All I Want is Pure Bottled Water
Testing for Pure Water

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AWQS International
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Introduction:

Bottled drinking water is very popular. People seek water that is pure, has great taste, and easy to carry. They do not want debris in their "pure" water. Recent publications indicate that bottled water may not be as pure as customers expect. Bottled water can contain debris ranging from bacteria, micro-organisms, particles from dead micro-organisms, and even larger plastic particles [1,2,3,4,5,6,7] .

This paper is a result of a quick study performed by AWQS International, Escondido, CA., USA. Still water in bottles, from major and local suppliers, were tested for purity using the AWQS Model 2018a Portable Water Monitor unit. Local tap water samples were also tested as a comparison to the bottled water. Purity, for this test, is defined as the absence of microbiological particles or non-organic particles in the size range of 500 nanometers (nm) to over 2,500 nm. (0.5 microns to 2.5 microns) . The particles consist mainly of bacteria, endospores, cysts, algae, or other small particles or parts of them, and are either alive (culturable or non-culturable) or dead. References cited above state that some of the larger particles of 5 microns to 500 microns are plastic. The smaller the concentration of the particles, the purer the water by this definition. Particle-free water would be the purest.

Measurement of the debris in bottled water does not by itself determine the safety of the water for drinking, but does measure how effective the treatment and bottling process is for removing small bacteria and other particle contaminants from the bottled water. The study was limited to still water, as carbonated water would require a de-gas step before measurement.

In addition to the AWQS measurements, the TDS and pH of the tested waters were also measured.

Figure 1 shows the AWQS International Model 2018a Portable unit prototype measuring a sample. The unit is 12" x 14" x 6" deep and requires less than 15 watts of power. The sample is passed once through the system and captured in a waste bottle. The flow through the system is adjusted to 6 mL/min.

Measurement Process: Six brands of bottled still water were acquired from local grocery stores along with three TAP Water samples and were used in this initial study. The major brands are not identified in this report for obvious reasons. The measurement made is a MIE scatter measurement of the forward light scattering from small particles in flowing water. It is quite sensitive to even sub-micron debris (particles) in the water.

The test samples were cooled to just under 4 degrees centigrade for a minimum of 4 hrs before the test. During the test, the sample bottle was placed into an ice bath to maintain the temperature. The cold water testing minimizes any tendency of the water to release micro-bubbles during the test.

Minute by minute data for the 4 size ranges was acquired for at least 10 minutes for each sample. The size bins, in nanometers (nm), are 500 to 700 nm, 700 to 1,000 nm, 1,000 to 2,500 nm, and greater than 2,500 nm. These particles are smaller than a human hair, which can be 17,000 nm to 180,000 nm. This unit does not measure virus particles, as their size ranges from 10 nm upwards to 300 nm.

One additional measurement is the average scatter signal above instrument scatter background. The average of the 10 measurements are presented. The data is gathered as CPM (counts per minute). The CPM values are converted to Concentration P/mL (Particles per mL) using calibration numbers obtained by running known concentrations of polystyrene spheres in filtered distilled water. For example, for this unit, 3.74 particles per mL in the water tested will produce 1 Count per Minute (CPM).

TDS and pH were also recorded for the samples.

Results: The results are plotted on a bar chart shown in **Figure 2**. The vertical scale is a log scale to allow viewing of the wide concentration variation from sample to sample. The 4 size bins are plotted along with the Scatter above background signal for each sample. The samples that appear to be missing some bin information are the result of zero to near zero values. BW = bottled water and TW =

tap water. PLEASE NOTE: Scatter signal is not in P/mL but in scatter amplitude units.

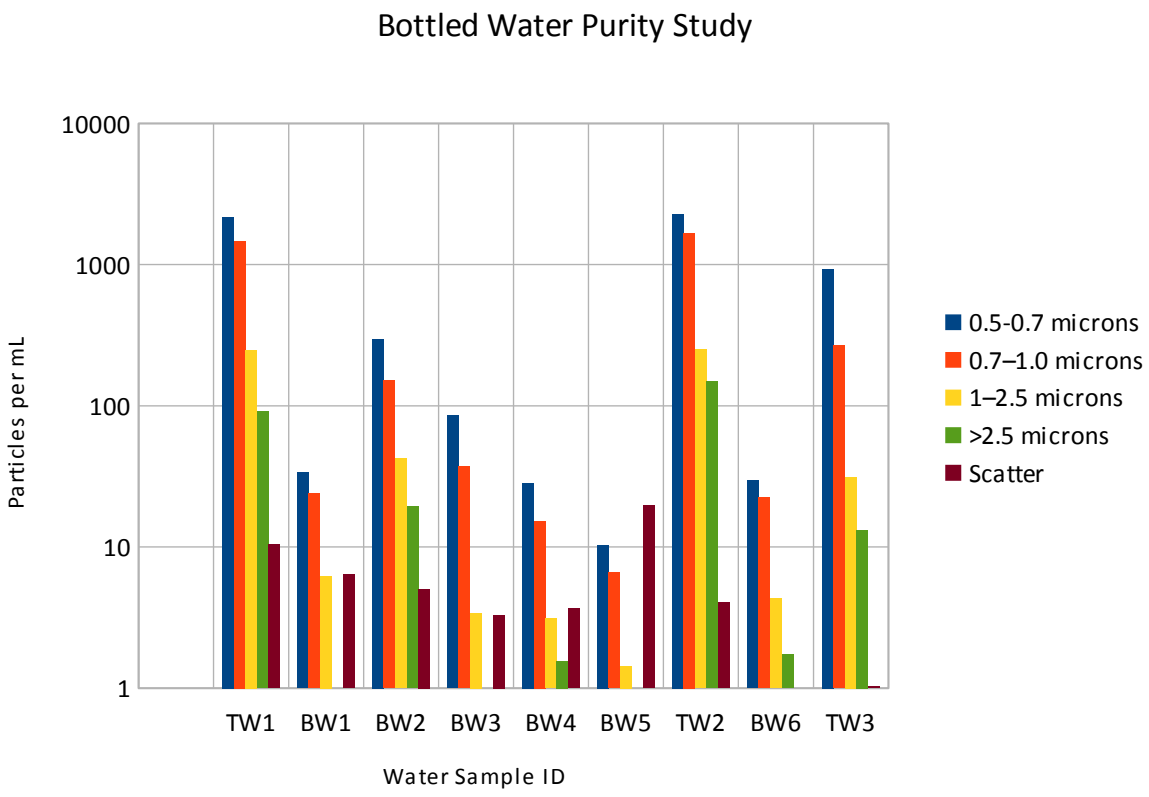

Figure 2. Results of the Bottled Water Study shown in 4 size bins and the overall scatter signal. TW = Tap Water, BW = Bottled Water.

Results are also tabulated in **Table 1.** Please note that the bottled water does appear to be purer than tap water. Also note BW5, which appears to be the purest; however, its scatter signal is the highest. See conclusions for comments on BW5.

Table 1. Debris measured in Particles per mL, the increase in Scatter Signal over background, the Total Dissolved Solids TDS in ppm, and the pH.

Sample	Particles per mL				Scatter		
	0.5-0.7 microns	0.7–1.0 microns	1–2.5 microns	>2.5 microns	Scatter	TDS (ppm)	pH
TW1	2172.4	1474.4	248.3	91.2	10.5	380	7.2
BW1	33.7	24.0	6.2	0.9	6.4	100	7.9
BW2	296.7	152.1	42.4	19.3	5.1	19	8
BW3	85.4	37.1	3.4	0.3	3.3	199	7.6
BW4	28.4	15.3	3.1	1.6	3.7	17	8.4
BW5	10.4	6.6	1.4	0.0	19.8	68	8.3
TW2	2288.5	1671.1	251.6	148.9	4.0	400	7.3
BW6	29.6	22.4	4.3	1.7	0.0	67	8.2
TW3	933.0	267.8	31.4	13.2	1.0	390	7.1

Finally, the total concentration in size bins 1 through 4 are summed to provide a quick summary of the water purity as shown in **Figure 3** and **Table 2**. PLEASE NOTE: Scatter signal is not in particles per milliliter (P/mL) but in scatter amplitude units.

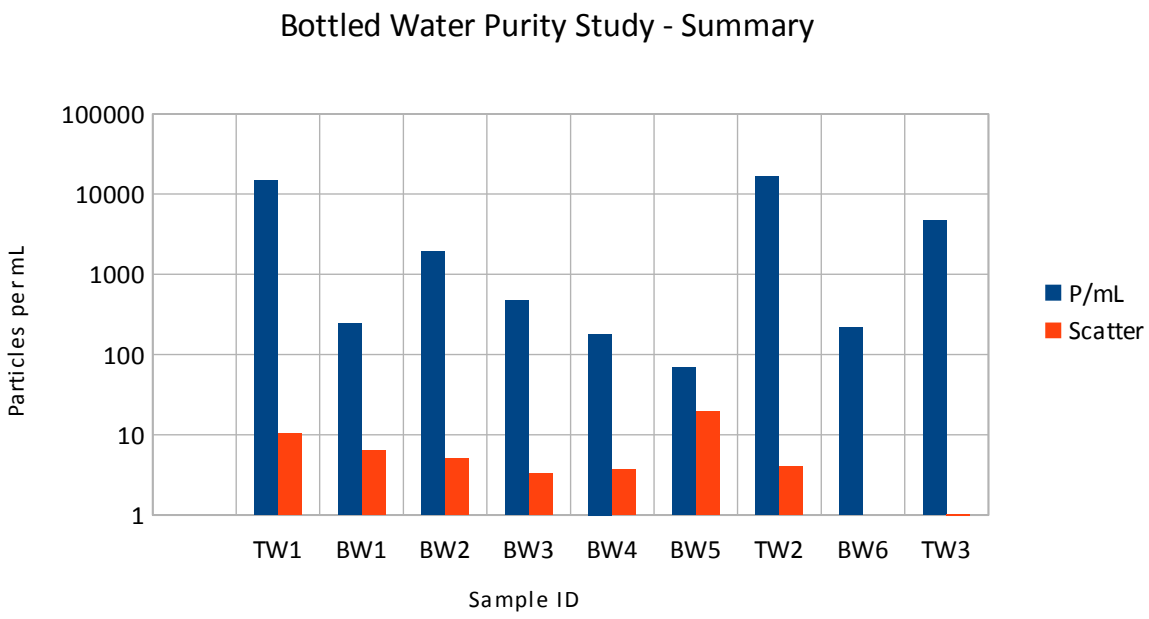

Figure 3. Summary showing the total particle per mL count in Bins 1-4 plus the scatter amplitude signal

Table 2. Debris measured in Particles per mL and the increase in Scatter Signal over background. The size bins are summed so the total P/ml is for sizes 0.5 micron on up past 2.5 microns

Water	P/mL	Scatter
TW1	14,909	10.5
BW1	242	6.4
BW2	1,909	5.1
BW3	472	3.3
BW4	181	3.7
BW5	69	19.8
TW2	16,307	4.0
BW6	217	0.0
TW3	4,658	1.0

Special Comments about BW5: Looking at the particles per mL only, Bottled Water 5 appears to be the purest sample tested. However, if you look at the scatter signal above background scatter, you see that BW5 has the highest scatter signal. The history of Sample BW5 is unique in that the bottle was left in an automobile for 2 weeks unopened, and under high daily temperature ranging from 89 F to 113 F (31.7 to 45 C). The interior of the vehicle probably approached 160 F (71 C) for several hours each day. The remaining samples were always kept at 37 F (2.8 C) after a short trip from the store to AWQS. Unfortunately, there is no history available for any of the bottled water samples from bottling to store shelf. The tap water samples were out of the tap directly to cooling. We suspect that the extra

scattering signal above background may be due to possible contamination from the bottle itself and this may warrant a study by itself.

Conclusions: Bottled water from various vendors produce different purity results. The purest water is not always the most expensive. This study did not measure "Taste" so that a bottled water product that measured the purest may not be the best tasting water. We did not measure distilled or de-ionized water as you should not be drinking that type of water. Also there appears to be no correlation between the measured particles and the TDS or pH signals.

The AWQS International Model 2018a portable allows quick measurements of the purity of water samples and shows that the system can discriminate between various samples. If a water treatment process is stable, then the results of measurement over time should be stable. If over time, there are spikes of contamination, the water treatment process has failed. We did not do a time study in this test. However, our Standard Model 2018a is a real-time on-line continuous measurement instrument meant to provide purity measurements 24/7. Please visit **www.awqs.co** for more detail about the instruments. The portable unit is prototype that we are currently testing. With enough interest, we would go into production of the portable unit.

If you would like several bottle water samples tested, please contact AWQS. A nominal charge for this service applies.

Finally, we do not currently recommend leaving open or unopened bottled water in hot vehicles.

References:

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