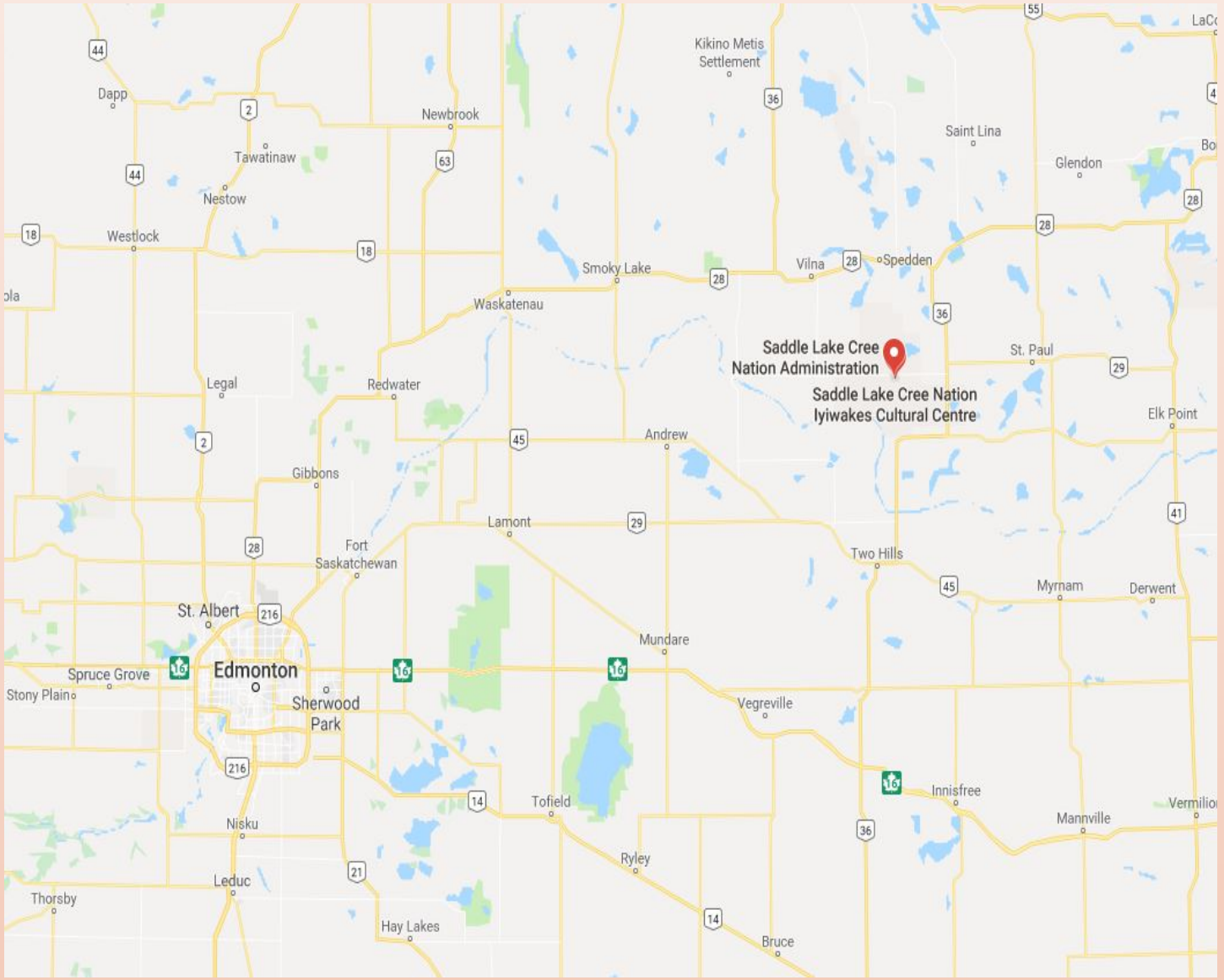
SDWF
Safe Drinking Water Foundation



The Tale of Saddle Lake Cree Nation

Saddle Lake Cree Nation

Saddle Lake Cree Nation is located almost 200 km northeast of Edmonton, Alberta. For decades, Saddle Lake residents dealt with a lack of reliable and adequate access to drinking water, suffering from what Indigenous and Northern Affairs Canada (INAC) rate as a high-risk surface water supply. The lake is a terminal lake (has no outflow) and, through evaporation, high levels of Dissolved Organic Compounds (DOC) are generated.

"I've never seen a water supply in such poor shape! The lake is covered with blue greens, which make mats in nearshore areas. Yet this is a drinking water supply for several thousand First Nations people! This is a story that city people need to hear and see. They cannot imagine that we have water problems of this magnitude in Alberta."
– Dr. David Schindler, Professor Emeritus, Science, Biological Sciences

Saddle Lake Cree Nation

Summers in Saddle Lake are characterized by extensive higher plant growth along the shores of the lake and open water frequently has massive blue-green algal blooms.

Saddle Lake Cree Nation

Even after treatment, the water distributed by the water treatment plant was among the worst in the country.

Why?

The source water for the community comes from Saddle Lake, and it is full of thick blue-green algae that washes up on shore in large quantities.

The water treatment plant was built in 1982 and required large quantities of harsh chemicals to treat the water. The chemicals cost upwards of $15,000 per month. In addition to the various chemicals that were used to treat the water, the distribution system itself was also poorly built.

After treatment, the aluminum levels in the tap water were still 10 times higher than the limit in the Guidelines for Canadian Drinking Water Quality.

Saddle Lake Cree Nation

This foam on Saddle Lake is generated under windy conditions and is caused by the high level of natural organic material.

What is DOC?

DOC is a general description of the organic material dissolved in water.

It is the result of decomposition of plant or animal material (that is why it is called organic – it comes from an organism that is alive or was once alive).

Organic carbon present in soil or water bodies may then dissolve when it is in water.

This dissolved organic carbon is transported by both surface water and ground water.

DOC, on its own, does not pose a health risk. However, it may become harmful when in combination with other aspects of water. When water that has a high level of DOC is chlorinated, harmful by-products called Trihalomethanes (THMs), which are carcinogenic (cancer causing), may be produced.

How Does DOC Affect Water Treatment?

DOC can interfere with the effectiveness of disinfection processes like chlorine. It can also promote growth of microorganisms by providing a food source.

DOC concentrations greater than 5 mg/L will complicate water treatment and may result in disinfection by-products, like THMs, to be formed in amounts which exceed the Guidelines for Canadian Drinking Water Quality.

Organic material in water can also cause aesthetic problems like unpleasant taste, odour, and colour. Organic content is usually higher in surface water than it is in ground water.

DOC will also increase colour in the treated water.

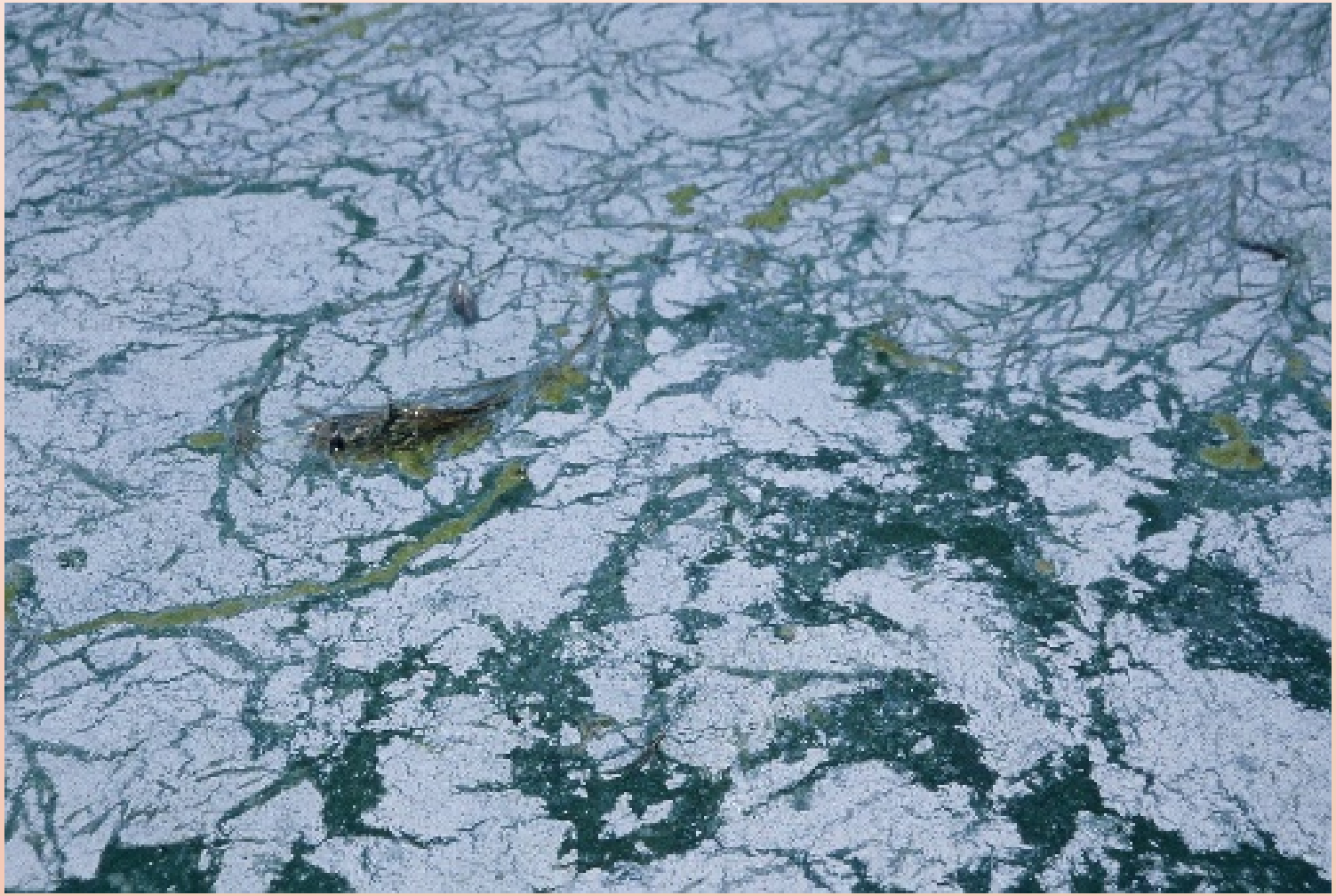
It is far more cost effective to prevent organic material from entering the raw water supply than it is to remove it afterwards. Treatment methods effective in removing DOC from water include: coagulation/flocculation processes, biological filtration, granulated activated charcoal, and distillation.

DOC and Water Treatment Complications

There is no concentration limit for DOC, but water treatment costs will dramatically increase as DOC increases. Source water with less than 2 mg/L of DOC tend to be easily treated while limiting disinfection by-products and do not increase the colour of the treated water.

Biological Activity, Algae, Bacteria

In surface water, biological activity is high and algae and bacteria drive processes that affect the quality of the raw water.



Chlorinating Organic Material

Another way of looking at high levels of Dissolved Organic Material (DOM) in water is to compare it with steeping tea (a hot water extraction of plant leaves resulting in DOM). Previously, a handy solution to this coloured water was simply to bleach the organics with chlorine and the water became colourless.

Chlorinated Organic Compounds

Such a simplistic solution is no longer acceptable as the chlorine reacts with the organics, forming many different chlorinated organic compounds.

Another concern with this approach is that bacteria present in the water before chlorination go from living to dead and we drink a graveyard of bacteria – that's not pleasant or healthy!

The community tried coagulation and gravity filtration, but this process failed to produce treated water of an acceptable quality.

Then, an engineering company felt that they could increase the coagulant dose (advanced coagulation) and put ultra-filtration after it. The community wanted the high DOC levels decreased to 2 mg/L to meet future THM regulations, which the community expected to be around 30 ug/L. Two pilots were carried out and the data collected was not encouraging – the 25 mg/L of DOC decreased to 12 mg/L.

Yield of THMs

Looking at the yield of Trihalomethanes (THMs) per mg of DOC it is clear that proper chlorination of this water after treatment would fail to achieve the Canadian guideline of 100 ug/L for THMs.

Therefore, advanced coagulation followed by ultra-filtration would not be sufficient for this community.

Biological Treatment of Surface Water

At Saddle Lake, biological treatment followed by Reverse Osmosis (RO) membranes was piloted. Also, before chlorination, the water ran through a mineral bed of calcium and magnesium.

The aim was to apply the Integrated Biological and Reverse Osmosis Membrane (IBROM) treatment process developed on ground water to surface water.

In the surface water IBROM process ceramic filtration material is used to carry out both particle removal and bioavailable DOC removal.

This results in low turbidity and biologically stable water for the RO membranes to treat.

Saddle Lake Now Has Good Drinking Water!

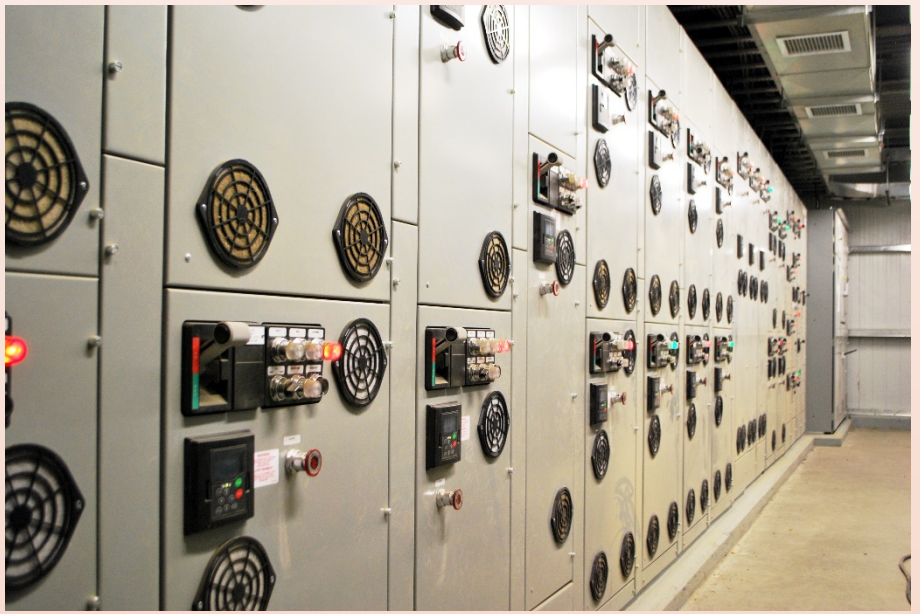
The surface water IBROM treatment process has successfully treated Saddle Lake's poor quality raw water source, producing a treated water with no detectable levels of DOC, below detectable THM (<5 ug/L), and producing stable chlorine residuals in the distribution system of 0.30 mg/L (the same amount that is added at the water treatment plant).

The addition of calcium and magnesium for pH adjustment and corrosion control also make the water healthy and the water meets World Health Organization (WHO) recommendations.

Not using chemicals in the biological water treatment process except for disinfection makes the treatment cost-effective.

The key is that it is essential to reach biological stability so that the RO membranes can treat the water without being fouled.

At Saddle Lake, the RO membranes have performed well for many years without cleaning.



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The first surface water biological treatment system in the world!