

NJCAT TECHNOLOGY VERIFICATION

Debris Separating Baffle Box (DSBB™) Stormwater Treatment System

Performance Verification of Sediment Capture and Scour using a Coarse Silica Sand

Bio Clean Environmental Services Inc.

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1. Introduction

The Bio Clean Debris Separating Baffle Box (DSBB™) is a stormwater treatment system utilizing non-clogging screening and hydrodynamic separation to capture pollutants. A test program was conducted by Good Harbour Laboratories (GHL), an independent water technology testing lab based in Ontario, Canada, to evaluate the performance of the DSBB™. The study results were submitted to the New Jersey Corporation for Advanced Technology (NJCAT) for verification. NJCAT is a private/public partnership that provides independent technology verification, education and information on emerging environmental and energy technology fields.

This testing program was based primarily on the *New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device (January 25, 2013)*. The particle size distribution (PSD) of the test sediment used for this study is coarser than that specified in the protocol, so the results will not be submitted to NJDEP for certification. This larger PSD is common in many regions throughout the nation and thus more applicable in these areas.

1.1 Description of Technology

The Debris Separating Baffle Box (DSBB) hydrodynamic separator is a manufactured treatment device (MTD) designed by Bio Clean Environmental Services Inc., a Forterra Company. The DSBB is an advanced stormwater treatment system utilizing non-clogging screening and hydrodynamic separation to capture pollutants. The non-clogging screening system stores trash and debris in a dry state, suspended above the sedimentation chambers, reducing nutrient leaching, bacterial growth, bad odors, and allowing for easier cleaning. The DSBB's triple chamber design provides high removal of total suspended solids over a wide range of particle sizes. This feature allows the system to be installed online, thus eliminating the need for diversion structures. The oil skimmer and hydrocarbon booms trap oil. The DSBB is approved by the California State Water Board for "full capture" which is defined as 100% removal of trash and debris down to 5 mm in size up to the screen treatment flow rate.

The DSBB is designed to evenly distribute entering stormwater thus optimizing its ability to capture suspended solids efficiently with minimal surface area. The system has no moving parts and operates utilizing the principles of gravity separation and flow path maximization to increase settling of particulates. The major components and the physical lay-out of the system are shown in **Figure 1**. All filtration screens, hinges and locking mechanisms are 304 stainless steel construction.

Runoff is directed into the system via the inflow pipe and enters the area above the first sediment chamber, as illustrated in **Figure 2**. The flow is split into two directions down the middle by the splitter screen and toward the filter screens along both sides of the system. As water travels along the splitter screen, debris and trash are directed onto the screens and clean water passes through the screen. The openings of the splitter screen face the opposite direction of the water flow preventing the screen from being blocked and creating a passive, self-cleaning effect as shown in **Figure 3**.

As the water passes over the first sediment chamber, the larger sediments settle to the bottom before reaching the filtration screens. This prevents larger sediments from entering the filter screens. The debris ramp directs the flow upward onto the filter screens to insure 100% capture of

all floatable material. As water passes over the first baffle wall, all trash and debris equal to or greater than 5 mm have been directed onto the filter screens to be retained. At this point in the system, flow has been spread out across its width to reduce velocity and increase settling of finer sediments. The filter screens utilize the same self-cleaning screens as the splitter screen and face the opposite direction of the flow. The filtration screens are elevated 3" above the outlet pipe invert and standing water level. During storm events, water can exit the filtration screens through the bottom and side screens. Since the openings face the opposite direction of the water flow, this further reduces velocity and increases the flow path. The second sediment chamber collects medium to finer sediments as water passes overhead toward the third sediment chamber and oil skimmer wall.

The oil skimmer wall protrudes downward below the standing water to capture and trap free-floating oils and hydrocarbons. The oil skimmer wall has a hydrocarbon boom and cage mounted to its influent side to provide increased capture of these hydrocarbons. As water passes under the oil skimmer and into the third sediment chamber, the remaining finer particulates and sediments are settled out. The second and third sediment chambers include turbulence deflectors to prevent scouring during higher flows.

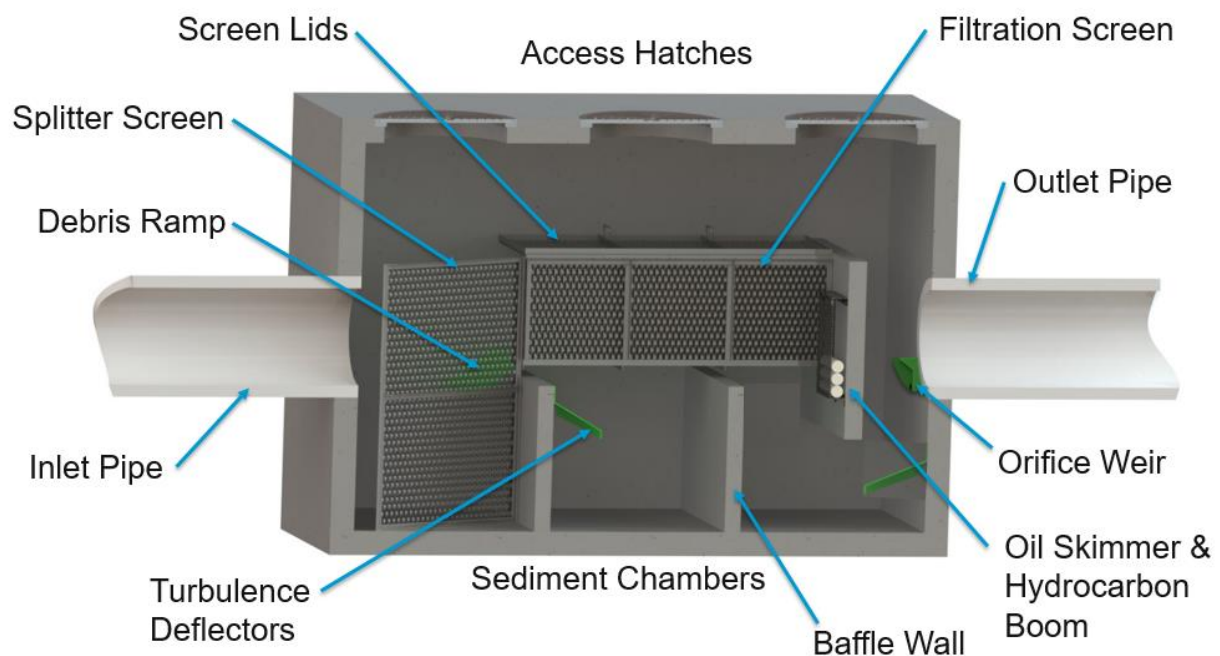


Figure 1 Cut-Away View

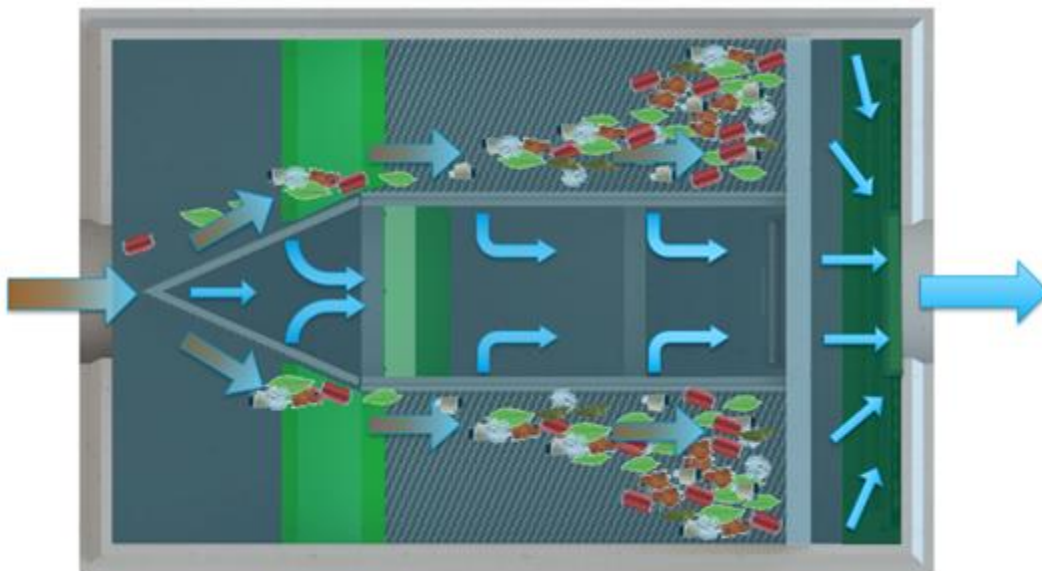


Figure 2 Operational Diagram – Top View

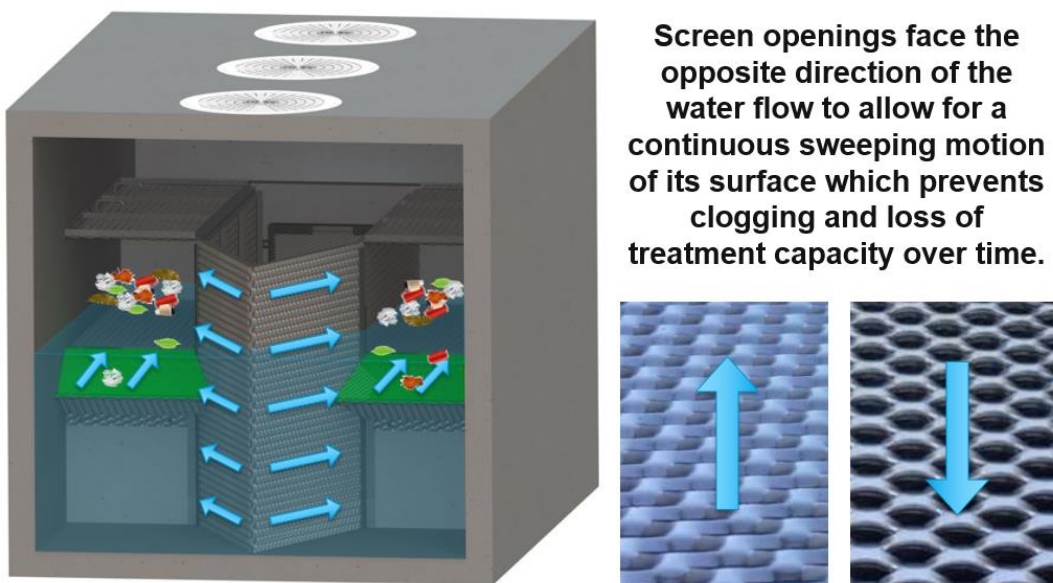


Figure 3 Operational Diagram – Front View & Screen Detail

The DSBB is designed to be installed online with minimal scouring and handle large flow rates with minimal head loss. During larger storm events, water passes over the top of the splitter screen and filtration screens. The filtration screens have sliding or hinged tops that prevent loss of captured trash and debris during higher flows. High flows have a direct path over the top of and between the screens toward the outlet side of the system, as shown in **Figure 4**, to minimize head loss. **Figure 5** is a cut sheet of the test unit (Model DSBB-2.5-5).

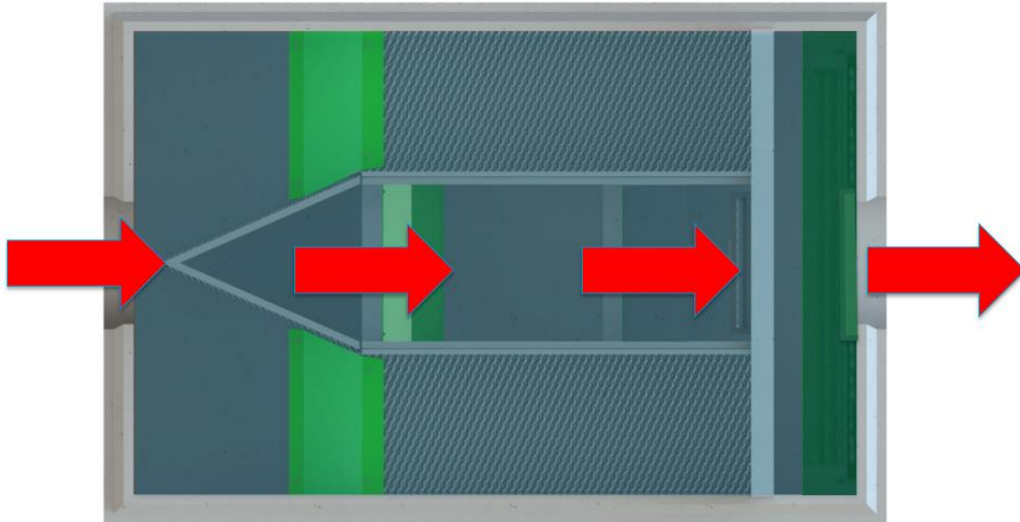


Figure 4 High Flow Bypass – Top View

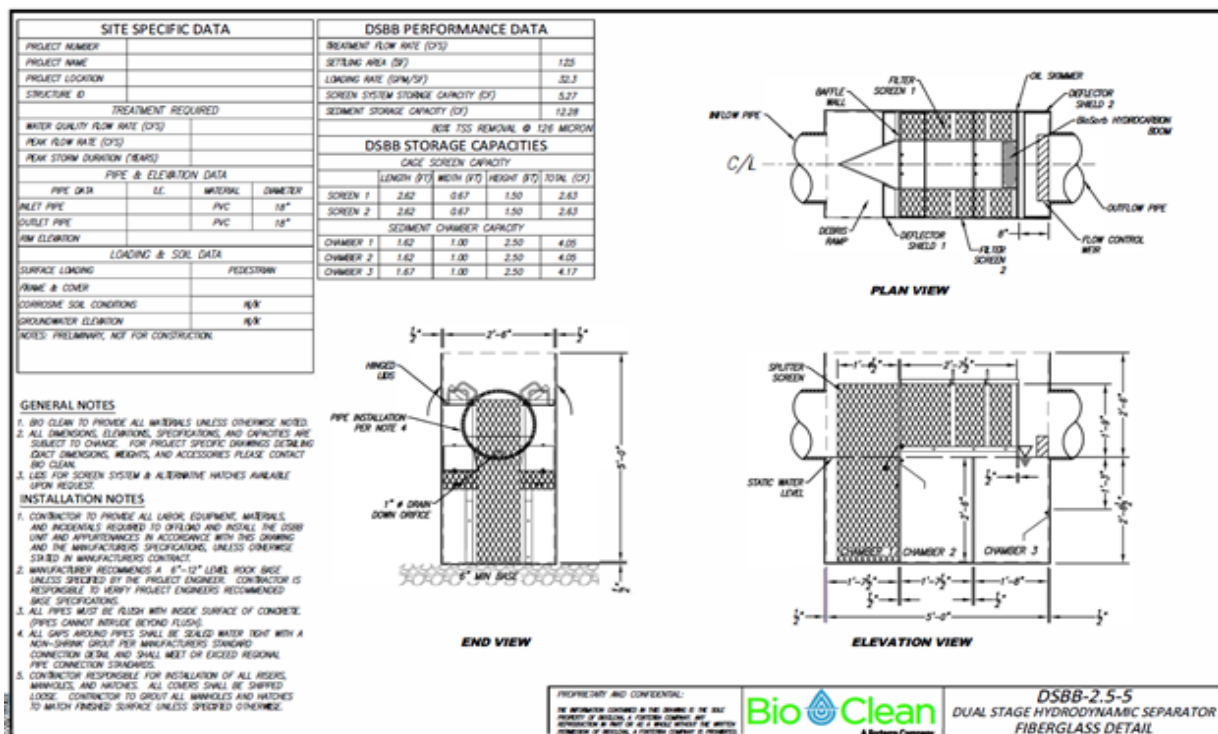


Figure 5 Cut Sheet of Test Unit

2. Laboratory Testing

The device tested was a 60-inch X 30-inch DSBB™ unit (DSBB-2.5-5) consisting of internal components housed in a plywood vault (**Figure 6**). In commercial systems, the internal components are typically housed in a concrete vault. The plywood vault of the test unit was equivalent to commercial concrete vaults in all key dimensions. The internals of the DSBB™ were supplied by Bio Clean. The use of a wooden vault was proposed due to the difficulties associated with transporting and physically supporting the weight of a concrete unit. Using plywood in lieu of concrete did not have an impact on system performance. The vault construction and the installation of the internals were completed by GHL. Testing of the unit occurred in September 2018.

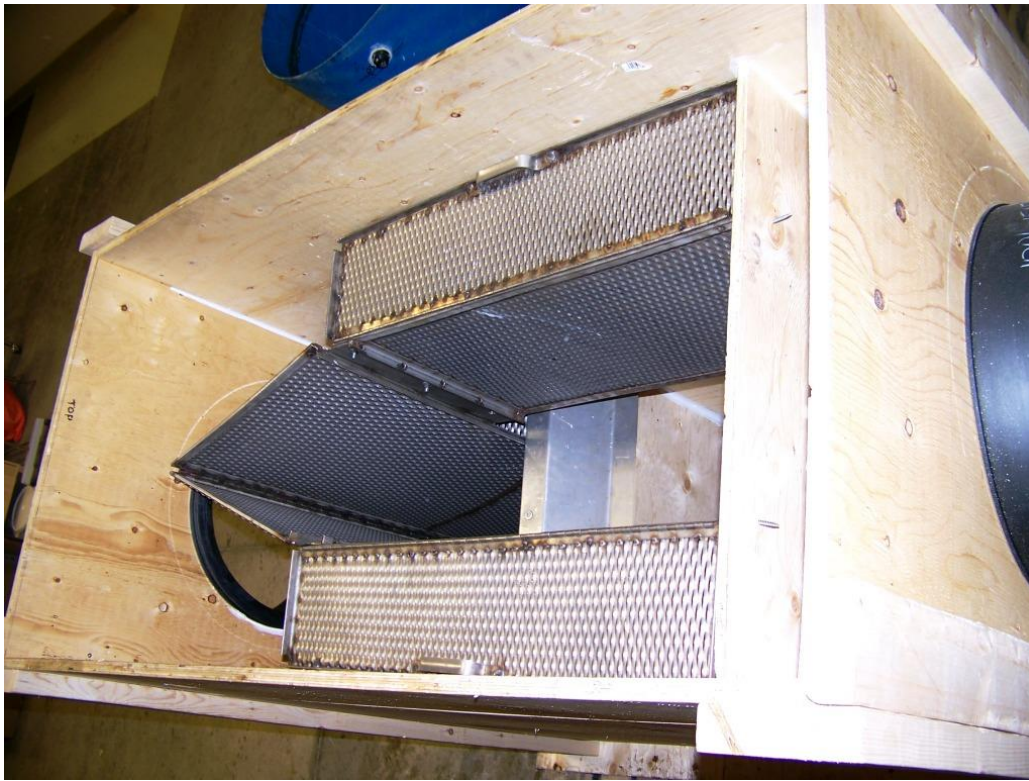


Figure 6 Debris Separating Baffle Box in Plywood Vault

2.1 Test Setup

The design specifications of the DSDB™ are provided in **Table 1**. The test unit had a total sedimentation area of 12.5 ft² and a maximum treatment flow rate (MTFR) of 0.9 cfs (404 gpm).

Table 1 Debris Separating Baffle Box Dimensions

Model Number	MTFR		Dimensions, L X W (inch)	Surface Loading Area (ft ²)	Surface Loading Rate (gpm/ft ²)	Sediment Storage Capacity (ft ³)
	cfs	gpm				
DSBB-2.5-5	0.9	404	60 X 30	12.5	32.3	12.5

The laboratory test set-up was a water flow loop, capable of moving water at a rate of up to 2.2 cfs. The test loop, illustrated in **Figure 7**, was comprised of water storage tanks, pumps, sediment filter, receiving tank and flow meters.

Water Flow and Measurement

From the water storage tanks, water was pumped using either a WEG Model FC00312 (1 – 200 gpm) or an Armstrong Model 8X8X10 4380 (200 – 1000 gpm) centrifugal pump, depending on flow rate required. Flow measurement was done using either a 3” Toshiba Model GF630 electromagnetic type flow meter with an accuracy of $\pm 0.5\%$ of reading (1 – 200 gpm) or an MJK Magflux Type 7200 flow meter Model 297237 with an accuracy of $\pm 0.25\%$ of reading (100 – 1000 gpm). The data logger used was a MadgeTech Process 101A data logger, configured to record a flow measurement once every minute.

The water in the flow loop was circulated through a closed filtration system (Fil-Trek model ELPA30-1012-8F-150, **Figure 8**), where the influent water was filtered using bag filters with a 1 μm nominal rating. The influent pipe to the DSBB™ was 18 inches in diameter and 150 inches long. The effluent pipe was 18 inches in diameter and 37 inches long. Water flow exited the DSBB™ and terminated with a free-fall into the Receiving Tank to complete the hydraulic circuit.

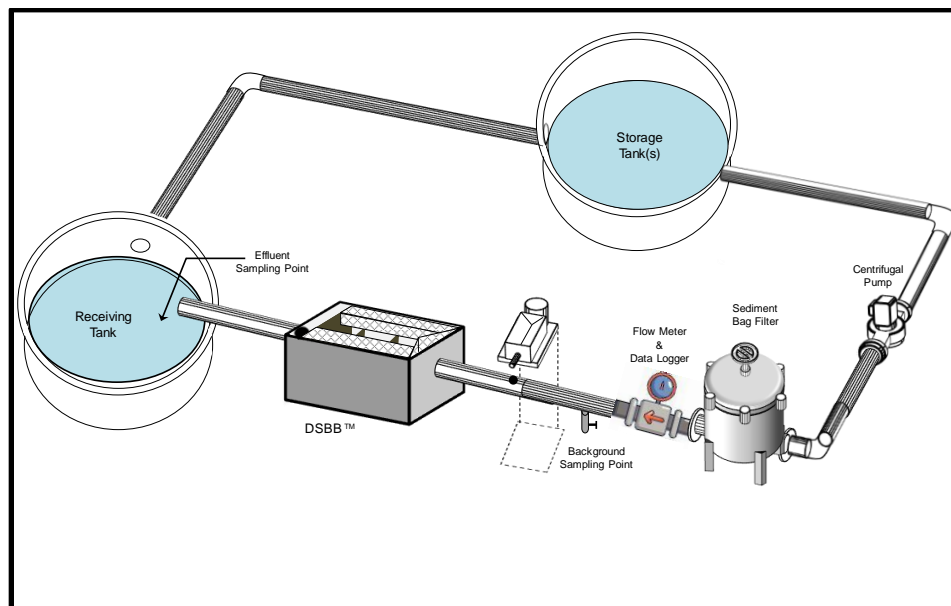


Figure 7 Test Flow Apparatus



Figure 8 Fil-Trek Filtration System

Sample Collection

Background water samples were collected in 1L jars from a sampling port located upstream of the auger feeder and downstream of the filtration system. The sampling port was controlled manually by a ball valve (**Figure 9**) that was opened approximately 5 seconds prior to sampling.

Effluent samples were also grabbed by hand. The effluent pipe drained freely into the Receiving Tank and the effluent sample was taken at that point (**Figure 10**).



Figure 9 Background Sampling Point



Figure 10 Effluent Sampling Point

The sampling technique was to take the grab sample by sweeping a 1 L wide-mouth jar through the stream of effluent flow such that the jar was full after a single pass.

Other Instrumentation and Measurement

Effluent water temperature was taken using a MadgeTech MicroTemp data logger, configured to take a reading once every minute. The sensor was suspended in the compartment closest to the influent pipe.

Run and sampling times were measured using a NIST traceable stopwatch, Control Company Model 62379-460.

The sediment feed samples that were taken during the run were collected in 500 mL jars and weighed on an analytical balance (Mettler Toledo, AB204-S).

The total amount of sediment fed during the removal efficiency runs was determined by mass-balance. The auger feeder was emptied out at the end of each test and the sediment was weighed using a Mettler Toledo BBA231-3BB35A/S industrial balance.

2.2 Test Sediment

The test sediment used for this study was commercially available silica sediment supplied by AGSCO Corporation, generally referred to as #110 but labeled #140-200. This particular batch was composed of five separate sediment lots that were blended by GHIL; the GHIL internal lot number for the blend is A022-20. During blending, three representative sediment samples were taken of the batch and analysed for particle size distribution using the methodology of ASTM method D422-63 (reapproved 2007). The testing was completed by GHIL and the PSD results are summarized in **Table 2** and shown graphically in **Figure 11**.

Table 2 Particle Size Distribution Test Sediment, GHIL Lot #A022-20

Particle Size (µm)	Test Sediment Particle size (%passing)			
	Sample 1	Sample 2	Sample 3	Average
1000	100.00	100.00	100.00	100.0
500	99.94	99.96	99.95	100.0
250	96.65	96.56	97.24	96.82
150	72.82	72.75	74.84	73.47
100	26.11	25.47	28.42	26.67
75	8.33	7.79	9.73	8.62
d ₅₀ (µm)	126	127	124	126

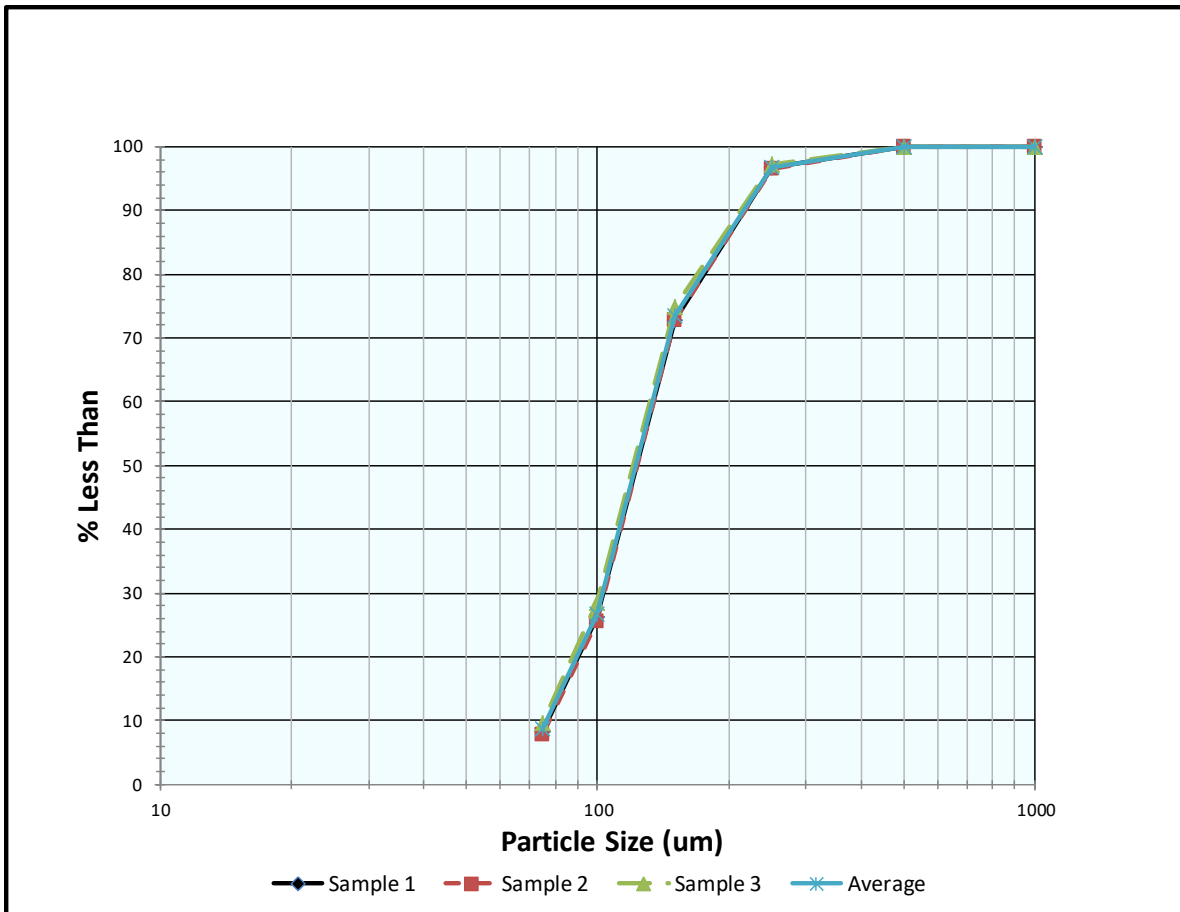


Figure 11 Average Particle Size Distribution of Test Sediment, GHL Lot #A022-20

2.3 Removal Efficiency Testing

The DSBB™ has a maximum sump sediment storage depth of 12 inches. Removal testing was conducted on a clean unit with a false floor installed in each compartment at 50% of the sump sediment storage depth, 6 inches above the vault floor. Removal Efficiency Testing was based on Section 5 of the NJDEP Laboratory Protocol for Hydrodynamic Sedimentation MTDs.

The test sediment was fed through an opening in the crown of the effluent pipe, 90 inches (5 pipe diameters) upstream of the DSBB™. The sediment feeder was an Auger Feeders Model VF-1 volumetric screw feeder with vibratory hopper. The feeder had a 10-gallon hopper above the auger screw to provide a constant supply of sediment. A funnel was used to direct the sediment into the pipe (**Figure 12**).



Figure 12 Sediment Addition Point

The test sediment was sampled six times per run to confirm the sediment feed rate. Each sediment feed rate sample was collected in a 500 mL jar over an interval timed to the nearest second and was a minimum 0.1 liter or the collection interval did not exceed one minute, whichever came first.

Effluent grab sampling began following three MTD detention times after the initial sediment feed sample. The time interval between sequential samples was 1 minute, however, when the test sediment feed was interrupted for measurement, the next effluent sample was collected following three MTD detention times from the time the sediment feed was re-established. A total of 15 effluent samples were taken during each run.

Background water samples were taken with the odd-numbered effluent samples.

2.4 Scour Testing

Prior to the start of testing, a false floor was installed 4 inches lower than 50% of the maximum sediment storage depth, 2 inches above the vault floor, and sediment was loaded into each compartment of the DSBB™ and leveled at a depth of 4 inches. The final height of the sediment was at an elevation equivalent to 50% of the maximum sump sediment storage capacity of the MTD. The same sediment that was used for the removal efficiency testing was also used for the scour testing pre-load. After loading of the sediment, the unit was gradually filled with clear water, so as not to disturb the sediment, to the invert of the inlet pipe. The filled unit was allowed to sit for 72 hours.

The scour test was conducted at a target flow rate of 2 cfs (898 GPM), more than two times the MTFR.

During the scour test, the water flow rate and temperature were recorded once every minute using a MadgeTech Process 101 data logger and a MicroTemp data logger. Flow to the system was increased gradually, over a four-and-a-half-minute period, until the target flow rate was achieved.

Sampling of background and effluent was conducted in the same manner as for the removal efficiency test. An effluent grab sample was taken once every two minutes, starting 0.5 minutes after achieving the target flow rate (5 minutes after initiating flow to the system), until a total of 15 effluent samples were taken. A total of eight background water samples were collected, simultaneously with the even-numbered effluent samples.

Duplicate samples were taken for both background and effluent. The primary set was analysed and reported while the second set was held under refrigerated conditions, in case there was a need for an investigation of an aberrant result.

3. Performance Claims

Per the NJDEP verification procedure, the following are the performance claims made by Bio Clean Environmental Services Inc. and established via the laboratory testing conducted for the Debris Separating Baffle Box (Model Number DSBB-2.5-5).

Total Suspended Solids (TSS) Removal Efficiency

The TSS removal rate of the DSBB™ using sediment with a median particle size (d_{50}) of 126 μm was determined using the weighted method specified by the NJDEP HDS MTD protocol. Based on a MTR of 0.9 cfs, the DSBB™ achieved a weighted TSS removal efficiency of at least 80%.

Maximum Treatment Flow Rate (MTR)

The DSBB™ unit tested had a total sedimentation area of 12.5 ft^2 and a maximum treatment flow rate (MTR) of 0.9 cfs (404 gpm). The maximum treatment loading rate is 32.3 gpm/ft^2 of sedimentation area.

Maximum Sediment Storage Depth and Volume

The maximum sediment storage depth is 12" which equates to 12.5 ft^3 of sediment storage volume.

Effective Treatment/Sedimentation Area

The effective treatment area of the unit tested was 12.5 ft^2 .

Detention Time and Wet Volume

The maximum wet volume for the DSBB™ is 281 gallons. The detention time of the DSBB™ is dependent upon flow rate. The design detention time, calculated by dividing the treatment volume by the MTR of 404 gpm, is 41.7 seconds.

Online/Offline Installation

Based on the laboratory scour testing results, the DSBB™ qualifies for online installation.

4. Supporting Documentation

To support the performance claims, copies of the laboratory test reports, including all collected and measured data; all data from performance evaluation test runs; spreadsheets containing original data from all performance test runs; all pertinent calculations; etc. were made available to NJCAT for review. It was agreed that as long as such documentation could be made available upon request that it would not be prudent or necessary to include all this information in this verification report. All supporting documentation will be retained securely by GHL and has been provided to NJCAT.

4.1 Removal Efficiency Testing

A total of 5 removal efficiency testing runs were completed in accordance with the NJDEP HDS protocol. The target flow rate ranged from 25 – 125% MTRF and the target influent sediment concentration was 200 mg/L. The results from all 5 runs were used to calculate an annualized weighted TSS removal efficiency for the DSBB™.

The total water volume and average flow rate per run were calculated from the data collected by the flow data logger, one reading every minute. The average influent sediment concentration for each test flow was determined by mass balance. The amount of sediment fed into the auger feeder during dosing, and the amount remaining at the end of a run, was used to determine the amount of sediment fed during a run, following correction for the mass of the six feed rate samples taken during the run. The mass of the sediment fed was divided by the volume of water that flowed through the DSBB™ during dosing to determine the average influent sediment concentration for each run.

Six feed rate samples were collected at evenly spaced intervals during the run to ensure the rate was stable. The COV of the samples had to be < 0.10 per the NJDEP protocol. The feed rate samples were also used to calculate an influent sediment concentration in order to double check the concentration calculated by mass balance.

The average effluent sediment concentration was adjusted for the background sediment concentration. In cases where the reported background sediment concentration was less than 2.3 mg/L (the method quantitation limit), 2 mg/L was used in calculating the adjusted effluent concentration.

Removal efficiency for each test run was computed as follows:

$$\text{Removal Efficiency (\%)} = \left(\frac{\text{Average Influent Concentration} - \text{Adjusted Average Effluent Concentration}}{\text{Average Influent Concentration}} \right) \times 100\%$$

The data collected for each removal efficiency run are presented below.

25% MTFR

Table 3 Sampling Schedule - 25% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	Background	Effluent
0	1		
9.33		1	1
10.33			2
11.33	2	2	3
20.67			4
21.67		3	5
22.67	3		6
32.00		4	7
33.00			8
34.00	4	5	9
43.33			10
44.33		6	11
45.33	5		12
54.67		7	13
55.67			14
56.67	6	8	15
57.67	End of Testing		
MTD Detention Time = 2.778 minutes Target Sediment Sampling Time = 60 seconds			

Table 4 Water Flow and Temperature - 25% MTFR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	101.0	100.3	-0.70 %	0.001	
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

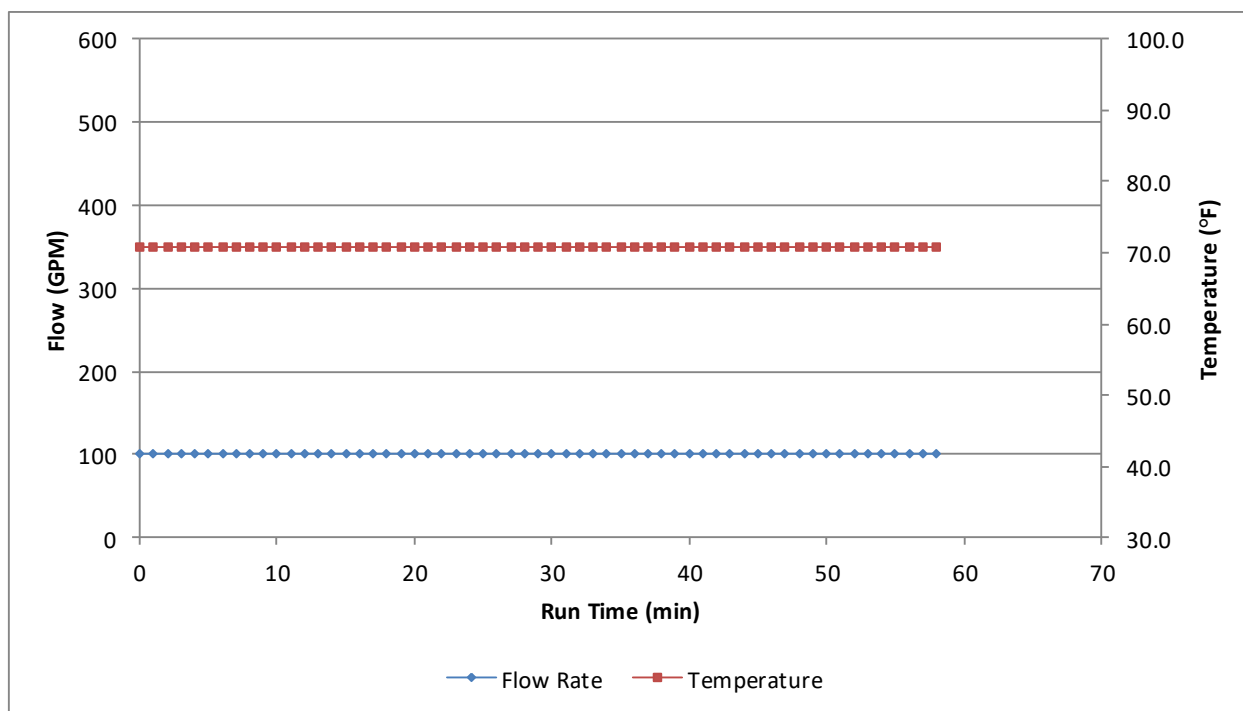


Figure 13 Water Flow and Temperature - 25% MTR

Table 5 Sediment Feed Rate Summary – 25% MTR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
1	75.985	Starting Weight of Sediment (lbs.)	54.873
2	73.272		
3	73.061	Recovered Weight of Sediment (lbs.)	45.481
4	74.996		
5	73.198	Mass of Sediment Used (lbs.)	9.392
6	72.649	Volume of Water Through MTD During Dosing (gal)	5183
Average	73.860		
COV	0.018	Average Influent Sediment Concentration (mg/L)	194.6*
QA/QC Limit	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples

Table 6 SSC and Removal Efficiency - 25% MTFR

Sample #	Suspended Sediment Concentration (mg/L)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	4.5	4.8	4.3	4.6	4.9	4.9	4.9	4.5	4.7	4.9	4.7	5.2	5.3	4.4	4.7
Background	2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0
Adjusted Effluent	2.5	2.8	2.3	2.6	2.9	2.9	2.9	2.5	2.7	2.9	2.7	3.2	3.3	2.4	2.7
Average Adjusted Effluent Concentration					2.8 mg/L			Removal Efficiency					98.6 %		

50% MTFR

Table 7 Sampling Schedule - 50% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	Background	Effluent
0	1		
5.17		1	1
6.17			2
7.17	2	2	3
12.33			4
13.33		3	5
14.33	3		6
19.50		4	7
20.50			8
21.50	4	5	9
26.67			10
27.67		6	11
28.67	5		12
33.83		7	13
34.83			14
35.83	6	8	15
36.83	End of Testing		
MTD Detention Time = 1.389 minutes Target Sediment Sampling Time = 60 seconds			

Table 8 Water Flow and Temperature - 50% MTR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	202.0	202.8	0.39 %	0.007	
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

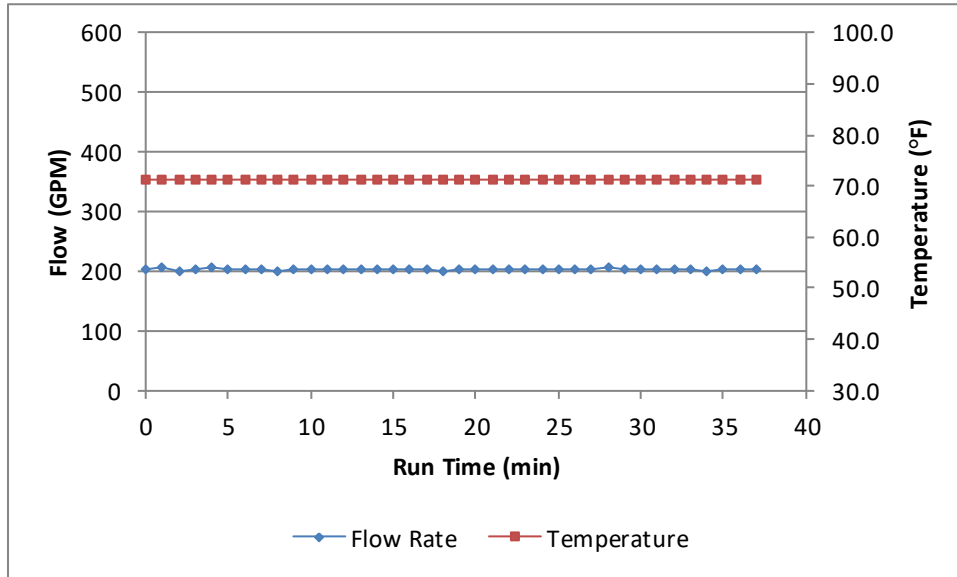


Figure 14 Water Flow and Temperature - 50% MTR

Table 9 Sediment Feed Rate Summary – 50% MTR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
1	154.950	Starting Weight of Sediment (lbs.)	60.340
2	155.507		
3	154.000	Recovered Weight of Sediment (lbs.)	47.663
4	157.237		
5	154.883	Mass of Sediment Used (lbs.)	12.677
6	157.526	Volume of Water Through MTD During Dosing (gal)	6256
Average	155.684		
COV	0.009	Average Influent Sediment Concentration (mg/L)	203.4*
QA/QC Limit	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples

Table 10 SSC and Removal Efficiency - 50% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	20.7	18.6	20.3	17.0	20.4	20.9	18.8	18.7	19.8	19.0	20.6	19.4	23.0	21.5	21.7
Background	2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0
Adjusted Effluent	18.7	16.6	18.3	15.0	18.4	18.9	16.8	16.7	17.8	17.0	18.6	17.4	21.0	19.5	19.7
Average Adjusted Effluent Concentration					18.0 mg/L			Removal Efficiency					91.1 %		

75% MTFR

Table 11 Sampling Schedule - 75% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	Background	Effluent
0	1		
3.44		1	1
4.44			2
5.44	2	2	3
8.89			4
9.89		3	5
10.89	3		6
14.33		4	7
15.33			8
16.33	4	5	9
19.78			10
20.78		6	11
21.78	5		12
25.22		7	13
26.22			14
27.22	6	8	15
27.89	End of Testing		
MTD Detention Time = 0.926 minutes Target Sediment Sampling Time = 40 seconds			

Table 12 Water Flow and Temperature - 75% MTR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	303.0	295.8	-2.4 %	0.006	
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

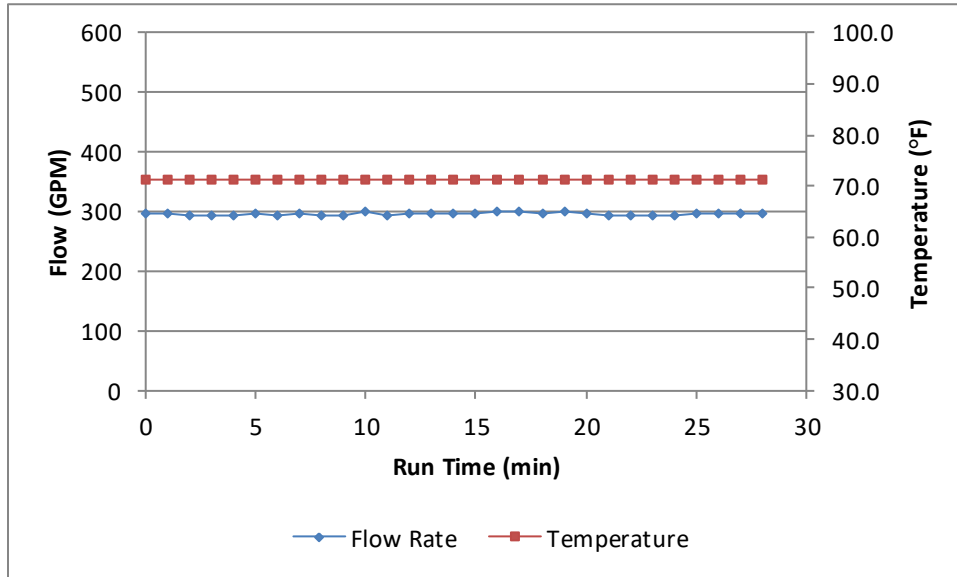


Figure 15 Water Flow and Temperature - 75% MTR

Table 13 Sediment Feed Rate Summary – 75% MTR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
1	223.066	Starting Weight of Sediment (lbs.)	70.967
2	224.836		
3	224.883	Recovered Weight of Sediment (lbs.)	57.177
4	225.736		
5	222.717	Mass of Sediment Used (lbs.)	13.790
6	222.132	Volume of Water Through MTD During Dosing (gal)	7061
Average	223.895		
COV	0.006	Average Influent Sediment Concentration (mg/L)	200.4*
QA/QC Limit	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples

Table 14 SSC and Removal Efficiency - 75% MTFR

Sample #	Suspended Sediment Concentration (mg/L)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	38.5	37.7	36.4	39.8	41.8	43.0	39.9	44.9	39.1	41.4	38.3	37.1	47.1	42.5	40.8
Background	2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0
Adjusted Effluent	36.5	35.7	34.4	37.8	39.8	41.0	37.9	42.9	37.1	39.4	36.3	35.1	45.1	40.5	38.8
Average Adjusted Effluent Concentration					38.6 mg/L			Removal Efficiency					80.7 %		

100% MTFR

Table 15 Sampling Schedule - 100% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	Background	Effluent
0	1		
2.58		1	1
3.58			2
4.58	2	2	3
7.17			4
8.17		3	5
9.17	3		6
11.75		4	7
12.75			8
13.75	4	5	9
16.33			10
17.33		6	11
18.33	5		12
20.92		7	13
21.92			14
22.92	6	8	15
23.42	End of Testing		
MTD Detention Time = 0.694 minutes Target Sediment Sampling Time = 30 seconds			

Table 16 Water Flow and Temperature - 100% MTR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	403.9	404.0	0.03 %	0.004	
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

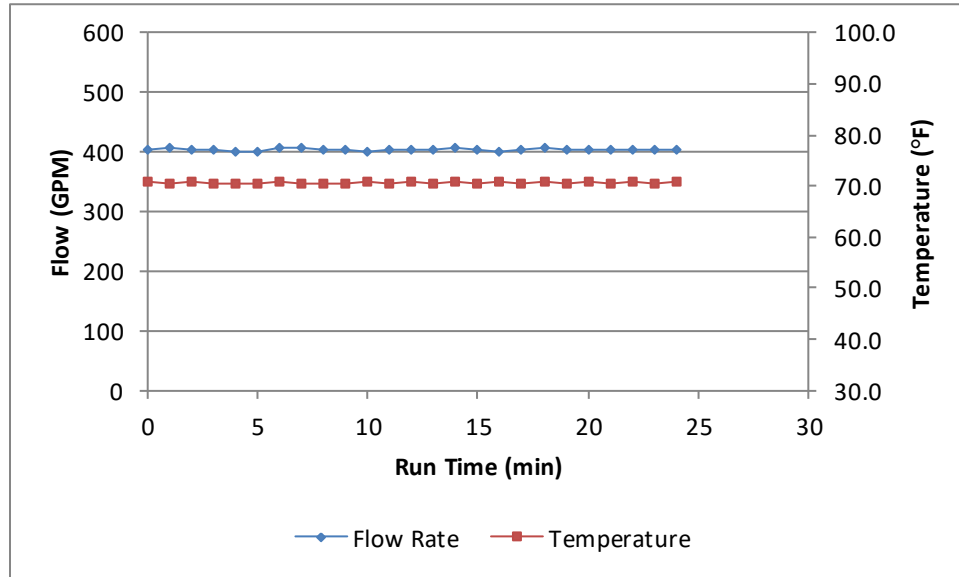


Figure 16 Water Flow and Temperature - 100% MTR

Table 17 Sediment Feed Rate Summary – 100% MTR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
1	314.973	Starting Weight of Sediment (lbs.)	61.840
2	316.822		
3	319.609	Recovered Weight of Sediment (lbs.)	45.338
4	317.393		
5	323.149	Mass of Sediment Used (lbs.)	16.502
6	318.362	Volume of Water Through MTD During Dosing (gal)	8249
Average	318.385		
COV	0.009	Average Influent Sediment Concentration (mg/L)	209.2*
QA/QC Limit	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples

Table 18 SSC and Removal Efficiency - 100% MTFR

	Suspended Sediment Concentration (mg/L)														
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	70.8	65.9	60.6	59.8	69.5	68.7	77.2	68.9	79.7	68.0	68.0	73.1	75.5	67.9	82.8
Background	2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0
Adjusted Effluent	68.8	63.9	58.6	57.8	67.5	66.7	75.2	66.9	77.7	66.0	66.0	71.1	73.5	65.9	80.8
Average Adjusted Effluent Concentration				68.4 mg/L			Removal Efficiency						67.3 %		

125% MTFR

Table 19 Sampling Schedule - 125% MTFR

Runtime (min)	Sampling Schedule		
	Sediment Feed	Background	Effluent
0	1		
2.08		1	1
3.08			2
4.08	2	2	3
6.17			4
7.17		3	5
8.17	3		6
10.25		4	7
11.25			8
12.25	4	5	9
14.33			10
15.33		6	11
16.33	5		12
18.42		7	13
19.42			14
20.42	6	8	15
20.83	End of Testing		
MTD Detention Time = 0.556 minutes Target Sediment Sampling Time = 25 seconds			

Table 20 Water Flow and Temperature - 125% MTR

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	504.9	504.4	-0.11 %	0.005	
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

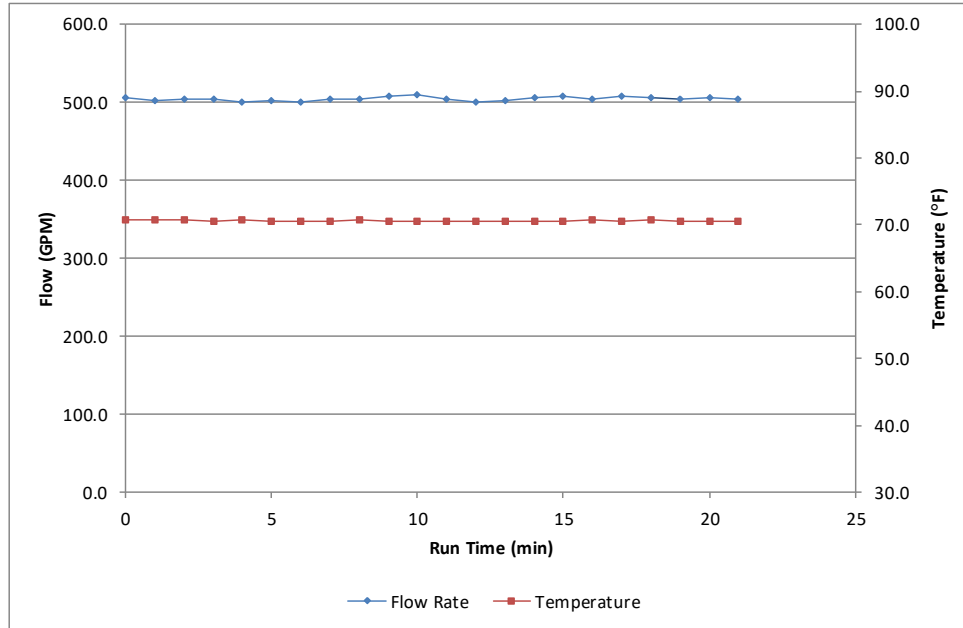


Figure 17 Water Flow and Temperature - 125% MTR

Table 21 Sediment Feed Rate Summary – 125% MTR

Sediment Feed Rate (g/min)		Sediment Mass Balance	
1	387.563	Starting Weight of Sediment (lbs.)	61.895
2	391.079	Recovered Weight of Sediment (lbs.)	43.883
3	388.432		
4	395.707		
5	389.999	Mass of Sediment Used (lbs.)	18.012
6	396.225	Volume of Water Through MTD During Dosing (gal)	9255
Average	391.501		
COV	0.009	Average Influent Sediment Concentration (mg/L)	205.4*
QA/QC Limit	0.10 PASS	QA/QC Limit	180 – 220 mg/L PASS

*Corrected for sediment feed rate samples

Table 22 SSC and Removal Efficiency - 125% MTFR

Sample #	Suspended Sediment Concentration (mg/L)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	97.1	93.5	104	90.6	103	93.3	86.8	85.0	93.1	88.7	94.4	88.8	110	88.9	90.1
Background	2.0		2.0		2.0		2.0		2.0		2.0		2.0		2.0
Adjusted Effluent	95.1	91.5	102	88.6	101	91.3	84.8	83.0	91.1	86.7	92.4	86.8	108	86.9	88.1
Average Adjusted Effluent Concentration				91.8 mg/L			Removal Efficiency						55.3 %		

Annualized Weighted Removal Efficiency

The annualized weighted removal efficiency for sediment in stormwater has been calculated using the rainfall weighting factors provided in the NJDEP laboratory test protocol. The DSBB™ annual weighted removal for a MTFR of 404 gpm is 83.6%, as shown in **Table 23**

Table 23 Annualized Weighted Removal Efficiency for DSBB

%MTFR	Removal Efficiency (%)	Annual Weighting Fact	Weighted Removal Efficiency (%)
25	98.6	0.25	24.6
50	91.1	0.30	27.3
75	80.7	0.20	16.1
100	67.3	0.15	10.1
125	55.3	0.10	5.5
Annualized Weighted Removal Efficiency			83.6%

4.2 Scour Testing

Scour testing was conducted in accordance with Section 4 of the NJDEP Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation MTD. Testing was conducted at a target flow rate of 2 cfs (898 gpm), more than 200% of the maximum treatment flow rate (MTFR).

Though the test sediment used for this did not comply with the PSD specification for the NJDEP removal efficiency performance testing, it did however meet the PSD requirements for the scour test sediment, as shown in **Table 24**.

Table 24 PSD of Scour Test Sediment (GHL Lot #A022-20)

Particle Size (μm)	Test Sediment PSD (% Passing)	NJDEP Scour Test Sediment Specification* (minimum % Less Than)
1000	100.0	100
500	100.0	90
250	96.82	55
150	73.47	40
100	26.67	25
75	8.62	10
d_{50} (μm)	126	N/A

*A measured value may be lower than a target minimum % Less Than value by up to two percentage points

In preparation for the scour test, the sump of the DSBBTM was fitted with a false floor, 4 inches below the depth of the 50% maximum sediment storage height. The sump was then loaded with test sediment so that when levelled, the sediment formed a layer at least 4 inches thick, confirmed by measuring the sediment thickness with a yard stick. After sediment loading, the sump was filled with water and allowed to sit for 72 hours.

At the start of testing, an issue was encountered with the data logger software. As a result, one of the data points during the equilibration period was taken after a 90 second delay, as opposed to 60 seconds. All of the remaining time points were taken once every 60 seconds, as required.

Effluent sampling began 5 minutes after the start of flow to the system and background samples were taken with even-numbered effluent samples, instead of odd-numbered ones. The original intent of the scour test plan was to take background samples with the odd-numbered effluent samples, however due to a sampling error, the first background sample was taken with effluent sample #2. Consequently, no background sample was taken concurrent with the first effluent sample. Background concentrations were constant throughout the scour test. The sampling frequency for the test is summarized in **Table 25**. Water and flow temperature are shown in **Table 26** and on **Figure 18**.

Table 25 Scour Test Sampling Frequency

Sample/ Measurement Taken	Run Time (min.)															
	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
Effluent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Background		X		X		X		X		X		X		X		X

Note: The Run Time of 0 minutes was the time at which flow to the system began.

Table 26 Water Flow and Temperature - Scour Test

Run Parameters	Water Flow Rate (GPM)				Maximum Water Temperature (°F)
	Target	Actual	Difference	COV	
	897.7	893.8	-0.43 %	0.005	
QA/QC Limit	-	-	±10% PASS	0.03 PASS	80 PASS

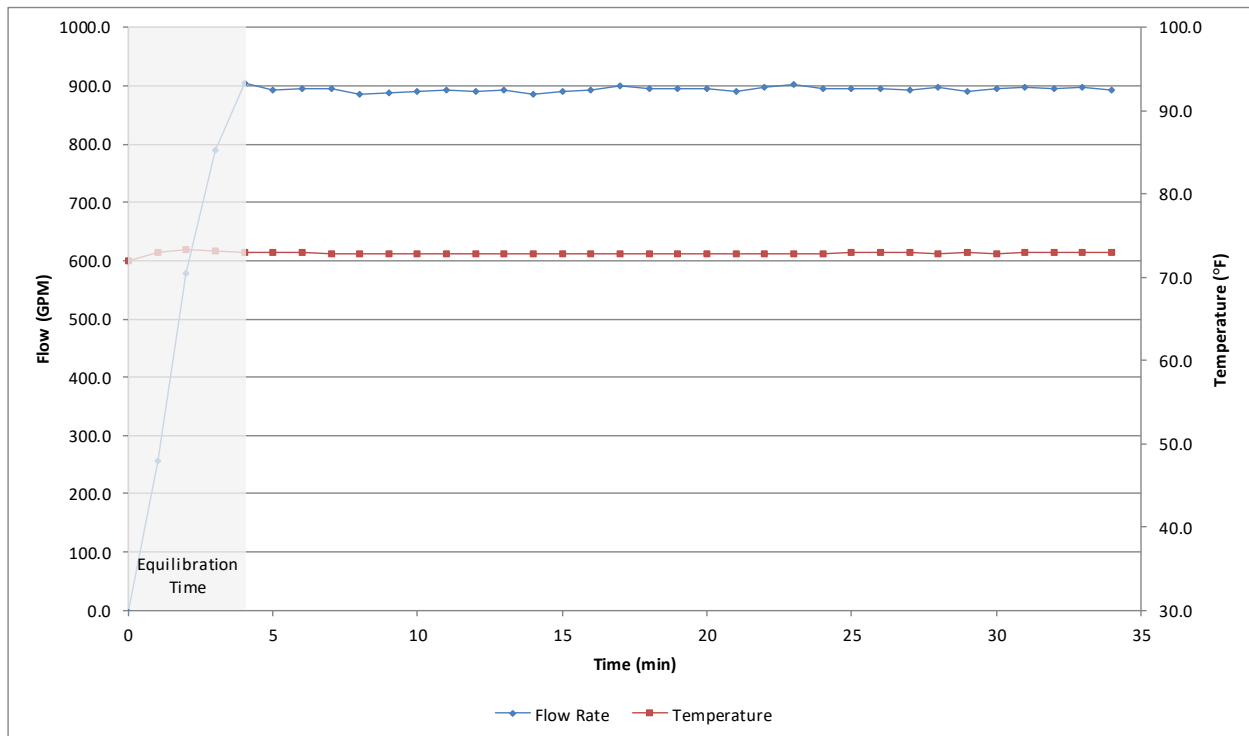


Figure 18 Water Flow and Temperature - Scour Test

The effluent and background SSC results are reported in **Table 27**. The adjusted effluent concentration was calculated as:

$$\text{Adjusted Effluent Concentration} \left(\frac{\text{mg}}{\text{L}} \right) = \text{Initial Concentration} - \text{Background Concentration}$$

All of the background sediment concentrations were found to be below the method reporting limit of 2.3 mg/L, therefore a background correction value of 2 mg/L was used for calculation purposes. The average adjusted effluent concentration was 1.0 mg/L; therefore, when operated at 200% of the MTRF, the DSBB™ meets the criteria for online use.

Table 27 Suspended Sediment Concentrations for Scour Test

	Scour Suspended Sediment Concentration (mg/L)														
Sample #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Effluent	3.9	5.8	4.3	2	2	2.4	2	2.5	3.5	4.5	2	3.4	2	2.7	2
Background		2.0		2.0		2.0		2.0		2.0		2.0		2.0	2.0
Adjusted Effluent	1.9	3.8	2.3	0	0	0.4	0	0.5	1.5	2.5	0	1.4	0	0.7	0
Average Adjusted Effluent Concentration								1.0 mg/L							

5. Maintenance Plans

The Debris Separating Baffle Box (DSBB), a stormwater dual-stage Hydrodynamic Separator is designed to remove high levels of trash, debris, sediments and hydrocarbons. The innovative screening system directs floatable trash, debris, and organics onto raised filtration screens for dry state storage which prevents septic conditions, odor, nutrient leaching and allows for easy removal. The raised filtration screens are assisted by a non-clogging inlet splitting screen which directs flows to the filtration screens while maintaining high treatment flow rates. The DSBB is able to effectively capture and store sediment with no maintenance or loss of treatment capacity for several years based on annual average loading in most regions.

Yet, as with all stormwater BMPs, inspection and maintenance on the DSBB Hydrodynamic Separator is necessary. Stormwater regulations require that all BMPs be inspected and maintained to ensure they are operating as designed to allow for effective pollutant removal and provide protection to receiving water bodies. It is recommended that inspections be performed multiple times during the first year to assess site-specific loading conditions. This is recommended because pollutant loading can vary greatly from site to site. Variables such as nearby soil erosion or construction sites, winter sanding of roads, amount of daily traffic and land use can increase pollutant loading on the system. The first year of inspections can be used to set inspection and maintenance intervals for subsequent years. Without appropriate maintenance a BMP can exceed its storage capacity which can negatively affect its continued performance in removing and retaining captured pollutants. Additional inspection and maintenance instructions, including visual enhancements and inspection and maintenance forms, are in the BC O&M Manual at: <http://www.biocleanenvironmental.com/wp-content/uploads/2018/12/Operations-Maintenance-DSBB-NJ-2.pdf>

Inspection Equipment

Following is a list of equipment to allow for simple and effective inspection of the DSBB Separator:

- Bio Clean Environmental Inspection Form (contained within the O&M manual).
- Flashlight.
- Manhole hook or appropriate tools to remove access hatches and covers.
- Appropriate traffic control signage and procedures.
- Measuring pole and/or tape measure.
- Protective clothing and eye protection.
- Note: Entering a confined space requires appropriate safety and certification. Entering is generally not required for routine inspections or maintenance of the system.

Inspection Steps

The core to any successful stormwater BMP maintenance program is routine inspections. The inspection steps required on the DSBB are quick and easy. As mentioned above the first year should be seen as the maintenance interval establishment phase. During the first year more frequent inspections should occur in order to gather loading data and maintenance requirements for that specific site. This information can be used to establish a base for long-term inspection and maintenance interval requirements.

The DSBB Separator can be inspected through visual observation without entry into the system. All necessary pre-inspection steps must be carried out before inspection occurs, especially traffic control and other safety measures to protect the inspector and nearby pedestrians from any dangers associated with an open access hatch or manhole. Once these access covers have been safely opened the inspection process can proceed:

- Prepare the inspection form by writing in the necessary information including project name, location, date & time, unit number and other info (see inspection form).
- Observe the inside of the system through the access hatches. If minimal light is available and vision into the unit is impaired utilize a flashlight to see inside the system.
- Look for any out of the ordinary obstructions in the inflow pipe, sediment chambers, filtration screens, splitter screen, or outflow pipe. Write down any observations on the inspection form.
- Through observation and/or digital photographs estimate the amount of floatable debris accumulated inside the filtration screens. Record this information on the inspection form. Check both the right and left filtration screens if applicable.
- Utilizing a tape measure or measuring stick estimate the amount of sediment accumulated in each of the three sediment chambers. Record this depth on the inspection form.
- Observe the condition and color of the hydrocarbon booms and any floating oils in front of the boom cage. Record this information on the inspection form.
- Finalize inspection report for analysis by the maintenance manager to determine if maintenance is required.

Maintenance Indicators

Based upon observations made during inspection, maintenance of the system may be required based on the following indicators:

- Missing or damaged internal components.

- Obstructions in the system or its inlet or outlet.
- Excessive accumulation of floatable trash, debris and foliage on the filtration screens in which the length and width of the chambers screens is more than half full and/or flow into the screens is fully impeded by these debris. Large items blocking the entrance.
- Excessive accumulation of sediment in any of the three separation chambers, such as when more than half-full (18" to 27" depending on the model size). See **Table 28**.

Maintenance Equipment

It is recommended that a vacuum truck be utilized to minimize the time required to maintain the DSBB Separator:

- Bio Clean Environmental Maintenance Form (contained in the O&M Manual).
- Flashlight.
- Manhole hook or appropriate tools to access hatches and covers.
- Appropriate traffic control signage and procedures.
- Protective clothing and eye protection.
- Note: Entering a confined space requires appropriate safety and certification. It is generally not required for routine maintenance of the system. Exception is deeper units where entry may be required to open filtration screen lids and replace hydrocarbon booms.
- Vacuum truck (with pressure washer attachment preferred).

Maintenance Procedures

It is recommended that maintenance occurs at least three days after the most recent rain event to allow for drain down from any associated upstream detention systems. Maintaining the system while flows are still entering it will increase the time and complexity required for maintenance. Debris captured on the filtration screens requires time to dry out which decreases time to remove and associated weight. Cleaning of the filtration screens and sediment chambers can be performed from finish surface without entry into the vault utilizing a vacuum truck on most installations. Depth and configuration of the installation may create conditions which would require entry for some or all of the maintenance procedures. Configuration and size of access hatches also affects the conditions in which entry may be required. Once all safety measures have been set up cleaning of the filtration screens, hydrocarbon boom(s) and/or sediment chambers can proceed as follows:

- Remove all access hatches (requires traffic control and safety measures to be completed prior).
- Locate the right and left filtration screens. Manhole or hatch access will be provided to each of these screens. As highlighted below, depending on the configuration of the DSBB the filtration screens may or may not have hinged lids depending on factors such as online or offline bypass, water level at peak flow, back flow conditions amongst other site-specific variables. Units that have lids are designed with hinges and locking mechanisms along the sidewall of the structure that can be unlocked from finish surface with an extension rod. The length of this rod is limited and for deeper installations entry may be required to unlock and open the lids.
- Once the filtration screens lids are opened (if applicable) the vacuum hose extension is inserted down into the screens for removal of debris. The width of the screen of the smallest

model is 9" therefore allowing a standard 8" vacuum hose to be used for all models and sizes. All debris should be removed with the vacuum hose and the pressure washer should be used to spray down and remove all debris on the bottom, side and top screens. Ensure that all holes within in the screen are cleared of debris. This is critical to restoring the full hydraulic capacity of the filtration screens. Once completed close and lock lids (if applicable).

- Using an extension on a vacuum truck position the hose over the opened access hatch or hatches leading to the first sediment chamber adjacent to the pipe inlet that includes the splitter screen. Lower vacuum hose into the sediment chamber on the left and right side of the splitter screen. This is where a majority of the larger sediments and heavy debris will accumulate. Remove all floating debris, standing water and sediment from this sediment chamber. Vertical access to the bottom of the sediment chamber is unimpeded. The vac hose can be moved from side-to-side to fully remove sediments at the corners. A power washer can be used to assist if sediments have become hardened and stuck to the walls or the floor of the chamber. The power washer should also be used to spray the splitter screen clean of any accumulated debris. The vacuum hose can also be inserted on the outlet side of the splitter screen (inside the V) to remove any remaining accumulated sediment.
- Repeat the same procedure in the second and third sediment chambers. Access to these two chambers is in the center of the system unlike the first sediment chamber. The filtration screens cover the sediment chamber along the sides yet allow for unimpeded access in the middle without requirement to open filtration chamber tops or go through the filtration screens (hinged floor) as found with other baffle box systems. Hatch or manhole size, quantity and location vary based on model size and site-specific project constraints. Various access hatch sizes and configurations are available to meet individual project requirements. Larger hatches, open assisted hatches and/or taller ID dimensions to increase headroom are available by request.
- Based on the color of the hydrocarbon booms replacement may be necessary. The booms are housed inside the boom cage which is attached to the influent side of the oil skimmer wall. The cage has a hinged top that can be opened from the finish surface using a hook, allowing access to the hydrocarbon booms. Once old booms are removed new booms can be dropped in and the top closed.
- NOTE: Filtration screens can be cleaned before or after cleaning and removal of sediment for the sediment chambers. Cleaning them before is preferred before removing sediment and standing water from the second and third chamber as debris and water will be deposited on the sediment chamber floors in the process of cleaning the filtration screens over the second and third chamber. Cleaning the first sediment chamber before the filtration screens allows the splitter screen to be fully exposed. Thus, the pressure washing of all screens (splitter and filtration) can be done at the same time if needed.
- The last step is to close up and replace all access hatches and remove all traffic control.
- All removed debris and pollutants shall be disposed of following local and state requirements.
- Disposal requirements for recovered pollutants may vary depending on local guidelines. In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste.
- In the case of damaged components, replacement parts can be ordered from the manufacturer. Hydrocarbon booms can also be ordered directly from the manufacturer.

6. Scaling

Table 28 - MTFRs, Dimensions, and Required Sediment Removal Intervals for DSBB Models

DSBB Model #	Inside Length (L), ft	Inside Width (W), ft	Below Invert (DBI) ¹ , ft	Treatment Flow Rate (MTFR) ² , cfs	Tested Loading Rate (gpm/sq ft)	Partition Height (PH) ³ , ft	Partition Thickness (PT), ft	Floor Area (FA) ⁴ , ft ²	Sediment Storage Area Volume, ft ³	Sediment Removal Interval (SRI) ⁵ , days
2-4	4.00	2.00	2.50	0.58	32.31	2.50	0.06	7.75	3.88	30.02
2.5-5	5.00	2.50	2.50	0.90	32.31	2.50	0.06	12.19	6.09	30.21
3-6	6.00	3.00	2.50	1.30	32.31	2.50	0.06	17.63	8.81	30.34
4-6	6.00	4.00	2.50	1.73	32.31	2.50	0.06	23.50	11.75	30.34
4-8	8.00	4.00	3.25	2.30	32.31	3.25	0.06	31.50	15.75	30.51
5-10	10.00	5.00	4.00	3.60	32.31	4.00	0.33	46.67	23.34	28.93
6-12	12.00	6.00	4.75	5.18	32.31	4.75	0.33	68.00	34.00	29.27
7-14	14.00	7.00	5.25	7.06	32.31	5.25	0.33	93.34	46.67	29.52
8-14	14.00	8.00	6.00	8.06	32.31	6.00	0.33	106.67	53.34	29.52
8-16	16.00	8.00	6.00	9.22	32.31	6.00	0.33	122.67	61.34	29.70
9-18	18.00	9.00	6.75	11.66	32.31	6.75	0.50	153.00	76.50	29.27
10-18	18.00	10.00	7.50	12.96	32.31	7.50	0.50	170.00	85.00	29.27
10-20	20.00	10.00	7.50	14.40	32.31	7.50	0.50	190.00	95.00	29.44
10-22	22.00	10.00	8.00	15.84	32.31	8.00	0.50	210.00	105.00	29.58
11-22	22.00	11.00	8.00	17.42	32.31	8.00	0.50	231.00	115.50	29.58
11-24	24.00	11.00	8.75	19.01	32.31	8.75	0.50	253.00	126.50	29.70
12-24	24.00	12.00	8.75	20.74	32.31	8.75	0.50	276.00	138.00	29.70

NOTES:

¹DBI = depth from invert of inlet pipe to bottom of unit

²MTFR scaling based on $0.9/12.5 = 0.072$ cfs/ft²

³PH = DBI

⁴FA = W x (L-2xPT)

⁵SRI Calculated from NJDEP HSD Protocol 2013 (Appendix A) 80% TSS Removal Efficiency

Table 29 - DSBB Model Scaling Ratios

				SD/SD		L/W		SD/L		SD/W	
DSBB Model #	Inside Length (L), ft	Inside Width (W), ft	Scaling Depth (SD) ¹ , ft	SD/SD ²	SD within 15% of DSBB 2.5-5?	L/W	L/W within 15% of DSBB 2.5-5?	SD/L	SD/L within 15% of DSBB 2.5-5?	SD/W	SD/W within 15% of DSBB 2.5-5?
Test Unit											
2.5-5	5.00	2.50	2.00			2.00		0.40		0.80	
MTFR < 250% of Test Unit											
2-4	4.00	2.00	2.00	1.00	Yes						
3-6	6.00	3.00	2.00	1.00	Yes						
4-6	6.00	4.00	2.00	1.00	Yes						
MTFR > 250% of Test Unit											
4-8	8.00	4.00	2.75			2.00	Yes	0.34	Yes	0.69	Yes
5-10	10.00	5.00	3.50			2.00	Yes	0.35	Yes	0.70	Yes
6-12	12.00	6.00	4.25			2.00	Yes	0.35	Yes	0.71	Yes
7-14	14.00	7.00	4.75			2.00	Yes	0.34	Yes	0.68	Yes
8-14	14.00	8.00	5.50			1.75	Yes	0.39	Yes	0.69	Yes
8-16	16.00	8.00	5.50			2.00	Yes	0.34	Yes	0.69	Yes
9-18	18.00	9.00	6.25			2.00	Yes	0.35	Yes	0.69	Yes
10-18	18.00	10.00	7.00			1.80	Yes	0.39	Yes	0.70	Yes
10-20	20.00	10.00	7.00			2.00	Yes	0.35	Yes	0.70	Yes
10-22	22.00	10.00	7.50			2.20	Yes	0.34	Yes	0.75	Yes
11-22	22.00	11.00	7.50			2.00	Yes	0.34	Yes	0.68	Yes
11-24	24.00	11.00	8.25			2.18	Yes	0.34	Yes	0.75	Yes
12-24	24.00	12.00	8.25			2.00	Yes	0.34	Yes	0.69	Yes

NOTES:

¹SD = Depth of invert of inlet pipe to bottom of unit (DBI) minus 0.5 ft (location of flase floor for tested unit).

²SD/SD = Ratio of scaling depth of the DSBB model to the test unit scaling depth.

7. Statements

The following attached pages are signed statements from the manufacturer (Bio Clean Environmental, Inc.), the testing lab (Good Harbour Labs), and NJCAT.

Bio Clean Statement



Date: 11/18/2018

To Whom It May Concern,

We are providing this letter as our statement certifying that the protocol titled "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (NJDEP HDS Protocol, January 2013) has been strictly followed with the exception of the particle size distribution which has a larger d50 size of 126 microns.

We certify that all requirements and criteria were met and/or exceeded during testing of the Debris Separating Baffle Box Hydrodynamic Separator.

If you have any questions please contact us at your convenience.

Sincerely,

Zachariha J. Kent
Director of Research & Development
Bio Clean, a Forterra Company.

Signature:  Date: 11-18-2018

P O Box 869 Oceanside CA 92049
(760) 433-7640 • Fax (760) 433-3176
www.BioCleanEnvironmental.net



November 20, 2018

Dr. Richard Magee, ScD., P.E., BCEE
Executive Director
New Jersey Corporation for Advanced Technology

Re: Performance Verification of the Debris Separating Baffle Box (DSBB™) Stormwater Treatment System using a Coarse Silica Sand.

Dear Dr. Magee,

Good Harbour Laboratories was contracted by BioClean Environmental Services Inc., A Forterra Company, to conduct a performance verification of their Debris Separating Baffle Box (DSBB™) Hydrodynamic Separator in general accordance with New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device (January, 2013). The testing did deviate from the protocol requirements in that the test material had a $D_{50} = 126 \mu$, instead of the required 75μ , and thus the report is not intended for submission to the New Jersey Department of Environmental Protection.

Good Harbour Laboratories is an independent hydraulic test facility located in Mississauga, Ontario Canada. I certify that we evaluated a 60 inch X 30 inch DSBB™ unit during September 2018 according to the aforementioned test protocol. The results presented in the NICAT Verification Report dated November, 2019 are accurate and all procedures and requirements stated in the test protocol were met or exceeded, with the PSD exception noted above. Good Harbour Laboratories has no vested interest in the test results or financial conflict of interest in providing independent testing services to BioClean Environmental Services Inc.

Sincerely,

Dr. Greg Williams, P.Eng.
Managing Director
Good Harbour Laboratories

Good Harbour Laboratories
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December 10, 2018

Mr. Zach J. Kent
VP of Product Development & Regulatory Compliance
Bio Clean Environmental Services Inc.
398 Via El Centro
Oceanside, CA 92058

Dear Mr. Kent,

Based on my review, evaluation and assessment of the testing on the Bio Clean Debris Separating Baffle Box (DSBB™) stormwater treatment system conducted by Good Harbour Laboratories, Ltd., Mississauga, Ontario, Canada, the test protocol requirements contained in the “*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*” (NJDEP HDS Protocol) were met with one exception: the sediment test particle size distribution (PSD) was coarser than specified in the NJDEP protocol. Consequently, the verification report does not qualify for NJDEP certification.

Test Sediment Feed -The mean PSD of the test sediment utilized for removal efficiency testing was significantly coarser than the PSD criteria established by the NJDEP Filter protocol (126 μm vs 75 μm).

Removal Efficiency Testing – The Bio Clean DSBB Model 2.5-5 achieved an annual weighted removal efficiency of 83.6% of the test sediment (d_{50} of 126 μm) for a MTFR of 404 gpm (0.9 cfs).

Scour Testing – The DSBB-2.5-5 model exhibited very low scour at 200% MTFR (1.0 mg/L) qualifying it for online use.

All other criteria and requirements of the NJDEP HDS Protocol were met. These include: flow rate measurements COV <0.03; test sediment influent concentration COV <0.10; test sediment influent concentration within 10% of the targeted value of 200 mg/L; influent background concentrations <20 mg/L; and water temperature <80 °F.

Sincerely,



Richard S. Magee, Sc.D., P.E., BCEE
Executive Director

8. References

1. NJDEP 2013. New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device. January 25, 2013.
2. GHJ Laboratory Notebook: A022, pp. 135- 160.
3. GHJ Laboratory Notebook: A023, pp. 1 - 39.