



## **MICROBIOLOGICAL LABORATORY REPORT SUMMARY- 2019**

### **Introduction:**

In 2018, Above Water Systems, Inc. (AWS) designed a cartridge to outperform the existing General Ecology Seagull IV® cartridge with respect to microbial reduction<sup>1</sup>. To verify performance, each cartridge was subject to an arduous microbiological reduction test with no rest periods in a laboratory setting. Taking into consideration test conditions from NSF P231, the challenge water was designed to be rigorous, encompassing pH, TOC levels, and type of microbial content.

### **Procedure:**

Test water was prepared using RO/DI water adjusted with Tannic Acid to yield a TOC level of 14-16 ppm and with Sodium Chloride (NaCl) added to yield a TDS value of 1350 – 1650 mg/L. The test water pH adjusted to 9.0-9.2, and the water was spiked with virus as MS2 targeting 4-5 log/mL, and with bacteria as Raoultella Terrigena (Rt), targeting 6-7 log/mL. The flow rate was set as close to 1.00 gpm as was attainable at 60 psi. The test was performed with continuous flow. Samples were collected at 5, 10, 15, 20, 25, and 30 gallons. The samples at 5, 15, and 30 were plated using a top agar overlay method (MS2) and a membrane filtration method (Rt). Dilutions were also plated.

### **Discussion:**

The AWS-1 Plus® cartridges were subject to testing in triplicate with a new General Ecology Seagull IV® cartridge. The AWS-1 Plus® cartridges were loaded into a laboratory station with multiple test positions. The lab station was set up to run four cartridges in parallel, consisting of three AWS-1 Plus® and one General Ecology Seagull IV® cartridge. Challenge water containing the contaminants listed above in the **Procedure** Description passed through each cartridge in parallel and resulting effluent waters were analyzed for any Microbial activity the cartridge failed to capture. The contaminants are in such great quantities that typical microbial reduction is expressed as log reduction, see **Appendix Table 1**. For example, if a cartridge is capable of 1 log reduction, it reduced the virus content by 90 %. Therefore a water containing 1,000,000 viruses was reduced to 100,000, see **Appendix Table 2**. However, in this case we have created some line graphs below to easily showcase the performance of the AWS-1 Plus® cartridges when compared to the General Ecology Seagull IV® cartridge.

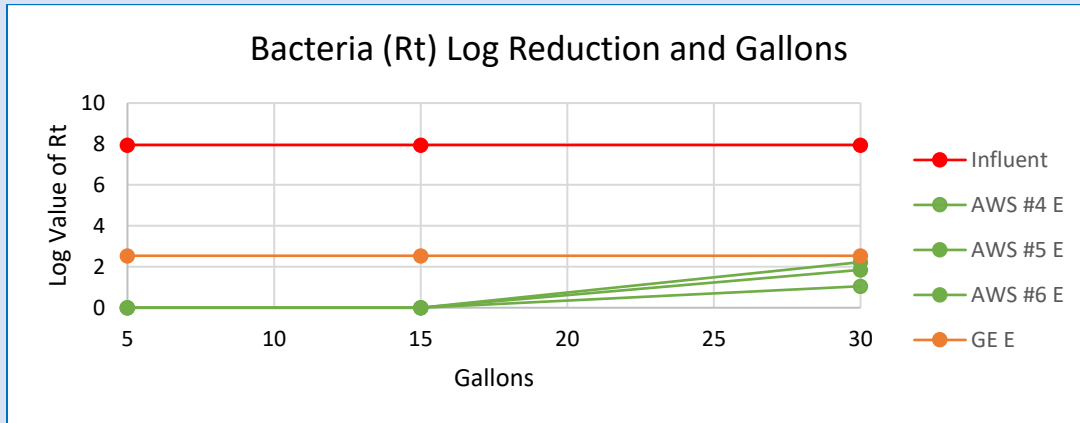
### **Results:**

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<sup>1</sup> **DISCLAIMER:** General Ecology, Inc® is a registered owner of the trademark Seagull®. This replacement product is not manufactured, endorsed, or approved by General Ecology, Inc®. This site makes no representation as to the effect the use of this replacement product may have on any warranty that you received with the purchase of a General Ecology, Inc® Seagull® IV systems.

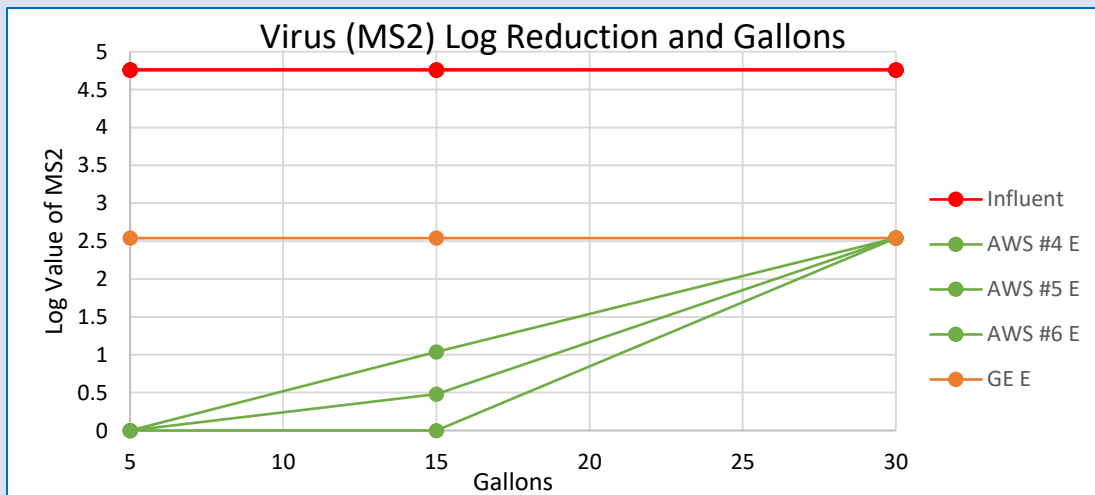
It was determined after filtering 5 gallons of challenge water that each of the AWS R&D cartridges were capable of a complete microbial reduction, whereas the General Ecology Seagull IV® cartridge had already failed to reduce the microbial content in the challenge water. After filtering 15 gallons of challenge water through each cartridge, the AWS cartridges were still able to completely reduce Rt contaminants and two out of three cartridges had significantly reduced MS2, whereas the General Ecology Seagull IV® cartridges failed to reduce either contaminant (MS2, Rt) in each of the sample points 5, 15, 30 gallons as displayed in **Graph 1** and **Graph 2**.

**Graph 1**



Graph of Rt reduction. Red line is the influent bacteria concentration expressed as a log value. The green lines represent the effluent concentrations for the AWS R&D cartridge. The orange line represents the General Ecology Seagull IV® cartridge effluent concentration. <sup>2</sup>

**Graph 2**



Graph of MS2 reduction. Red line is the influent virus concentration expressed as a log value. The green lines represent the effluent concentrations for the AWS R&D cartridge. The orange line represents the General Ecology Seagull IV® cartridge effluent concentration. <sup>3</sup>

<sup>2</sup> Above Water Systems, Inc. Microbiological Laboratory Report, April 2019, Data on file.

<sup>3</sup> Above Water Systems, Inc. Microbiological Laboratory Report, April 2019, Data on file.

**Appendix**

**Table 1.**

**Original Data**

<b>AWS #4</b>				
<b>Sample Point</b>	<b>Flow gpm</b>	<b>Total gal</b>	<b>MS2 (C/R)</b>	<b>Rt (C/R)</b>
5 gal	0.95	5	4.76/4.76	7.95/7.95
15 gal	1.05	15	<b>4.76/3.72</b>	7.95/7.95
30 gal	0.95	30	<b>4.76/&lt;2.22</b>	7.95/6.90
<b>AWS #5</b>				
<b>Sample Point</b>	<b>Flow gpm</b>	<b>Total gal</b>	<b>MS2 (C/R)</b>	<b>Rt (C/R)</b>
5 gal	1.06	5	4.76/4.76	7.95/7.95
15 gal	1.06	15	4.76/4.28	7.95/7.95
30 gal	0.96	30	<b>4.76/&lt;2.22</b>	<b>7.95/5.72</b>
<b>AWS #6</b>				
<b>Sample Point</b>	<b>Flow gpm</b>	<b>Total gal</b>	<b>MS2 (C/R)</b>	<b>Rt (C/R)</b>
5 gal	0.96	5	4.76/4.76	7.95/7.95
15 gal	1.06	15	4.76/4.76	7.95/7.95
30 gal	0.96	30	<b>4.76/&lt;2.22</b>	7.95/6.10
<b>General Ecology Seagull IV® cartridge</b>				
<b>Sample Point</b>	<b>Flow gpm</b>	<b>Total gal</b>	<b>MS2 (C/R)</b>	<b>Rt (C/R)</b>
5 gal	0.76	5	<b>4.76/&lt;2.22</b>	<b>7.95/&lt;5.41</b>
15 gal	0.95	15	<b>4.76/&lt;2.22</b>	<b>7.95/&lt;5.41</b>
30 gal	0.95	30	<b>4.76/&lt;2.22</b>	<b>7.95/&lt;5.41</b>

Red = Failure. MS2 = virus (log/mL), Rt = Bacteria (logs/100mL), C/R = Challenge/Reduction logs<sup>4</sup>

<sup>4</sup> Above Water Systems, Inc. Microbiological Laboratory Report, April 2019, Data on file.

**Table 2.<sup>5</sup>**  
**Log Reduction Explanation**

Log Reduction	Number of CFU's	Reduction %	Times Smaller
0 log	1000000	0%	N/A
1 log	100000	90%	10
2 log	10000	99%	10
3 log	1000	99.9%	1000
4 log	100	99.99%	10000
5 log	10	99.999%	100000
6 log	1	99.9999%	1000000

CFU (colony forming units)

**Table 3.<sup>6</sup>**

General Ecology Seagull IV® cartridge9/13/18				
Sample	Flow	Total	MS2	Rt
Point	gpm	gal	(C/R)	(C/R)
5 gal	0.96	5	4.76/0.06	8.31/<3.77
15 gal	0.96	15	<b>4.76/0.04</b>	8.31/<1.77
30 gal	0.96	30	<b>4.76/0.11</b>	8.31/<1.77
General Ecology Seagull IV® cartridge5/31/18				
Sample	Flow	Total	MS2	Rt
Point	gpm	gal	(C/R)	(C/R)
5 gal	1.06	5	4.76/2.272	Contamination
15 gal	0.96	15	4.76/0.39	Contamination
30 gal	0.96	30	<b>4.76/0.30</b>	Contamination
General Ecology Seagull IV® cartridge3/14/18				
Sample	Flow	Total	MS2	Rt
Point	gpm	gal	(C/R)	(C/R)
5 gal	1.06	5	5.00/1.10	8.20/3.35
15 gal	1.06	15	5.00/<0.23	8.20/2.29
30 gal	1.06	30	<b>5.00/-0.12</b>	8.20/<5.65

Red = Failure. MS2 = virus (log/mL), Rt = Bacteria (logs/100mL), C/R = Challenge/Reduction logs

<sup>5</sup> Above Water Systems, Inc. Microbiological Laboratory Report, April 2019, Data on file.

<sup>6</sup> Above Water Systems, Inc. Microbiological Laboratory Report, April 2019, Data on file.

The table below highlights results from the March, 2019 *Evaluation of the AWS1 Plus® and General Ecology Seagull IV® Filtration Units In a Side by Side Comparison*. These data show the *E. coli* log reduction for the AWS1 Plus® and Seagull IV® in a head to head comparison. The *E. coli* substrate is used as a surrogate to test a cartridge's ability to reduce bacteria in one gallon per minute flow rates. The AWS1 Plus® was able to demonstrate a 6-log reduction of *E. coli*; the Seagull IV® cartridge was not able to meet this reduction of *E. Coli* at any point.

<b><i>E. coli</i> Results For Units AWS1 Plus #1 And Seagull IV</b>			
<b>Sample #</b>	<b>Sample ID</b>	<b>Result (MPN/100 mL)</b>	<b>Log Reduction</b>
190322-1	Influent 5 Gallons	4.7 x10 <sup>7</sup>	
190322-2	Effluent AWS1 5 Gallons	7.4	6.8
190322-3	Effluent Seagull 5 Gallons	5.9 x10 <sup>4</sup>	2.9
190322-4	Influent 10 Gallons	4.2 x10 <sup>7</sup>	
190322-5	Effluent AWS1 10 Gallons	7.7x10 <sup>2</sup>	4.7
190322-6	Effluent Seagull 10 Gallons	3.3 x10 <sup>3</sup>	4.1
190322-7	Influent 15 Gallons	5.6 x10 <sup>7</sup>	
190322-8	Effluent AWS1 15 Gallons	4.1 x10 <sup>3</sup>	4.1
190322-9	Effluent Seagull 15 Gallons	4.4 x10 <sup>5</sup>	2.1
190322-10	Influent 20 Gallons	6.1 x10 <sup>7</sup>	
190322-11	Effluent AWS1 20 Gallons	6.3 x10 <sup>3</sup>	4.0
190322-12	Effluent Seagull 20 Gallons	6.5 x10 <sup>5</sup>	2.0
190322-13	Influent 25 Gallons	4.5 x10 <sup>7</sup>	
190322-14	Effluent AWS1 25 Gallons	1.2 x10 <sup>4</sup>	3.6
190322-15	Effluent Seagull 25 Gallons	3.7 x10 <sup>5</sup>	2.1
190322-16	Influent 30 Gallons	4.4 x10 <sup>7</sup>	
190322-17	Effluent AWS1 30 Gallons	1.5 x10 <sup>4</sup>	3.5
190322-18	Effluent Seagull 30 Gallons	9.2 x10 <sup>5</sup>	1.7

Source BioVir Laboratories<sup>7</sup>

<sup>7</sup> BioVir Laboratories, Benicia, California, USA. *Evaluation of the AWS1 Plus and General Ecology Seagull IV Filtration Units In a Side by Side Comparison* Test Report, March 27, 2019- Data on File