

Hydroworks® HydroDome Laboratory Testing

Introduction

A HydroDome was tested in the Hydroworks' laboratory for TSS removal using the mass capture method. The TSS removal tests indicate that the HydroDome would be rated at 18.6 gpm/ft² based on the NJDEP weighting formula.

Laboratory Setup

Test Loop

A HD2 insert was installed in a 2 ft diameter tank with a 2.5 ft sump. The 2 foot diameter tank was installed in a test loop comprising of a return tank with a HydroFilter cartridge, a Multiquip 2" submersible pump, a Seametrics WMP104 magmeter, an ASAHI 3" gate valve, and 3" diameter PVC piping. A diagram of the test setup is shown in Figure 1.

Water was pumped out of a 4 ft diameter storage tank through 3" PVC piping to the HydroDome. A Seametrics WMP104 3" diameter magmeter was installed in a submerged section of pipe upstream of the HydroDome to ensure full pipe flow at all flow rates for accuracy of the magmeter readings. Discharge into the HydroDome was comprised of an elbow at the end of the piping into the HydroDome structure facing directly downwards on to the HydroDome from above to simulate the flow coming in from an inlet grate. The HydroDome outlet discharged freely into a 3" discharge pipe back to the storage tank. Water entering the storage tank was filtered through a 2ft diameter HydroFilter (HF) cartridge prior to being pumped back through the 3" pipe loop.

TSS injection

A tee was installed in a horizontal section of 3" piping less than 12" upstream of the downturned elbow discharging into the HydroDome structure. A plastic hopper with a digitally controlled variable speed auger was used to meter out the TSS into the flowing water in the test loop. The initial mass to be put into the loop during each test was measured using a LS-30 scale accurate to 1.0 gram. An average of 607 g was used for each test making the measurement error of the input mass approximately 0.2%.

All of the initial mass weighed for each test was input through the test loop. Any residual TSS (dust) was washed out of the hopper into the test loop with the water flowing through the loop for at least 3 detention times after the cessation of all TSS input to ensure all input TSS had adequate time to circulate through the system.

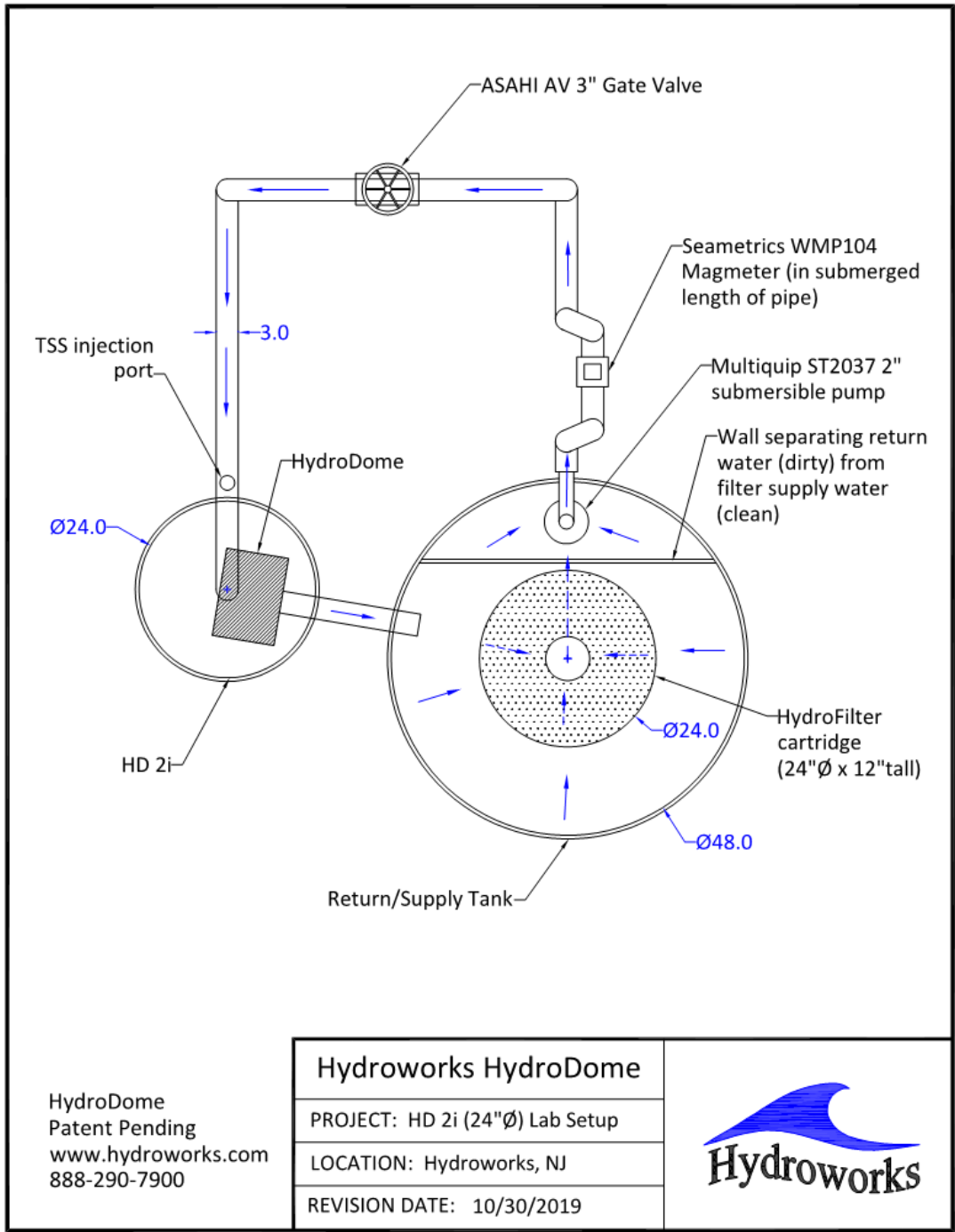


Figure 1. HydroDome Test Loop

TSS Particle Sized Distribution

The TSS used for testing was the AGSCO NJDEP (1-1000 um) TSS Mixture. The particle size distribution for the AGSCO (1-1000) sediment is shown in Figure 2. The AGSCO NJDEP mixture was designed to meet the NJDEP test TSS specifications. As demonstrated in Figure 2, the AGSCO TSS is close to the TSS specified by NJDEP.

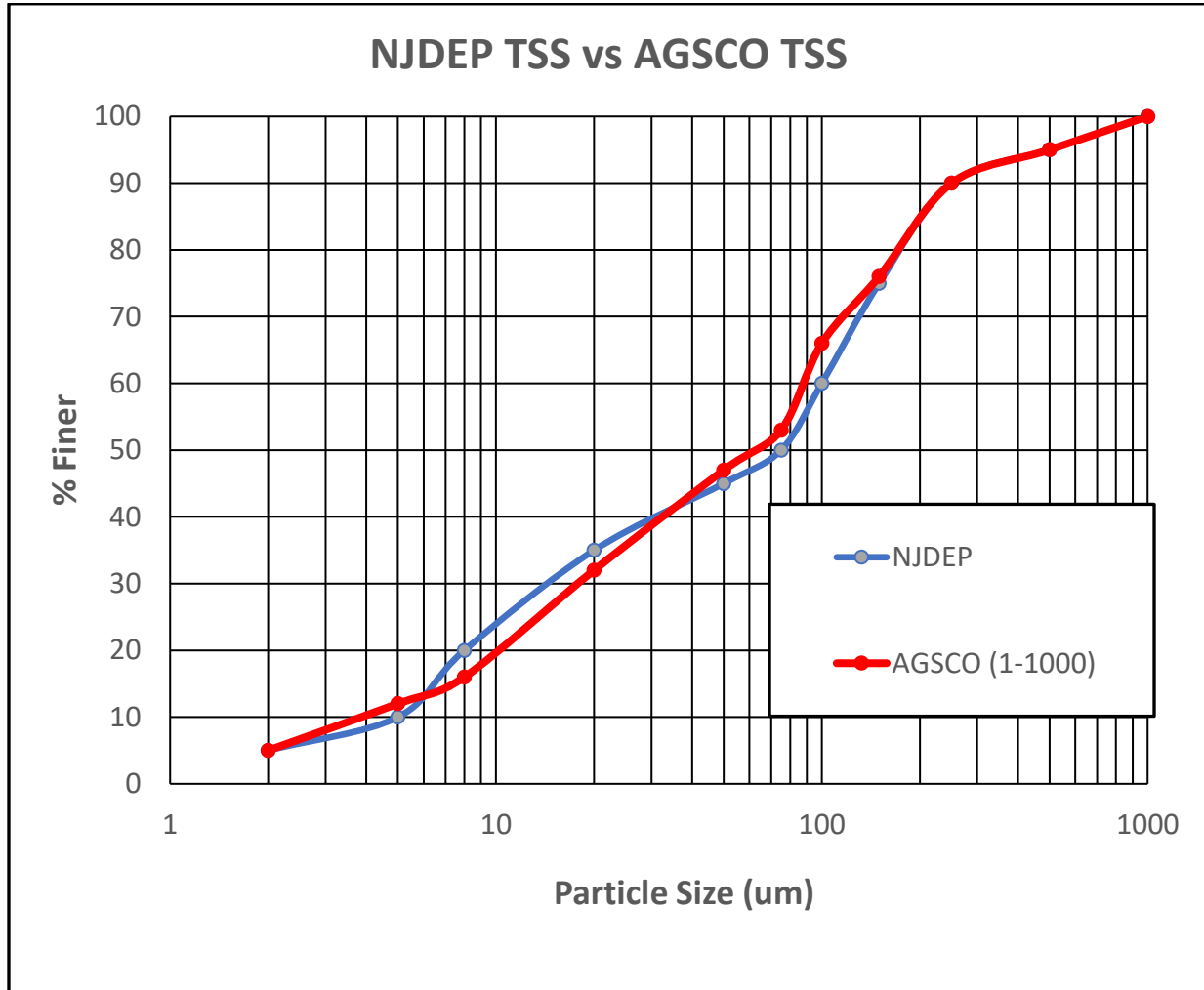


Figure 2. Test TSS Particle Size Distribution

Flowrate

The HydroDome was tested at flow rates ranging from 1 gpm/ft² to 19 gpm/ft². The flow rate was controlled using an ASAH 3" gate valve. TSS injection began within 3 to 5 minutes after the desired flow rate for each test was stabilized based on readings from the Seametric WMP104 magmeter. The flow rate during each test was continually monitored based on the continuous readings from the magmeter to ensure the flow rate was at the desired value throughout the test.

TSS Removal

After each TSS removal test, the tank was allowed to sit for 24 h before the captured TSS was removed from the HydroDome structure. Clear water was decanted from the separator and discarded without filtering or measurement. The remaining water and sediment was collected in two 5-gallon pails. The water in the pails was then heated with a 1500 W bucket heater to clarify the water. Clear water was evaporated / decanted and discarded without measurement.

The remaining water sediment slurry was transferred to a non-ferrous tray and heated in an oven until all of the remaining water was evaporated. The sediment was repeatedly dried and weighted until the weight of the dry sediment did not change over time by more than 1%. The trays were weighed prior to adding the sediment water mixture and the weight of the tray was subtracted from the final weight of the dried sediment to determine the TSS removed.

TSS removal was based on the weight of the removed TSS divided by the input TSS that was previously weighed prior to the start of the test.

The input TSS was weighed without drying it prior to placement in the injection hopper, whereas the removed TSS used to calculate TSS removal was dried in an oven. This is conservative since the input TSS would be lower if dried, or correspondingly, the removed TSS would be higher if the moisture content (2%-6%) was added back in, resulting in higher TSS removals than reported in this study.

TSS Removal Results

Eight tests were conducted ranging from 1 to 20 gpm/ft². The average input TSS weight per run was 607 grams. The average input TSS concentration was 145 mg/l. The average water temperature during the tests was 73.6 °F. At no time did the water temperature exceed 80 °F. Test data is shown in Table 1.

Run	1	2	3	4	5	6	7	8
TSS in (g)	544	578	632	630	606	640	600	630
Flow (gpm)	12.2	21.5	31.3	60.1	3.15	41.1	51.2	31.7
Flow (gpm/ft2)	3.9	6.8	10.0	19.1	1.0	13.1	16.3	10.1
Time TSS (min)	80	55	34	48	100	90	59	86
TSS loading (mg/l)	147	129	157	58	508	46	52	61
Time Flow (min)	100	65	42	55	110	105	73	95
Temp start (F)	77.4	77.2	75	73.1	73.2	70.4	68.4	70.2
Tem end (F)	78.6	78.8	75	74.9	74.2	71.8	70.2	72.7
TSS removed (g)	364	334	314	248	436	296	248	334
TSS removal (%)	66.9%	57.8%	49.7%	39.4%	71.9%	46.3%	41.3%	53.0%

The results of the eight runs are plotted in Figure 3. Results followed an exponential distribution with good accuracy. The correlation coefficient (r) of the exponential trendline from the test data was 0.99.

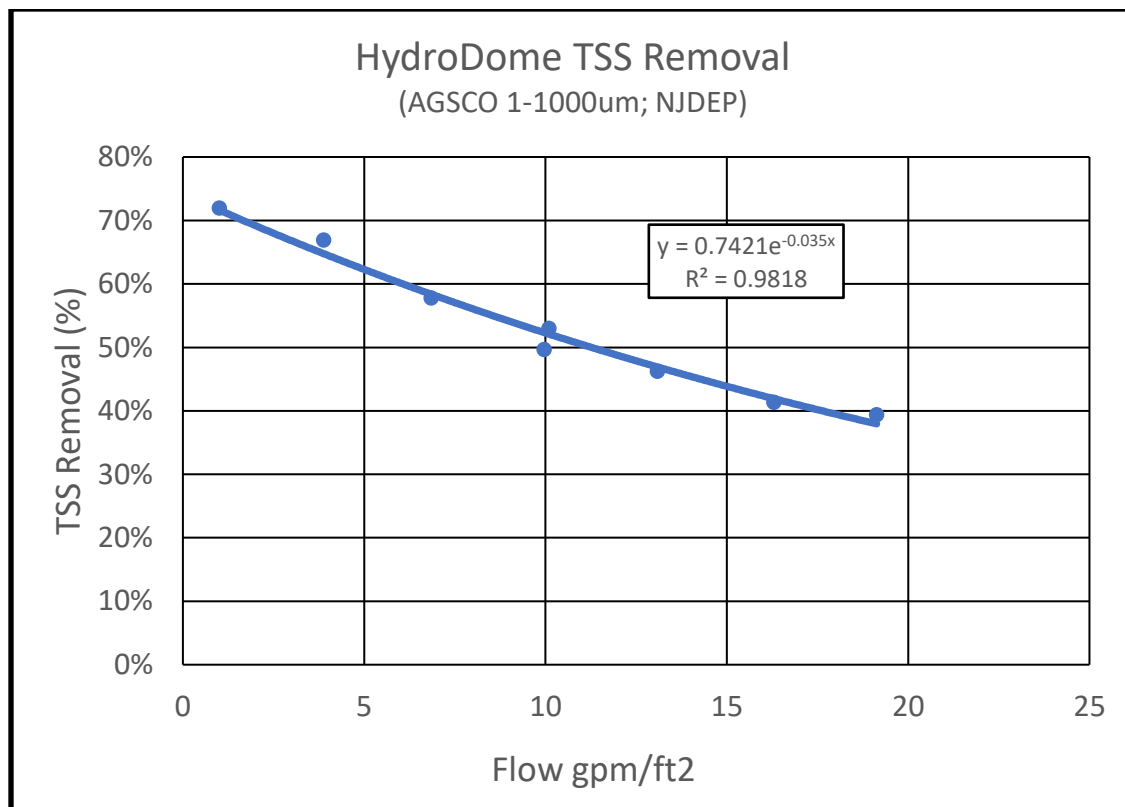


Figure 3. HydroDome TSS Removal Curve

Calculated Water Quality Flow Rate

The regression equation from Figure 2 was used along with the NJDEP weighting criteria (Table 2) to define a NJDEP water quality flow rate for HydroDome.

%MTFR	Flow (gpm/ft²)	TSS Removal*	NJ Wt	Wt TSS
0.25	4.65	63.1%	0.25	15.8%
0.5	9.3	53.6%	0.3	16.1%
0.75	13.95	45.5%	0.2	9.1%
1	18.6	38.7%	0.15	5.8%
1.25	23.25	32.9%	0.1	3.3%
			Sum	50.0%

*based on the regression line in Figure 2

**MTFR= Maximum Treatment Flow Rate = WQF

Based on the NJDEP weighting system and the TSS removal curve from Figure 2, the hydraulic loading rate for 50% removal of the is 18.6 gpm/ft². Table 4 provides a sizing table for the HD3 through HD 6 based on this analysis and surface area scaling.

HD 3	0.29
HD 4	0.52
HD 5	0.81
HD 6	1.17

The water quality flow rates given in Table 4 are based on the TSS particle size distribution given in Figure 2 (AGSCO 1-1000 / NJDEP). Water quality flow rates for coarser TSS distributions (i.e. OK110), or finer TSS, will be respectively higher, and lower, than those provided in Table 4.

Summary

A Hydroworks HydroDome was tested in Hydroworks' laboratory using the mass capture method. The water quality flow for the HydroDome was calculated to be 18.6 gpm/ft² based on the AGSCO (1-1000 um) TSS tested and NJDEP water quality flow weighting calculations. This flow rate was used to scale flow rates for the HD 3 through HD 6 models based on the widely accepted method of surface area scaling. These flow rates are specific to the TSS tested and will vary higher or lower depending on whether the design TSS is coarser or finer than the AGSO TSS.