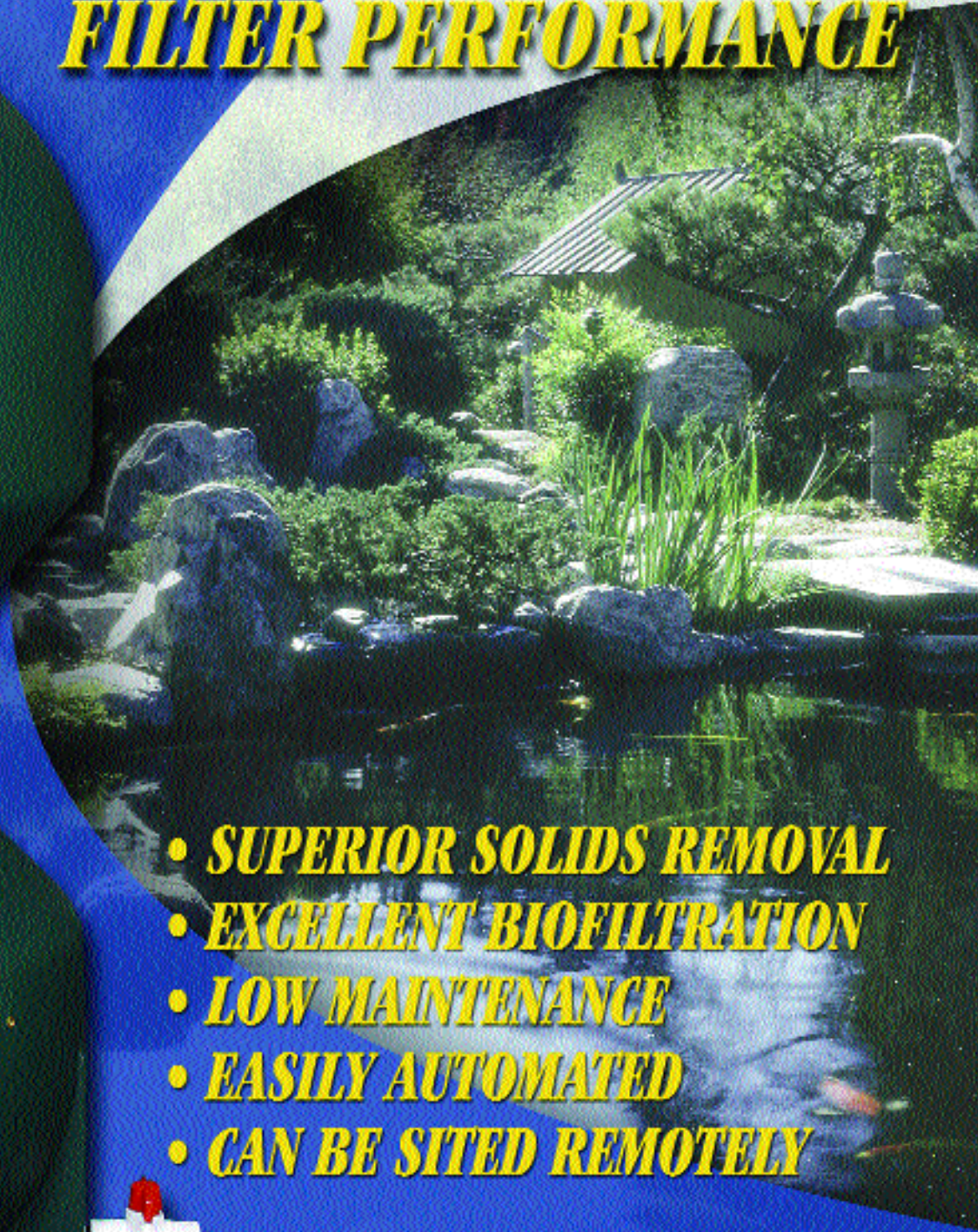
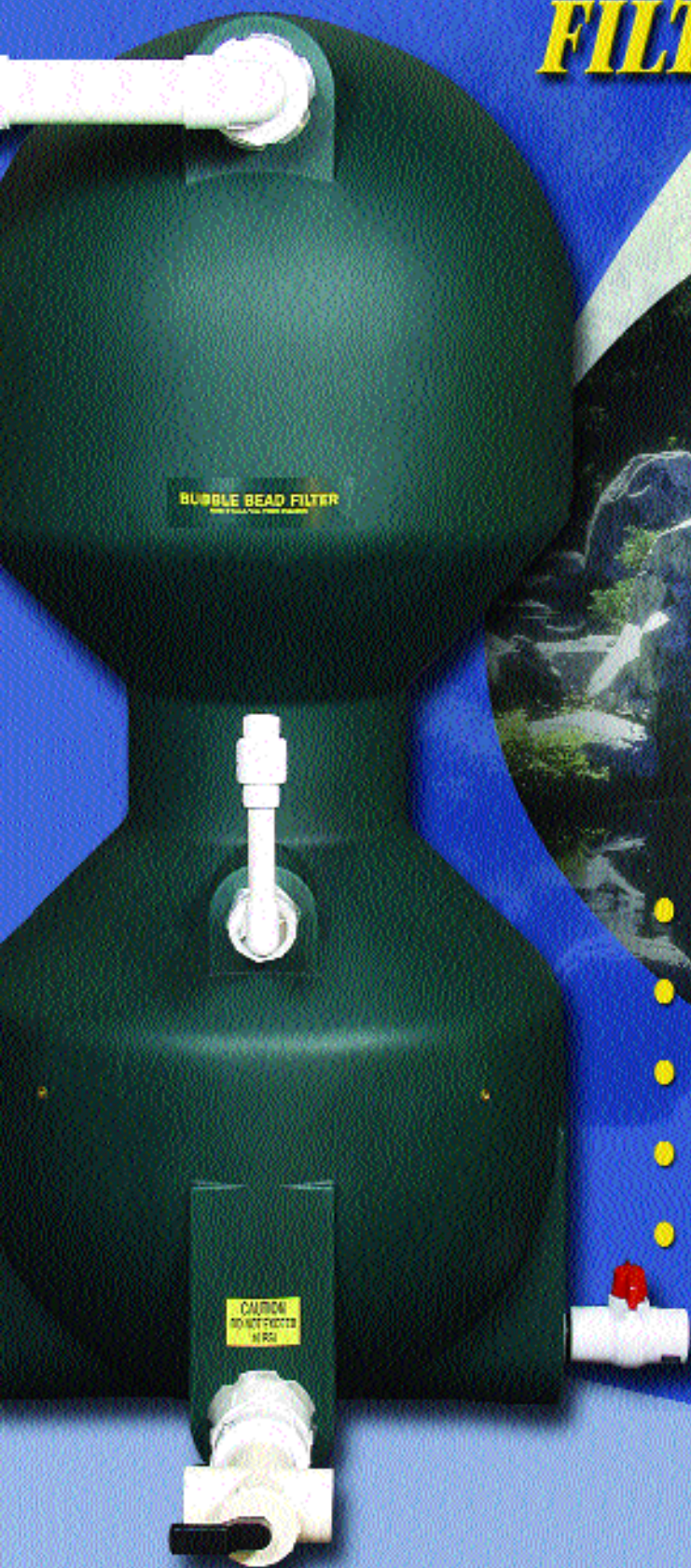


# **DEMAND** **BUBBLE BEAD** **FILTER PERFORMANCE**



- **SUPERIOR SOLIDS REMOVAL**
- **EXCELLENT BIOFILTRATION**
- **LOW MAINTENANCE**
- **EASILY AUTOMATED**
- **CAN BE SITED REMOTELY**

# **BEAD FILTER**

## **Theory of Operation**



Bead Filters are generally classified as "expandable granular biofilters" or EGB's. They are distinguished by the use of plastic buoyant granular media. Water from the aquatic system passes through the packed bed of plastic beads. The beads capture the solids, while simultaneously providing a large surface area (400 ft<sup>2</sup> /ft<sup>3</sup>) for the attachment of nitrifying bacteria which remove dissolved nitrogenous wastes. Bead Filters are often referred to as Bioclarifiers for their ability to perform both biofiltration and clarification in a single unit.

Bead filters are excellent clarification units capable of maintaining display-quality water at high waste loading rates. Studies have shown that acclimated Bead Filters capture 100% of particles > 50 microns and 48% of particles in the 5-10 micron range per pass.

Bubble-Washed Bead Filters typically operate at 5-10 psi which facilitates the use of low to medium head pumps which reduces overall pump horsepower requirements, as well as energy consumption. Additionally, backwash waterloss rates are as low as 1% of those experienced by typical sand filters. Bead Filters are also easily automated, never require replacement of the filter media and are immune to caking and channeling.

Biofiltration depends on the attachment and growth of beneficial bacteria to the surface of the bead media. These bacteria extract dissolved chemicals from the water and convert them to particulate biomass or harmless dissolved compounds. Given a proper environment, the bacteria grow in a thin film covering the surface of our media. Each ft<sup>3</sup> of our bead media contains approximately 600,000 beads that provide 400 ft<sup>2</sup> of surface area for the propagation of bacterial films. There are literally hundreds of different species of bacteria at work in a biofilter. Most of the bacteria are classified as "heterotrophic" species, which actively break down organic materials into carbon dioxide and water. The most critical, however, are broadly described as nitrifying bacteria, consisting primarily of the genera Nitrosomonas and Nitrobacter. These bacteria are responsible for the conversion of the toxic nitrogen forms, ammonia and nitrite, to relatively harmless nitrate. Management of biofiltration is critical in aquatic systems.

Clarification is the process of removing suspended solids from water. Suspended solids in an aquatic system are generally small particles (< 100 microns) of undigested or partially digested food, bacteria, algae, clay, and silt, suspended in the water column. Fine suspended solids tend to reduce the clarity of the water, whereas larger organic particles create a serious waste load problem by consuming tremendous amounts of oxygen, thus adversely affecting the aquatic system's ecology.

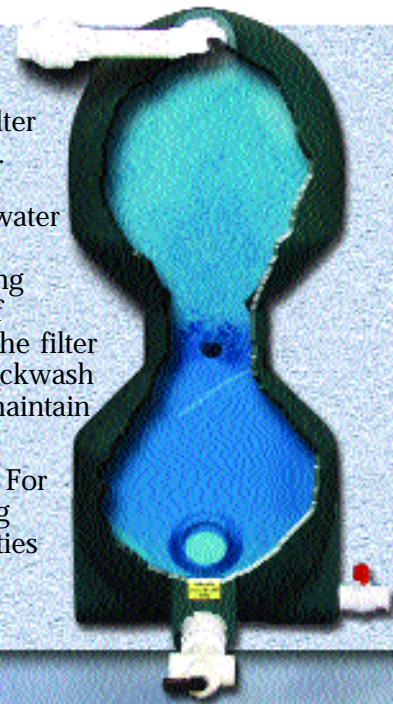
Bead Filters remove suspended solids by at least four different mechanisms as water is passed through the packed bed of plastic beads. Particles >100 microns are subjected to Physical Straining. For slightly smaller particles (50-100 microns) the most dominant mechanism is Settling. Suspended particles (5-50 microns) are removed by Interception, a subtle process caused by collisions between the particle and the bead media surface. Finer particles (<20 microns) are removed through Bioabsorption, the capture of particles by the bacterial biofilm. Bead filters are excellent clarification units, capable of maintaining display quality water at high waste loading rates. Studies have shown that Bead Filters capture 100% of particles > 50 microns and 48% of particles in the 5-10 micron range per pass.



## **BUBBLE-WASHED BEAD FILTERS**

The Bubble-Washed Bead Filter is an effective alternative to our Propeller-Washed Bead Filter for lighter loading and lower flow aquatic systems. The filtration mechanisms are the same. The difference is in its simpler, yet very effective method of backwashing. A backwash is accomplished by shutting off the circulation pump and opening the sludge valve. As the water drains from the filter, air rushes in through the "air inlet" expanding and agitating the bead media in a vigorous boiling type action. As the media passes through our patented washing throat, the captured solids are propelled downward and out of the filter. Once the flow of wastewater stops, simply close the sludge valve and turn the circulation pump back on. The filter is now in normal operation with a clean filtration bed. The Bubble-Washed Bead Filter backwash process is vigorous enough to remove unwanted solids and debris, yet gentle enough to maintain a healthy bio-film on the bead media.

Our filters have been more thoroughly tested than any other filter on the market. Period! For over 10 years, Bubble-Washed Bead Filters have been the choice of the most discriminating water garden and Koi pond enthusiasts in the U.S. and Europe. Also, many research facilities and aquaria have discovered there is simply no substitute for the easy maintenance and effectiveness of our Bubble-Washed Bead Filters.



# BUBBLE-WASHED BEAD FILTER SIZING CRITERIA

Bead filter sizing criteria are highly dependent on the application in which the filter will be utilized. For assistance in selecting the appropriate Bead Filter for your application you can visit our website at [www.BeadFilters.com](http://www.BeadFilters.com) to download a copy of the Bead Filter Sizing Worksheet or you can use our Electronic Bead Filter Sizing Calculator. Worksheets should be faxed or e-mailed to AST for review and/or sizing recommendations.

## Filter Application

### Aquaculture

**Bioclarification:** In applications where bead filters are acting as bioclarifiers providing both solids capture and biological filtration, they are sized according to the maximum amount of feed (35% protein dry pellets) that will be introduced into the system per day. Bead Filter Sizing recommendations are presented in Table 1 below for both standard bead media (Figure 1) and enhanced nitrification bead media (Figure 2). For “bioclarification applications” requiring additional nitrification such as seafood holding systems, bait systems and/or cold water applications we offer enhanced nitrification bead media as an option. EN Media are essentially “shaped beads” which provide protection for the delicate bacterial biofilm during backwashing. By reducing abrasion of the bacterial biofilm during backwashing, the use of EN Media can boost nitrification rates up to 50% over standard bead media.

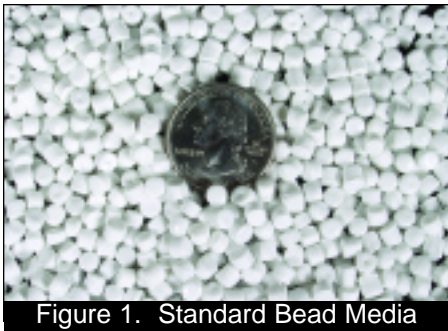


Figure 1. Standard Bead Media



Figure 2. Enhanced Nitrification Bead Media

**Solids Capture Only:** In applications where BubbleBead Filters will only be used as clarifiers we size the filter according to either the maximum daily feed input or simply choose a filter size with a flow rate compatible with the biological filter. Our estimated size assumes you will backwash the filter at least twice per day. Increase loading can be obtained with increased backwash frequency.

### Display

**Koi / Display Ponds:** In applications where bead filters are installed on Koi Ponds as bioclarifiers, we utilize a hydraulic sizing criteria whereby we like to obtain a 2 hour turnover of the entire pond through the filter. This rate is dictated by the algae reproduction rate, which is estimated to be 4-6 hours and coincides with the recommended pond turnover rate through a UV Sterilizer required to kill algae faster than it can reproduce.

**Displays with “Underwater Viewing”:** In applications where the display will have “underwater viewing”, we also use a hydraulic sizing criteria to estimate the required filter size needed to perform bioclarification. Our experience is that zoos and aquariums demand their systems turnover every 30 minutes. We also recommend the use of a properly sized and installed ozone system on displays with underwater viewing.

Table 1 represents the filtration capacities for Bubble-Washed Bead Filters for several applications. The criteria presented already have a substantial safety factor included. The units can be used as a solids capture device, as an aquaculture bioclarifier (providing complete solids capture and nitrification, or in support of display tanks and ponds). The bioclarifier category is divided into three sub-categories reflecting changes in water quality objectives. For aquaculture fingerling/ornamental growout two separate loading guidelines are provided for warmwater and coldwater conditions. In both cases, the criteria are designed to ensure that a TAN level below 0.5 mg-N/L can be achieved. These are peak sustainable loading guidelines meaning that a filter can sustain the indicated TAN concentration at the peak loading for an indefinite period. Finally, a set of criteria is provided for broodstock and fry systems that provides very pristine water quality with a maximum TAN below 0.3 mg-N/L. The safety factors on these later criteria are high and no adjustment for coldwater is required. Criteria for Koi ponds and display systems are limited by fine solids capture, and not nitrification. Criteria for these applications are expressed by the total volume of the pond or tank. These criteria are set to ensure a high degree of water clarity.

The table assumes that the units are backwashed regularly as demanded by the application. Less frequent washing decreases the peak capacity of these units, whereas, more frequent washing can substantially increase their peak capacities. Pond and display criteria are not subject to peak loading conditions and are not as sensitive to backwash frequency. The aquaculture growout bioclarification category was excluded from this table, since Bubble-Washed Bead Filters are not recommended for use in high-density grow-out applications.

# BUBBLE-WASHED BEAD FILTER SIZING CRITERIA (Cont.)

Table 1 also contains criteria for Enhanced Nitrification media. This media is specifically designed to enhance the retention of nitrifying bacteria in the bead bed. This increased bacterial capacity is reflected in the higher peak loading estimates. Systems that are operated below their peak loading capacity will display a lower residual TAN and nitrite concentration than would be obtained by the same sized filter with spherical beads. In a sense a small bead filter with EN media nitrifies like a larger bead filter (usually the next size up). In those applications limited by nitrification capacity, the EN media allows a smaller filter to carry a bigger load. The EN media, however, presents no benefit to the pond and display tank applications since EN media does not capture fine solids any better than spherical beads. Marine and coldwater applications particularly benefit from the use of EN media. Marine nitrifying bacteria and cold water bacteria tend to be slow growing so the extra protection provided by the EN media can decrease the biofilters' sensitivity to change.

Table 1. **Bubble-Washed Bead Filter Sizing Recommendations**

New Filter Models	XS300A	XS500	XS1000	XS2000	XS4000	XS6000	XS8000	XS10000	XS12000	XS20000
Old Filter Models	BBF-1/4A*	BBF-1/4	BBF-1/2	BBF-1	BBF-2	BBF-3	BBF-4	BBF-5	BBF-6	BBF-10
Flow Rate (gpm)	10	10	10	15	30	45	60	75	90	150
Bioclarification Aquaculture Fingerling/Ornamental Grow-out >15 deg C Std beads/En Media (lbs feed/day)	.13/.17	.13/.17	.25/.33	.50/.67	1/1.3	1.5/2	2/2.7	2.5/3.3	3/4	5/6.7
Bioclarification Aquaculture Fingerling/Ornamental Grow-out <15 deg C Std beads/En Media (lbs feed/day)	.08/.13	.08/.13	.17/.25	.34/.5	.67/1	1/1.5	1.34/2	1.68/2.5	2/3	3.35/5
Bioclarification Aquaculture Broostock/Fry/Holding/ Conditioning Std beads/En Media (lbs Feed/day)	.06/.10	.06/.10	.13/.19	.25/.38	.5/1.75	.75/1.1	1/1.5	1.25/1.9	1.5/2.3	2.5/3.8
Max Koi Load (lbs)	6.25	6.25	12.5	25	50	75	100	125	150	250
Solids Only (lbs feed/day)	.125	.125	.25	.50	1.0	1.5	2.0	2.5	3.0	5.0
Outdoor Pond Size (gallons)	200*	500	1,000	2,000	4,000	6,000	8,000	10,000	12,000	20,000
Display w/under-water Viewing (gal)	200	300	300	450	900	1,350	1,800	2,250	2,700	4,500

Note: New BBF filter model numbers represent the maximum recommended pond volume (gallons).

Old BBF filter model numbers represented the volume of bead media in cubic feet.

\*Aquarium Model.

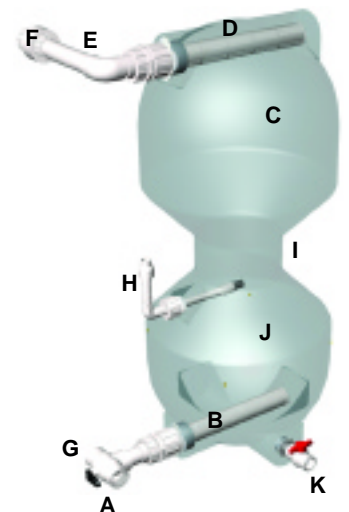
## BUBBLE WASHED BEAD FILTER CONFIGURATION

### Normal Operation:

- Water is pumped through the Filter Inlet via a 3-way Valve positioned to (A) and the Diffuser (B).
- Water passes upwards through Bead Bed (C) for bioclarification and exits through Screen (D).
- Filtered water is returned through Effluent Line (E) and a Check Valve (F).

### Backwashing:

- The pump is turned off and the 3-way Valve at the Inlet is turned to the Sludge Drain Position (G).
- Backwashing is accomplished by completely draining the water from the filter.
- As water drains from the filter, the air is sucked into the Air Inlet Check Valve (H).
- Agitation of the beads is accomplished as air rises up through the Washing Throat (I) and beads and water drop down into the Expansion Chamber (J).
- As the beads enter the Expansion Chamber (J), they initially sink with momentum, and then float upwards as buoyancy takes hold. As this occurs, water is sweeping past the beads and serves to carry away the solids freed from the bead media.
- Once the filter unit has drained completely, the 3-way Valve is returned to position (A) and the Pump (not shown) is turned back on.
- An unscreened Emergency Drain (K) is provided at the bottom of the filter unit.



**AST also offers Automated Backwash Controllers for all BBF Filters.**

## Length/Weight Conversion Chart

Use this chart to estimate your current Koi load and project your maximum Koi load.

Length of Fish in Inches	Weight of Fish in Ounces
4"	0.4
5"	0.5
6"	1.5
7"	2.4
8"	3.6
9"	5.1
10"	6.9
11"	9.2
12"	12
13"	15
14"	19
15"	23
16"	28
17"	34
18"	41
19"	48
20"	56
21"	64
22"	74
23"	84
24"	96
25"	109
26"	122
27"	137
28"	152
29"	169
30"	186
31"	207
32"	228
33"	250
34"	273
35"	298
36"	324

FILTER MODEL	Cubic Feet of Bead Media	Dimensions, Material & Color Options	Recommended Maximum Pond Volume (gallons)	Maximum Pressure (psi)	Maximum Koi Load (pounds)	Maximum Recommended Flow Rate (gpm/gph)	Approximate Backwash Waterloss (gallons)	Recommended Pumps*	Recommended UV Sterilizer for Algae Control**
BBF-XS300A	0.25	20"H x 12" dia P.E. Green	75-200 (Aquarium)	10	6.25	10/600	2.5	Danner MD7 Danner MD9.5 Danner MD12	AST 25-1 Watt
BBF-XS500	0.25	32"H x 10" dia P.E. Green	500	10	6.25	10/600	5	Artesian A1/8-30 Danner MD7 Danner MD12 SEQ-3600-12	AST 25-1 Watt
BBF-XS1000	0.50	35"H x 12" dia P.E. Green	1,000	10	12.5	10/600	8.5	Artesian A1/8-30 Danner MD12 Danner MD18 SEQ-3600-12	AST 25-1 Watt
BBF-XS2000	1.0	42.5"H x 16" dia P.E. Green/Brown	2,000	10	25	15/900	12	Aquaflor 1/15 hp Artesian A1/8-35 Danner MD24 SEQ-4200-12 SEQ-3200-20 SEQ-6000PRM17	AST 40-1 Watt
BBF-XS4000	2.0	49"H x 19.5" dia P.E. Green/Brown	4,000	10	50	30/1,800	25	Aquaflor 1/8 hp Artesian A1/4-40 SEQ-4300-20 SEQ-5000-22 Sta-Rite 1/6 hp LTL	AST 80-1 Watt
BBF-XS6000	3.0	49"H x 19.5" dia P.E. Green/Brown	6,000	10	75	45/2,700	25	Aquaflor 1/6 hp Dragon 1/4 hp SEQ-5000-22 Sta-Rite LT-ACL	AST 80-2 Watt
BBF-XS8000	4.0	60"H x 26" dia P.E. Green/Brown	8,000	10	100	60/3,600	45	3/4 hp Dyna Max Aquaflor 1/6 hp Artesian A1/4-49 SEQ-5800-23 SEQ-7200PRM23	AST 80-2 Watt
BBF-XS10000	5.0	60"H x 26" dia P.E. Green/Brown	10,000	10	125	75/4,500	45	3/4 hp Dyna Max Dragon 3/4 hp SEQ-5800-23 SEQ-7200PRM23	AST 80-2 Watt
BBF-XF12000	6.0	82"H x 32" dia Fiberglass Green/Paintable	12,000	15	150	90/5,400	65	3/4 hp Dyna Max Aquaflor 1/4 hp Artesian A1/3-56 Dragon 1 hp	AST 120-2 Watt
BBF-XF20000	10.0	88"H x 34" dia Fiberglass Green/Paintable	20,000	15	250	150/9,000	150	1-1/2 hp Dyna Max (2) Aquaflor 1/4 hp Artesian A1.5 Dragon 1.5 hp	AST 150-2 Watt

\* Actual pump selection depends on your individual system hydraulics (i.e. pipe size, length of pipe, elevation, etc.).

\*\* Recommended UV Sterilizers are sized to provide a minimum of 30,000 UW-sec/cm<sup>2</sup>. AST UV's include vertical mounting kits to attach UV directly to the filter.

Length/Weight Conversion Chart

\* Assumes normal size of healthy fish

\* Re-printed from KOI USA May/June 2001 issue with permission of author, Larry Lunsford.

# DEMAND BUBBLE BEAD FILTER PERFORMANCE



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