If we want to put another perspective on the enormity of Yellow Quill's challenges then we can compare average particle levels in Yellow Quill's drinking water with that of Saskatoon's drinking water. This means that Yellow Quill was at times distributing *1,600 times more particles* than Saskatoon! Then, consider this: Yellow Quill got its water from Pipestone Creek, a small creek that only flowed for a week or two in the spring, and an upstream community discharged its sewage lagoons into this creek at the same time Yellow Quill filled its reservoir with this water whereas Saskatoon's raw water is pumped from a fast flowing river, the South Saskatchewan River, which originates in the Rocky Mountains. What would you have done if you were Yellow Quill's water treatment plant operator? Quit?

Yellow Quill's Water Woes

When I first came to Yellow Quill in June 1999 Yellow Quill had been on a boil water advisory for 4 years. In total it lasted 9 years. But consider my description of Yellow Quill's raw water and the low level of treatment. Does this not raise another question? Are there limits for how poor the quality of a water can be before a boil water advisory should actually be changed to a Do Not Consume order? Boiling the water will kill microorganisms, but many contaminants would not be altered much. While boiling will kill microorganisms their remains will still be in the water. So you go from drinking living to drinking dead organisms. Apparently, officialdom tolerated the abysmal quality of Yellow Quill's water problem but it may have been because the story did not get out into the media and become an issue. That came later. And this was Canada? My life took an abrupt turn as I walked out of Yellow Quill's water treatment plant that June day in 1999.

I volunteered for Yellow Quill for the next three years. Four elderly community members filed a class action law suit against the federal government. Yellow Quill's plight was discussed in the House of Commons. It was covered by national media. An engineering company suggested six different water treatment processes for Yellow Quill. However, after Yellow Quill demanded that both current and future Guidelines for Canadian Drinking Water Quality had to be met the senior engineer on the project removed all six processes. His comment: "None of the suggested water treatment processes can meet the Canadian Guidelines." Yet, several of these processes are still in use in communities that have not been made aware of the real challenges in drinking water. Indeed, new water treatment plants are constructed using these same, unsound processes.

Searching for Water Quality

A First Nation now *has to demand* that its new/retrofitted water treatment plant will meet the Guidelines for Canadian Drinking Water Quality. There is no federal legislation requiring distributed water in First Nations communities to meet any guidelines. But, surely, if the federal government is underwriting the construction of a new water treatment plant ought it not meet the full complement of the Guidelines for Canadian Drinking Water Quality? If that were true wouldn't most articles about drinking water in First Nations communities tell positive rather than negative stories? Indeed, what could be more positive than providing communities with safe drinking water?

Ask anybody anywhere and they believe that if the federal government pays for the construction of a water treatment plant in a First Nation community that it will meet the full complement of the Guidelines for Canadian Drinking Water Quality. Unfortunately, perception is not reality.

By not implementing the full complement of Guidelines for Canadian Drinking Water Quality, First Nation communities are left vulnerable to poor quality tap water. Most cities in Canada, in addition to meeting these guidelines, also aim to meet the more stringent US Environmental Protection Agency regulations. And, cities treat much better quality raw water sources. But, 16 years ago the technologies required to treat Yellow Quill's poor quality raw water source had not been developed yet.

Yellow Quill's Desire to Have Safe Drinking Water in Every Home

Community members talked about safe drinking water in every home throughout the Yellow Quill community. My involvement with Yellow Quill was met with support everywhere, Chief and Council as well as community members. One of Yellow Quill's then councillors, Verna Cachene, put it like this: "At Yellow Quill we prayed for somebody to help us in our plight. When Dr. Hans moved to our community to try to sort out the water problems we knew our prayers had been answered."

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June 19, 1999 Dr. Peterson took a water sample from the South Saskatchewan River near Saskatoon, which originates in the Rocky Mountains. It is the raw water source for the City of Saskatoon. He also took a water sample from the raw water coming into the Yellow Quill water treatment plant at that time.

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This is when I started to wonder, what does safe drinking water mean? Does it mean meeting the Guidelines for Canadian Drinking Water Quality? Does it mean meeting US Environmental Protection Agency Regulations? Does it mean meeting European Drinking Water Quality Regulations? Or, does it mean meeting World Health Organization's guidelines? The US National Research Council stated that if you treat poor quality water sources you need to do better than just meeting regulations. So, what did that mean? Safe drinking water to me started to mean *meeting all global regulations/guidelines and then to take several additional steps to make sure that the treated tap water is truly safe to drink.* This is what the US National Research Council recommended and it became my Holy Grail. It wasn't going to be easy to realize my dream. I will write more about this in my follow-up articles.

The Technical Aspects of Water Treatment

Looking closer at the Yellow Quill problem and the very poor quality distributed water, I started to wonder what the best way to address the issues was. I am a scientist and the first thing a scientist would do is to better define the problem. So we carried out sampling and testing to get a clearer picture of the magnitude of the problem. Yellow Quill did not have coliforms or E. coli in its distributed water, and that was a good thing because even the general public knows E. coli can to be dangerous. The reason for these coliforms to be absent is simply that they are easy to kill with chlorine. But, what about organisms that are not so easy to kill with chlorine? Like *Campylobacter*? Campylobacteriosis is a reportable illness and, unfortunately, we found *Campylobacter* in Yellow Quill's distributed water. We determined many other issues, but how do you convey these types of problems to community members?

This is when I realized that unless we were able to communicate with community members what the issues in their water were they would be more likely to accept unsafe drinking water. But, if they knew, why would even one community member accept unsafe drinking water – drinking water that at the very least could not meet Guidelines for Canadian Drinking Water Quality?

And why would any community want to hire an engineering company that doesn't require that a manufacturer post a performance bond stating that their water treatment process will meet the full complement of the Guidelines for Canadian Drinking Water Quality? Why does the federal government not make it *a condition for providing the funding* that engineering companies and manufacturers will produce water that meets Canadian Guidelines to protect First Nations communities?

I think the answer to this is that the First Nation feels overwhelmed. The federal government has an engineer at the Project Management Team (PMT) table. The engineering company has an engineer at the PMT table. Then there is the project manager. All are professionally-educated, and sometimes when a province has a representative there, he/she will also be an engineer. The First Nation will be concerned that they may not be understanding the issues fully and seek advice from the "technical expertise" at the table. After all, surely this technical expertise would not lead a community astray, would they?

Prodding further at Yellow Quill, this is what I learned: Conventional water treatment processes add one or several chemicals to the raw water and then this (these) chemical(s) react with the raw water and the water is then filtered through a granular filter. This typically works well on *high quality* raw water sources. But, what if they are *extremely poor* quality water sources like at Yellow Quill in 1999?

Chorine in Drinking Water Treatment

To kill micro-organisms a water operator uses chlorine. There are two common indicators for the presence of disease-causing organisms: total coliforms and E. coli. Testing for these coliforms is useful in water that has not been chlorinated, but is of less value in chlorinated water as coliforms die long before many other disease-causing organisms have vanished. But, testing for them is easy. After an operator adds chlorine (free chlorine) to the water he/she then measures how much chlorine is left before the water is distributed to the community. Chlorine will not only kill organisms, but it also reacts with many compounds dissolved in the water. When the *free chlorine* reacts with these compounds it forms *combined chlorine*, which together with the free chlorine, add up to *total chlorine*. When free and total is the same there is no combined chlorine in the water. No combined chlorine in the water is ideal. Few water treatment processes can achieve this although this is standard for the Integrated Biological Reverse Osmosis Membrane (IBROM) process. IBROM is what many consider Best Available Technology (BAT) or the Gold Standard in water treatment.

Water Quality Testing

Health Canada routinely assesses whether a drinking water is OK from coliforms and E. coli, as well as free and total chlorine. Health Canada requires a minimum level of 0.2 mg/L of free chlorine, but has set no maximum levels for either free or total chlorine. Total coliforms and E. coli are but 2 out of the 77 health parameters in the Canadian Guidelines. Is this enough? Are those tests telling us enough about the quality of tap water in a community? After the Walkerton waterborne disease outbreak in May 2000, Health Canada epidemiologists flew me down to Guelph and I spent a day talking to them about waterborne diseases. When I gave them a general overview there were about 30 people attending (some from universities). I asked the question: "Can any of you determine if a tap water is safe by testing for E. coli, coliforms, total and free chlorine?" Nobody raised their hands. If you asked a water manager for a city he/she would laugh at you. It cannot be done. We need to improve on this. Lately Health Canada has added Trihalomethanes (THMs) to the list, but what about some others?

What about ammonium? This compound is not even in the Canadian 77 health or 15 aesthetic guidelines, but its presence will determine if a water can be properly disinfected or not. Would a dialogue be necessary to determine what the minimum testing for distributed drinking water in First Nations communities ought to be? We know cities aim to comply with Guidelines for Canadian Drinking Water Quality plus US Environmental Protection Agency Regulations for distributed drinking water. We know that many First Nations have compromised water sources. The US National Research Council says that we need to do more, not less, than cities. I understand that for routine testing we may need a simpler approach than cities. Below I outline some simple measures that all water treatment plant operators can take.

Conventional Treatment of Poor Quality Raw Water

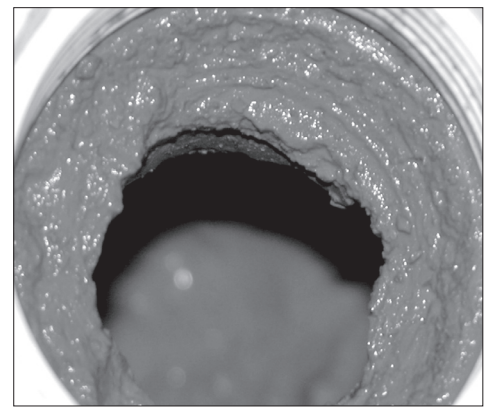
Here is what happens when you try to use conventional water treatment processes on poor quality raw water: The chemicals react with some of the compounds in the raw water and the granular filters also remove some of the contaminants, but not all. How much is left behind? Can we test for this? Yes, and it costs virtually nothing and it is very effective. I will use Yellow Quill as an example to explain how.

The water is treated and then chlorinated. The water then flows into a treated water reservoir from where it is pumped out into the distribution system and to your taps. What happens if only *some* of the contaminants are removed from the raw water? The contaminants will remain in the water. They can settle to the bottom of the treated water reservoir or they can remain suspended in the water. If they are suspended in the water you will have them in your tap water. If they settle to the bottom you will, at times of high water demand and low reservoir levels, also have them in your tap water as the settled material is stirred up.

This is the fate of particles such as when you mix tea leaves with finely ground coffee. Nobody does that, but this is only an example. Pouring hot water on your coffee/tea mix will generate a reddish (tea)/black (coffee) water. This beverage is composed of both particles (coffee grounds and tea leaves), as well as compounds that are dissolved giving the water its colour. We use this mix of tea leaves, coffee grounds, and dissolved compounds that give our concoction its colour as an example. In the same way we have leftover particles from the treatment as well as dissolved compounds slipping by the treatment. During high demand *settled particles* are stirred up and can reach your tap. The dissolved compounds don't need high flows to get to your tap, you get them at any flow rate. The particles and the dissolved compounds can generate many problems in the treated water reservoirs and the distribution system. Undesired problems include the growth of bacteria.

Food for Bacteria in Water: Where does it go?

Any raw water source is composed of a literal "smorgasboard" of food for bacteria. This "food" is mainly dissolved in the water (in our example above the reddish/black water we get from tea leaves and coffee grounds). After conventional treatment bacterial growth from these compounds will cover the treated water reservoir walls and the inside of pipes in the distribution system all the way to your tap. Bacterial growth happens whenever there is food for bacteria in the water. An example of this is shown in the image above. When bacteria grow on a *surface* rather than suspended in the water it is called a "biofilm." As conventional treatment systems cannot remove bacterial food sources in the treatment process, these compounds end up in the treated water reservoir and the distribution system. This results in biofilm growth and is part of the generation of "ooze" on treated water reservoir bottoms.



The photo shows an extreme example of biofilm bacteria growth, which will happen in conventional water treatment plants, such as Yellow Quill's in 1999. There is no biofilm in IBROM water plants once the water is treated.

The IBROM process relies on biofilm growth of water-purifying bacteria in its biofilters. That is why it has "Biological" in its name. During the IBROM water treatment process all food and nutrient sources for bacteria are removed in these filters and no bacterial growth will occur in the Reverse Osmosis (RO) membranes, the treated water reservoirs, or the distribution system and they will remain squeaky clean. In contrast to biofilm bacteria, bacteria growing in the water are called "planktonic bacteria" and Health Canada used to have a guideline for them. They called it Heterotrophic Plate Count or HPC. Up to 500 HPC was allowed per mL of treated water. The IBROM process produces water that has *less than 2 HPC per mL*. This is the detection limit.

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Yellow Quill's Treated Drinking Water Reservoirs

There is no data for the amount of bacterial food and other contaminants that end up in the treated water reservoirs in First Nations communities so to describe the 1999 Yellow Quill situation is important. The contaminants that have flowed into the treated water reservoir continue to change and we can view the treated water reservoirs and the distribution system as a second treatment system. When you have water with a lot of leftovers, biological and chemical processes continue to operate *after* that water has been treated in the water treatment plant. So, the water at the tap can become very different from the water that left the water treatment process. We can even say that in communities with chemical treatment systems there is not only the treatment process in the water plant, but also the continuing unintended but inevitable treatment that happens in the treated water reservoirs and the distribution system. We can get an idea of how much is happening in the treated water reservoir by examining what happens when these reservoirs are cleaned. So, let's move on and examine Yellow Quill's treated water reservoirs more closely. When the treated water reservoirs at Yellow Quill were cleaned *there was a foot of black ooze covering the bottom of the reservoir.*

Does Your Water Treatment Process work?

There are many lessons to be learned from Yellow Quill's plight. We, at the SDWF, became better able to define water treatment processes that don't work. These non-working water treatment processes let large numbers of contaminants flow into the treated water reservoirs and the distribution system. From a water treatment plant operator's perspective this can lead to high levels of turbidity in the distribution system and it invariably leads to increases in combined chlorine and loss of chlorine residuals. This may compromise water quality because chlorine is a safeguard against possible microbial contamination after treatment. But, as Health Canada only tests in the distribution system (and raw water) it is difficult to pin down the level of your 3 treatments happening at the end of the water treatment process, after storage in the treated water reservoir, and after the water has been sitting in the distribution system. Health Canada determines water quality after all three treatment steps, in the distribution system.

My message here is pay close attention to what you find in the treated water reservoirs and note down how thick of a layer of "ooze," if any, you may have. In IBROM plants 25-cent coins are dropped to the bottom of treated water reservoirs, and at full water level the depth of a treated water reservoir is usually 3 to 4 meters. So, in this test the operator will look through 3 to 4 meters of water. In IBROM plants the quarter is visible for years. Isn't this wonderful? *There is no ooze*. Yearly cleaning of treated water reservoirs becomes obsolete with the IBROM. 100% of the treatment takes place in the water treatment plant. The treated water reservoirs and distribution system remain clean. Indeed, if there are bacteria attached to treated water reservoirs or distribution system when IBROM treated water starts flowing these bacteria will die of starvation and they will be removed. Fire hydrants should still be flushed as they often corrode and this corrosion should be removed.

Responsibility and Liability for Drinking Water Quality

Community members that are exposed to unsafe drinking water can actually take legal action against Chief and Council. The federal government signed over responsibility and liability for First Nations drinking water to Chiefs and Councils. This happened in capital transfer agreements in 2007 where many footnotes tied First Nations to this responsibility and liability. The government chose this escape route through contract with First Nations. But, is this fair? Some First Nations have handed back responsibility and liability for water to the federal government until such time the First Nation has a water treatment process that can consistently meet the Guidelines for Canadian Drinking Water Quality. This may mean that the community needs to construct a new water treatment plant or retrofit an existing one. Moving responsibility and liability back to the federal government from the First Nation is best done through a Band Council Resolution. This may also be the fastest way to get a First Nation's water issues dealt with promptly.

Moving Drinking Water Issues Forward

In my opinion, the federal government has a tremendous opportunity to move drinking water issues forward in First Nations communities. The federal government has access to raw and treated water data *from* all Canadian reserves. It should not take long to compare raw and treated water data and determine what works and what doesn't work. Just one thing to remember – while the raw water data is from water coming into the water treatment plant, the treated water data is from the distribution system. The federal government needs to take one additional step: Obtain treated water data as it has gone through the water treatment process and after it has been chlorinated. This is before the water has been stored in the treated water reservoirs. With this information it will be possible to determine the impacts of water quality changes in the treated water reservoirs and distribution system. And, let's face it, the federal government has the technical expertise, not the First Nations.

I have had very good discussions with several Indian Affairs and Assembly of First Nations people in Ottawa; they are knowledgeable and are keen to use their skills to effect change for the better in First Nations communities. I asked one Indian Affairs person: "Why did INAC hire you?" and the response was: "The issues surrounding drinking water were not as simple as Indian Affairs originally thought!"

In the next issue of the *Tribune* I will describe how two Indian Affairs employees got the ball rolling to get safe drinking water to Yellow Quill in a hurry. Resources were put in place to carry out extensive piloting and I ended up living at Yellow Quill's well heads for 22 months. I will show you that by applying science to Yellow Quill's water it became possible to identify problems that had to be overcome. Once problems were identified it was possible to find solutions for those problems. If you don't know you have a problem then, in reality, you have actually two problems. You first need to identify the problem before you can hope to devise a solution for it. Unfortunately, many First Nations communities have two problems.

Happily, communities like Yellow Quill, Saddle Lake, and James Smith Cree Nations have now eliminated their problems. The Chief of James Smith Cree Nation, Justin Burns, put words to this: "We are very happy in the community here that we have a facility such as this (the IBROM) to produce safe drinking water for our community. It is a stepping stone for the people of James Smith and also for the future reserves to come here and look at our plant and, hopefully, get something like this in their home communities so that unsafe drinking water will be a thing of the past."

When Yellow Quill's treated water reservoir was cleaned, before IBROM, the photo of water collected from near the bottom shows that the colour of water in the pail is black. Below that was the ooze.

Ooze is all that remained at the bottom of the treated water reservoir from Yellow Quill's old water treatment system. After the IBROM was commissioned you can now drop a quarter to the bottom of the reservoir and years later you can still see that quarter. There is no more ooze.