



# WATER TREATMENT TRAILER

December 1997

## WHY IS SURFACE WATER TREATMENT NECESSARY?

Water used for drinking and household use, especially water from a surface water supply, must be treated before it is used so it is safe and aesthetically pleasing.

Common in-house water treatment systems used in the Prairies were compared to some alternative treatment techniques as part of research conducted under the Canada-Saskatchewan Agriculture Green Plan Agreement. Different water treatment equipment was installed in a portable trailer to allow the equipment to be tested on different surface water supplies and to be moved to different sites for demonstration purposes.

Farm water supplies from dugouts (small on-farm reservoirs) may have high levels of dissolved organic carbon (DOC), turbidity and colour. In-house treatment systems must reduce these parameters to provide a safe and pleasing water supply. The impact of these parameters on water quality and drinking water safety are summarized in **Water Quality Matters** "Prairie Water Quality Problems".

## WHAT IS THE WATER TREATMENT TRAILER?

Various water treatment systems were installed in a portable trailer to allow for long-term testing of different equipment treating the same water supply over the same time period. The purpose of the trailer was to compare two types of in-house water treatment systems:

- conventional and alternative primary treatment systems, designed to provide high quality non-potable water for the entire household; and

- add-on components designed to supply safe cooking and drinking water in the kitchen.

Specifically, the systems were studied to see how well they removed DOC, colour and turbidity from the water.



The mobile treatment trailer was parked beside a dugout and water was pumped from a portable intake secured to a floating dock



Technicians sampled water weekly to judge the performance of each treatment system inside the trailer



## WHAT WATER TREATMENT SYSTEMS WERE TESTED?

Five treatment systems were tested. The components of each system and the approximate cost are shown in Table 1. Each system included a rapid (pressure) sand filtration system as the first component or “barrier” in the treatment system. Water from four different dugouts was tested during the summer of 1995. Each water supply had a high concentration of DOC and was highly coloured.

**Table 1:** Water Quality Trailer Treatment Systems and Cost

TREATMENT SYSTEM	TYPE OF SYSTEM	COMPONENTS	APPROXIMATE COST
BAC	Biological Activated Carbon	rapid sand, slow sand and BAC filters, storage tank and kitchen sink RO unit	\$6,000
GAC	Granular Activated Carbon	rapid sand and GAC filters, kitchen sink RO unit	\$2,500
RO	Reverse Osmosis	rapid sand filter and kitchen sink RO unit	\$1,500
NF	Nanofilter	rapid sand filter and NF unit	\$2,500
UF	Ultrafilter	rapid sand and GAC filters and UF unit	\$3,500

## HOW DID THE SYSTEMS COMPARE?

The performance of the different water treatment systems are summarized in Table 2.

**Table 2:** Comparison of Treatment System Performance in Reducing DOC and Colour

SYSTEM	QUALITY OF WATER	LENGTH OF TIME GOOD QUALITY WATER WAS PRODUCED	FLOW RATE (during the study period)	VOLUME OF GOOD QUALITY WATER TREATED	SUPPLY
<b>BAC</b>	very good	entire study period (4 months)	0.4-1.0 L/min	116,000 L (25,000 gal)	6 - 8 months of total household demand**
<b>GAC</b>	good	25 days	0.5-0.7 L/min	22,000 L (4,800 gal)	1 - 2 months of total household demand**
<b>RO</b>	excellent	entire study period (4 months)	30 L/day*	3,300 L* (725 gal)	all drinking and cooking water
<b>NF</b>	excellent	entire study period (4 months)	.05 L/min* or less	80,000 L* (18,000 gal) or less	all drinking and cooking water
<b>UF</b>	very good	entire operating period (22 days)	0.3 L/min* or less	9,500 L* (2,100 gal) or less	all drinking and cooking water

**Notes:**

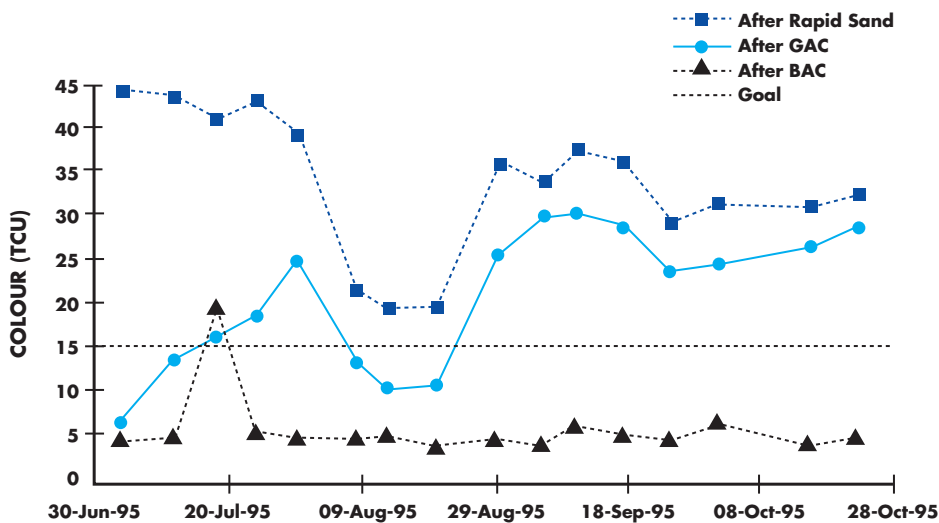
\* estimated

\*\* a typical household requires a continual flow rate of 0.5 L/min or about 700L/day, which is equivalent to 20,000 L per month (4,500 gallons per month)

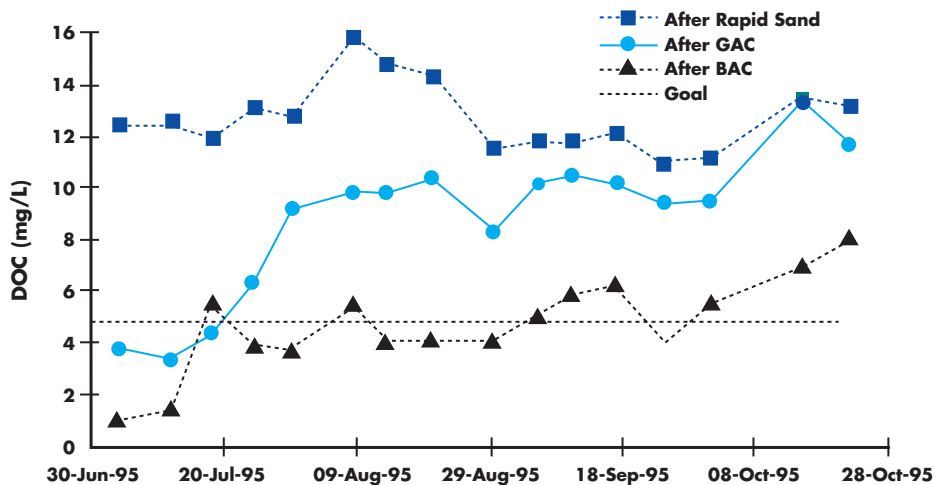
# WHAT WERE THE RESULTS?

The performance of the rapid sand, GAC and BAC systems is shown in Figures 1 and 2.

**Figure 1:** Comparison of Rapid Sand, GAC and BAC Treatment Systems for Removal of Colour



**Figure 2:** Comparison of Rapid Sand, GAC and BAC Treatment Systems for Removal of Dissolved Organic Carbon (DOC)



Some conclusions are presented below;

- The rapid sand filter reduced turbidity, but had limited ability to remove DOC or colour. By itself, it did not provide good quality water for household use.
- The granular activated carbon (GAC) filter initially showed good removal of DOC, colour and turbidity, but was exhausted after approximately one month.
- The biological activated carbon (BAC) system consistently removed DOC, colour, and turbidity throughout the study period.
- The RO and NF membrane processes consistently showed excellent removal of DOC and colour (greater than 85% removal for each) and good reductions of turbidity (see Table 3).
- The UF membrane process showed only moderate DOC and colour removal (less than 35% each), but provided good turbidity reduction.
- Water samples after RO treatment were free from microbiological contamination except in two instances. Properly operated and maintained membranes, whether RO, NF, or UF, should normally supply microbiologically-safe water.

**Table 3:** Molecular Weight Cutoff (MWCO) for Membranes

MEMBRANE	MOLECULAR WEIGHT CUTOFF (MWCO)	DOC REMOVAL (%)	COLOUR REMOVAL (%)
Reverse Osmosis (RO)	50	92-100	80-100
Nanofilter (NF)	100	93-98	83-92
Ultrafilter (UF)	20,000	34	32

## WHAT OPERATION & MAINTENANCE IS REQUIRED?

- All treatment systems require regular maintenance to operate properly and safely.
- A manual air and water backwash of the filters is essential for the BAC system after treating approximately 15,000 L (3,300 gallons) of water.
- An appropriate air supply system is needed to supply oxygen to the microbes in the BAC system.
- Light barriers or opaque tanks are necessary for the BAC system to prevent algae from growing in the water.
- The GAC filter loses its ability to adsorb organic material over time. Therefore, for optimum water quality, the filter must be replaced when the carbon is exhausted. In this study, the carbon was exhausted after about 30,000 L (6,600 gallons) or after about 30 days of continuous use.
- RO, UF and NF membrane systems require pre-treatment because dugout water can clog or foul the membranes.
- The five micron filter which is placed in front of all RO, NF and UF membranes, must be replaced at regular intervals depending on the quality of the source water.

## ARE THERE ANY LIMITATIONS?

- Coliform bacteria indicate the presence of micro-organisms in the water. Coliforms were detected in the water after the rapid sand and GAC filters, and in smaller numbers after passing through the BAC filter. Drinking water should contain *NO* coliforms. Therefore, the water *MUST* be disinfected before it is used for drinking. Disinfection processes include chlorination, ultraviolet light or ozonation.
- For a membrane to function, a portion of the water is rejected by the membrane while the treated product water is passed through the membrane. For kitchen tap RO units, approximately seven to 20 times as much water may be rejected for each unit of treated water that is produced. These ratios can increase if pre-treatment is inadequate. Membrane productivity is also reduced with lower water temperatures.
- Biological treatment converts ammonium to nitrate. If the source water is high in nitrates, then biological treatment may increase nitrates to a level that exceeds Canadian Drinking Water Quality Guidelines. It should be noted that an RO unit would reduce nitrates to a safe level.

## THE BIGGER PICTURE

The research showed that treatment technologies traditionally used in rural Saskatchewan such as sand filtration or GAC filters are not sufficient to treat source waters rich in organic matter, unless the GAC filter media is replaced frequently.

Biological systems are a good multi-barrier approach for domestic water treatment, improving water quality at each step in the process (see the **Water Quality Matters** publication “In-house Water Treatment Systems.”)

Membrane water treatment systems produce high quality water. But, further study is needed to determine sizing and pre-treatment requirements to meet the demands of an entire household.

The Surface Water Treatment Trailer will continue to be used to treat water for demonstration and research purposes. A ground water treatment trailer has also been constructed to investigate alternative processes for treating well water.

For further information on rural Prairie water quality and treatment technology:

- contact your local Prairie Farm Rehabilitation Administration office (PFRA is a branch of Agriculture and Agri-Food Canada);
- read the other publications in PFRA’s **Water Quality Matters** series;
- get a copy of “Rural Prairie Water Quality: Searching for Solutions for On-farm Users” available from PFRA; or
- read Prairie Water News, available from PFRA, or on the Internet at [www.quantumlynx.com/water](http://www.quantumlynx.com/water)

NO ENDORSEMENT GIVEN

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