NJCAT TECHNOLOGY VERIFICATION

Aqua-Swirl® XCelerator® High Performance Stormwater Treatment System

AquaShield™, Inc.

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1. Description of Technology

The Aqua-Swirl® XCelerator® High Performance Stormwater Treatment System (XCelerator® XP) is a hydrodynamic separator designed and supplied by AquaShield™, Inc. The XCelerator® XP technology removes pollutants including suspended solids and debris from stormwater runoff.

The XCelerator® XP is a rapid or high flow rate device that has no moving parts and operates on gravity flow or movement of the stormwater runoff entering the structure. The cross-sectional area of the treatment chamber represents the effective treatment area of the device. Operation begins when stormwater enters the treatment chamber where sediment capture and storage are accomplished. Water initially flows downward from the inlet and is then forced upward through an array of inclined plates. This design encourages particles to settle onto the surfaces of the inclined plates and accumulate at the bottom of the chamber. The inclined plates are scaled to maintain a consistent surface area loading rate across all model sizes of the XCelerator® XP. The treated flow exists from the XCelerator® XP through an outlet structure positioned at the effluent outlet pipe opening. The outlet structure controls the flow of treated water out of the treatment chamber and is sized to the maximum treatment flow rate (MTFR) of the system. The inclined plate assembly incorporates a high-flow bypass weir that allows flows exceeding the MTFR to spill over and continue to the outlet structure without passing through the inclined plates. Internal bypass flow volumes that exceed the MTFR never comingle with the treatment volume, which is measured upward from the chamber floor to the point of bypass.

2. Laboratory Testing

Laboratory testing has been performed to independently verify that the XCelerator® XP is eligible for certification by the New Jersey Department of Environmental Protection (NJDEP) as a 50% Total Suspended Solids (TSS) removal device. The XCelerator® XP model XP-2 was tested in accordance with the "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device," January 1, 2021 (updated April 25, 2023). Testing was conducted in Chattanooga, Tennessee at the AquaShield™, Inc. Hydraulic Laboratory Facility under the supervision of Southern Environmental Technologies, Inc. of Sewanee, Tennessee. The observer was pre-approved by the New Jersey Corporation for Advanced Technology (NJCAT) as cited in the XP-2 Quality Assurance Project Plan (QAPP).

2.1 Test Unit

The full-scale, commercially available XP-2 test unit is a hydrodynamic separator (HDS) constructed of polymer coated steel (PCS). The XP-2 test unit and flow paths are illustrated in **Figures 1** and **2**. The test model has a 2.5-foot inner diameter (30 inches) and 4.9 ft^2 of effective treatment area. Note that the unit base was fabricated with extra depth to facilitate various false floor positions for testing purposes. Key dimensions of the test unit were measured by the independent observer prior to beginning this testing program to ensure that the assembly was consistent with a commercial XP-2. The false floor depth was confirmed by the observer.

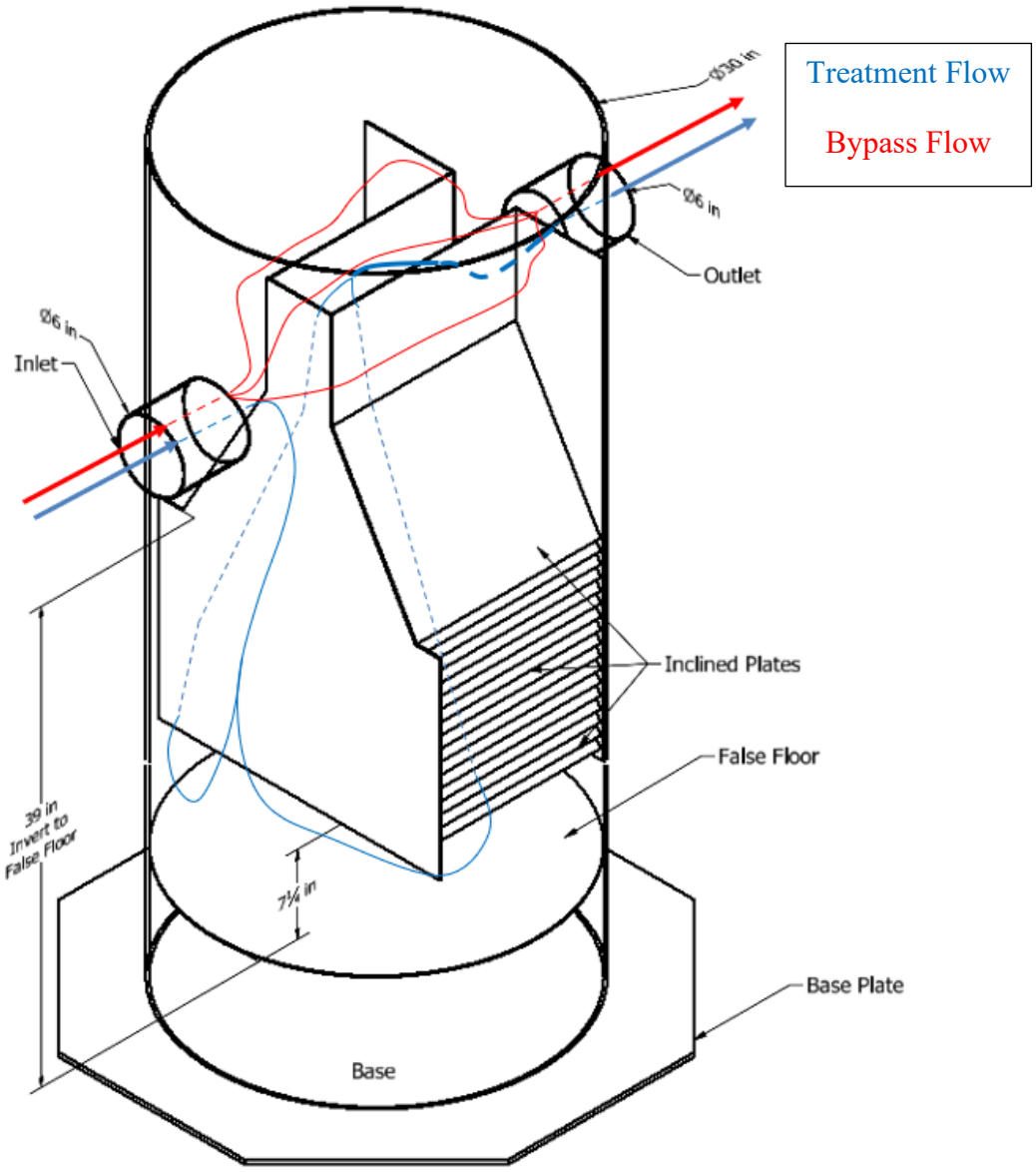

Figure 1 Aqua-Swirl® XCelerator® High Performance Model XP-2 Test Unit

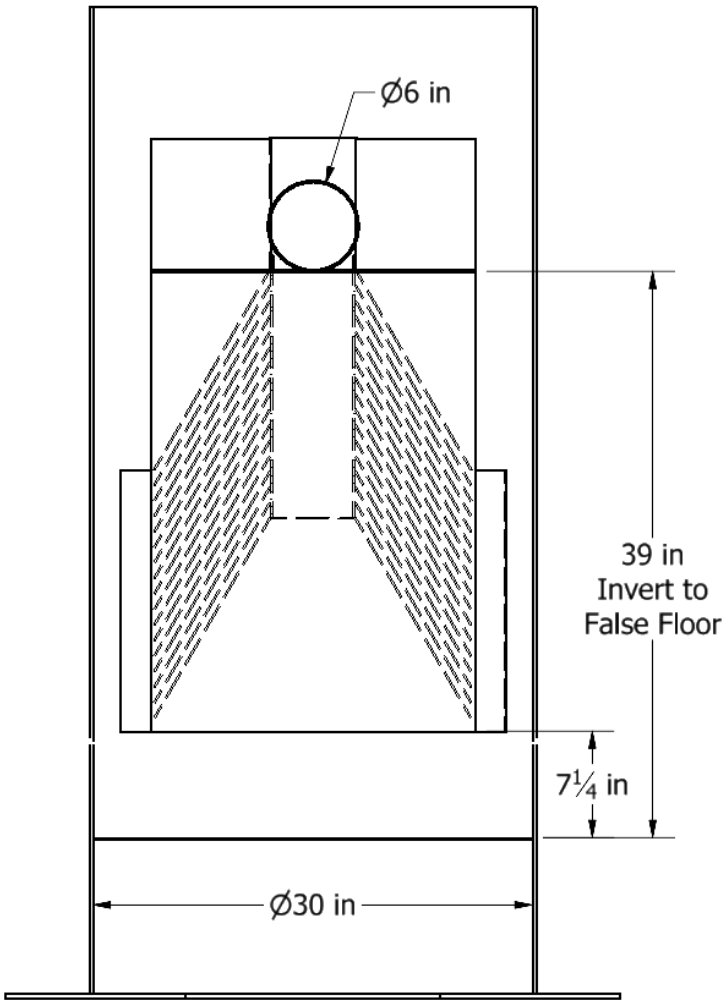

Figure 2 Aqua-Swirl® XCelerator® High Performance Model XP-2 Test Unit

2.2 Test Setup

The XP-2 test loop is illustrated in **Figure 3** as a recirculation system designed to provide metered flow up to approximately 529 gpm (1.18 cfs) for this testing program. A 10-HP pump draws water from the 18,000-gallon reservoir supply tank assembly (18 tanks at 1,000 gallons each) via a 6-inch diameter Schedule 40 PVC pipe. A 1-micron (µm) background sediment filtration assembly is located downstream of the pump and upstream of the background sample location.

Influent piping from the background filter assembly is routed through a Badger M-2000 flowmeter, past the background sampling port, to an elevated platform where the influent test sediment feeder is positioned 13 inches upstream from the test unit. The 6-inch diameter conveyance pipe leads directly to a tee for injecting sediment into the crown of the pipe positioned upstream of the test unit. The 6-inch diameter pipe then leads from the sediment feeder directly to the XP-2 test unit. The slope of the piping run to the test unit is a minimum 1.0%. Influent and effluent piping utilized the same slope.

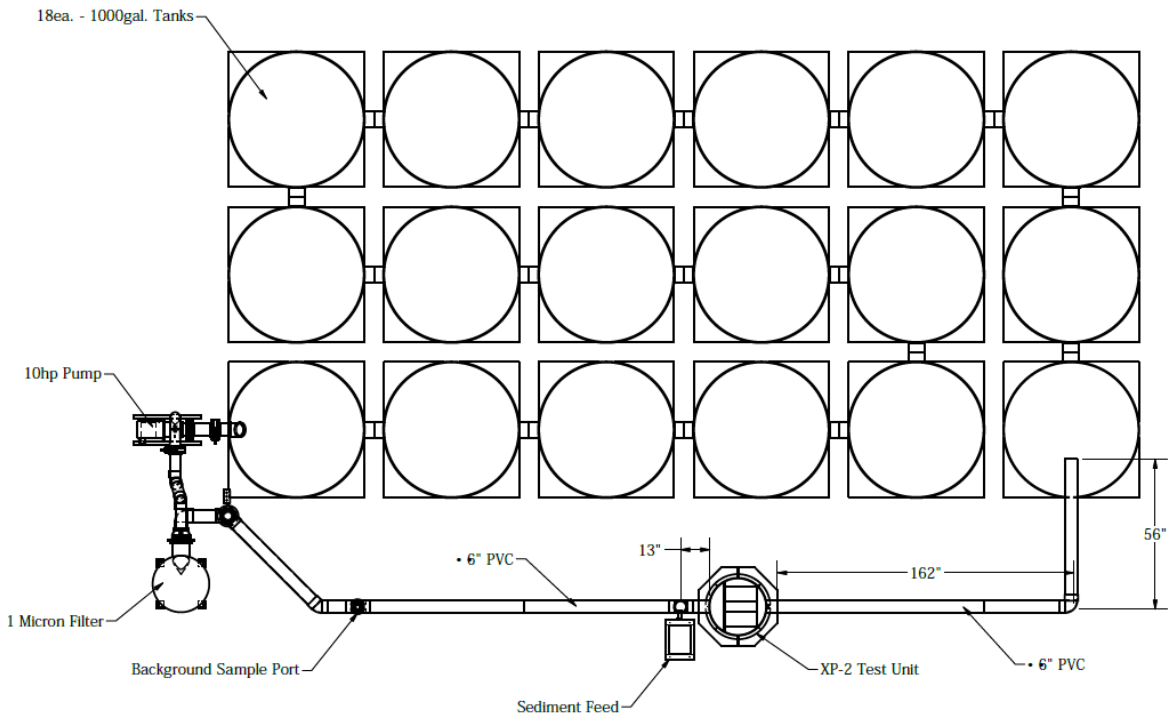

Figure 3 XP-2 Test Loop Configuration

Two stubout piping connections are made to the XP-2 using Fernco™ couplers for influent and effluent flow. These couplers provide a smooth transitional flow path between the influent and effluent PVC piping and test unit stubouts. Effluent 6-inch diameter PVC piping runs 18.2 feet to the discharge point. Water free falls from the effluent pipe into the reservoir tank assembly where scour test effluent samples are collected by grab sampling from that flow stream. The XP-2 test unit is shown in place within the test configuration in **Figure 4**.

Figure 4 XP-2 Test Position

2.2.1 Flow

The inflow to the test unit is measured using a Badger M-2000 flow meter. The flow rate is averaged and recorded at a minimum every 60 seconds throughout the duration of the test using a calibrated Lascar EL-USB-4 Data Logger. The accuracy of the flow measurement is ±2%. The maximum allowable coefficient of variation (COV) for flow documentation is 0.03. A photograph of the pump, filter, and flow meter is shown in **Figure 5**.

Figure 5 Background Sample Port and Test Loop Equipment Locations

2.2.2 Water Temperature

Water temperature measurements were obtained using a calibrated Lascar EL-USB-TC temperature logger with Lascar K-type thermocouple probe. Calibration was performed at the test facility prior to testing. Temperature readings were documented to assure an acceptable testing water temperature that does not exceed 80.0° F. Water temperature controls were not necessary.

2.2.3 Sediment Injection

Test sediment was injected into the crown of the influent pipe 13 inches upstream of the test unit. Injection was accomplished using an IPM Systems Auger® volumetric screw feeder, model VF-2 with an attached vibrator. The auger screw is driven with a variable speed drive and was calibrated with the test sediment feed prior to testing to establish a relationship between screw RPM and feed

rate in mg/minute. A calibrated stopwatch was used to establish this relationship. The feeder has a 1.5-cubic foot vibratory hopper to provide a constant supply of test sediment. Sediment feed samples were collected in clean one-liter bottles and weighed on a calibrated Tree Model HRB-413 analytical balance manufactured by LW Measurements, LLC. Calibration samples were collected over time intervals that did not exceed one minute, except when extending the collection time was required to ensure a minimum sample size of 20.0 g. The mass of test sediment injected from the hopper and into the influent pipe flow stream was weighed using an Ohaus Defender 5000 scale.

2.2.4 Sample Concentration Analysis

Background and scour effluent sediment concentration samples were independently analyzed according to the protocol by AIRL, Inc. of Cleveland, Tennessee in accordance with ASTM Designation D 3977-97 (re-approval 2019), "Standard Test Methods for Determining Sediment Concentration in Water Samples."

2.3 Laboratory Proficiency

Proficiency in performing ASTM D3977 was demonstrated before testing began according to Section 3.B of the protocol. Six Total Suspended Solids (SSC) samples, three at 20 mg/L (+/-) and three at 50 mg/L (+/-), were prepared by AquaShield™ using the same test sediment as for sediment removal testing and submitted to AIRL, Inc. for analysis. Sampling was witnessed by the observer. The results of these analyses are presented below in **Table 1**. These results are within the ±15% allowed in Section 3.B.3 of the protocol and confirm the proficiency of AIRL, Inc. to perform ASTM D3977 analysis.

Table 1 Laboratory Proficiency SSC Results

Sample Number	Measured Concentration (mg/L)	Reported Concentration (mg/L)	% Recovery	Average % Recovery
1	17.0	17.0	100	98.2
2	17.0	17.0	100	
3	18.0	17.0	94.4	
4	45.0	55.0	122.2	101.9
5	51.0	49.0	96.1	
6	48.0	42.0	87.5	

2.4 Test Sediment

The particle size distributions (PSDs) for the removal efficiency test sediment and scour test sediment were independently verified to meet the specifications in Section 4.A of the protocol by GeoTesting Express in Acton, Massachusetts (A2LA, AASHTO, and USACE accredited) using ASTM test methods D6913 and D7928. The removal efficiency sediment blend was mixed on-site

and stored in five-gallon buckets with 50 pounds of sediment per bucket for a total of 14 buckets, until the independent observer collected samples for PSD testing. For each of the three removal efficiency test sediment samples, three representative samples were taken from separate 50-pound buckets and composited. Thus, nine of the 14 five-gallon buckets were sampled to obtain the three PSD samples. After sampling, the removal efficiency sediment buckets were combined into a single 55-gallon drum.

2.4.1 Removal Efficiency Test Sediment

The results of the PSD for the removal efficiency test sediment are shown in **Table 2** and **Figure 6**. This sediment was comprised of 2- to 1,000-µm silica particles, with a median (D_{50}) of 54.2 µm. The moisture content of the removal efficiency test sediment was 0.0%, as determined by the ASTM D2216 method.

Table 2 Particle Size Distribution of Removal Efficiency Test Sediment

Size (µm)	% Finer				Average	Δ from Protocol
	NJDEP	RE-1	RE-2	RE-3		
1,000	100	99	99	99	99.0	-1.0
500	95	96	96	96	96.0	1.0
250	90	89	89	89	89.0	-1.0
150	75	78	78	76	77.3	2.3
100	60	60.4	60.4	59.7	60.2	0.2
75	50	54	54	54	54.0	4.0
50	45	49.2	48.7	49.5	49.1	4.1
20	35	38.3	40.5	40.3	39.7	4.7
8	20	19.5	20.4	21.4	20.4	0.4
5	10	13.1	13.1	14.1	13.4	3.4
2	5	3.6	4.2	4.6	4.1	-0.9
D_{50} (µm)	75	53.5	56.3	52.7	54.2	-20.8

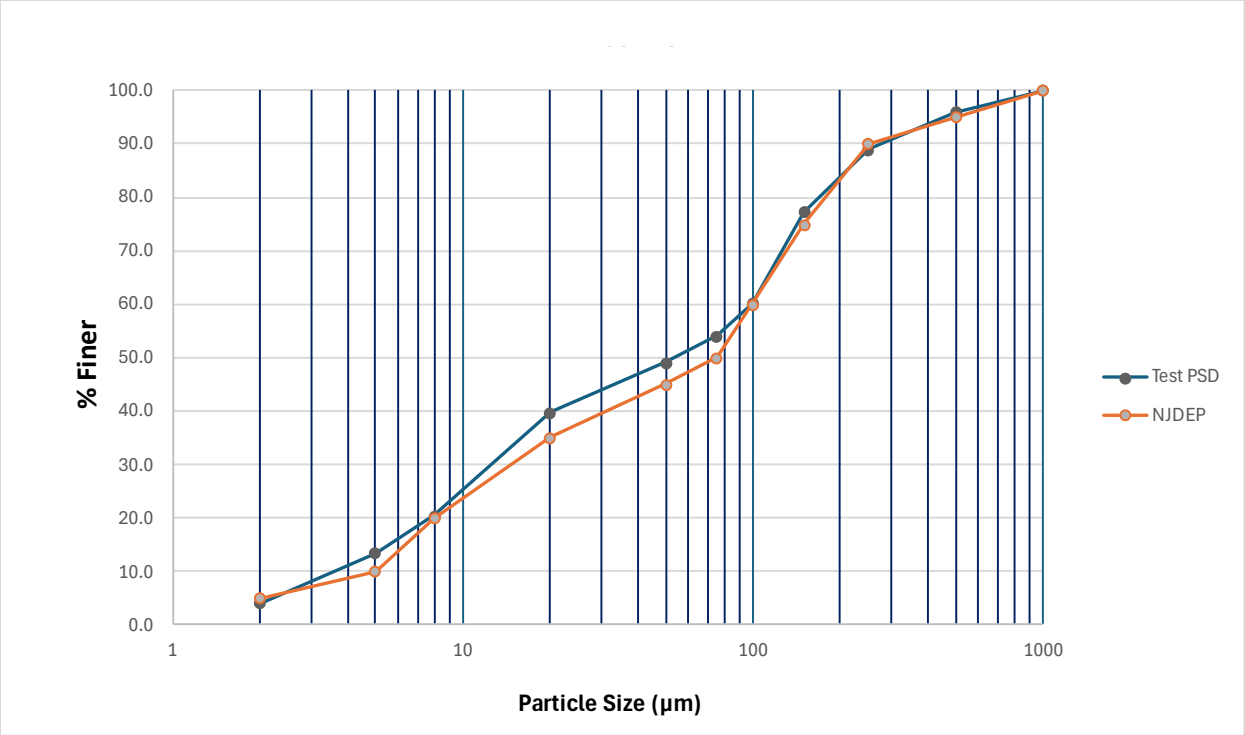

Figure 6 Average Removal Efficiency Test Sediment PSD vs. NJDEP PSD Protocol Specification

2.4.2 Scour Test Sediment

The PSD used for scour testing is comprised of 50- to 1,000-µm particles as shown in **Table 3** and **Figure 7**. Scour test sediment was stored in a 55-gallon drum and three PSD samples were taken at different layers within the drum. The drum of scour test sediment was sealed by the observer until scour testing began. PSD samples were analyzed in accordance with ASTM D6913, "Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis," which confirmed that the PSD complies with the protocol for scour testing.

Table 3 Particle Size Distribution of Scour Test Sediment

Size (µm)	NJDEP	Scour-1	Scour-2	Scour-3	Avg.	Δ from Protocol
1,000	100	100	100	99	99.7	-0.3
500	90	96	97	96	96.3	6.3
250	55	60	64	60	61.3	6.3
150	40	49	51	48	49.3	9.3
100	25	30	31	28	29.7	4.7
75	10	15	16	13	14.7	4.7
50	0	5.0	4.2	4.2	4.4	4.4

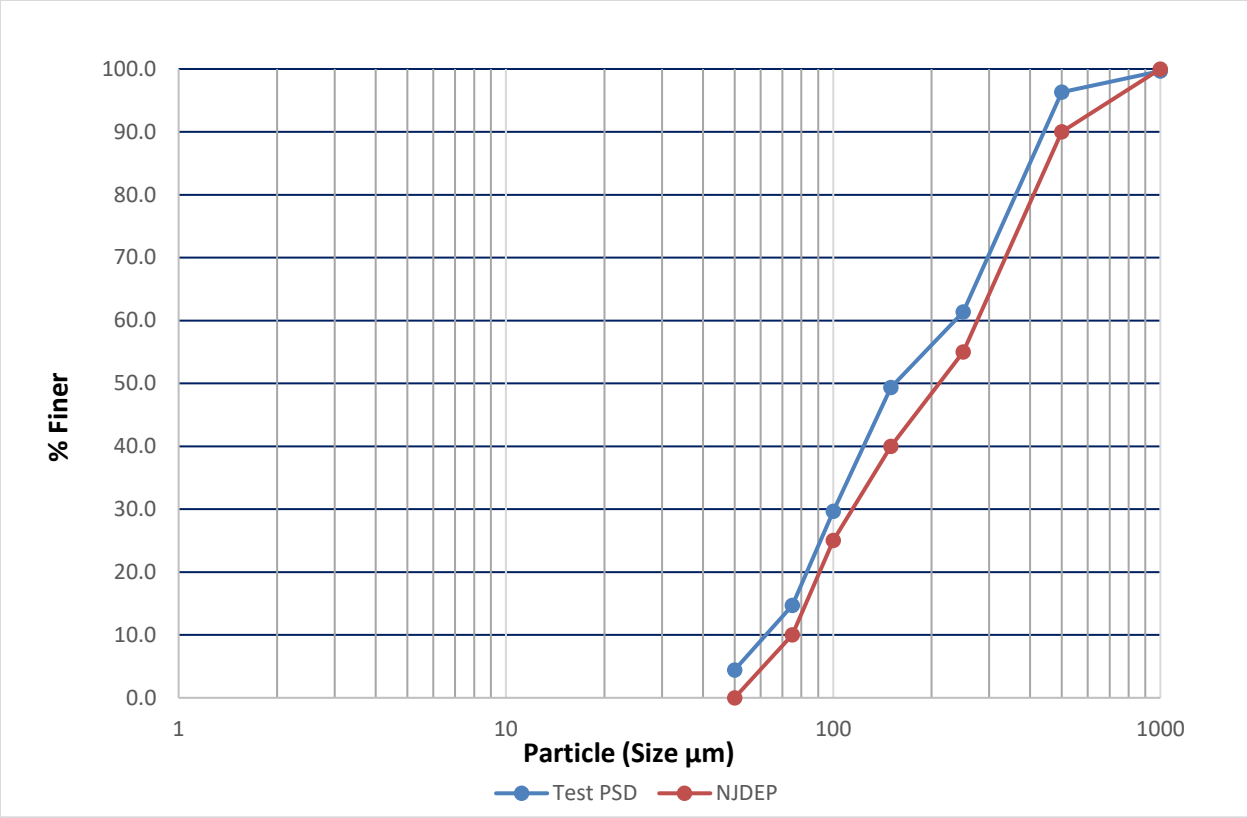

Figure 7 Average Scour Test Sediment PSD vs. NJDEP PSD Protocol Specification

2.5 Sediment Removal Efficiency Testing Procedure

The sediment removal efficiency tests were conducted in accordance with protocol Sections 4B and 4C using the Mass Capture Test Method. Performance was measured at 10%, 25%, 50%, 75%, 100%, 125%, and 150% of the target MTFR of 196 gpm (0.44 cfs, 40 gpm/ft^2). No sediment was pre-loaded into the test unit for the sediment removal efficiency test runs.

Flow rates were measured at the location shown in **Figure 5** and were recorded following Section 4.B.3 of the protocol. Allowable variation from the target flow rate was ±10%, with a COV ≤ 0.03. The calibrated flow meter data logger recorded flows once per minute and the average flow rate was determined for each test run. Water temperature was recorded at 60 second intervals and did not exceed 80.0 °F during any test run.

Test sediment was fed via an auger device targeting an influent concentration of 200 mg/L (±20 mg/L). Six calibration samples were taken from the injection point at evenly spaced intervals over the duration of each test flow as described in Section 4.B.2. One calibration sample per hour was collected when the test duration exceeded six hours. Sediment feed calibration samples were collected over time intervals not exceeding one minute. Collection times were extended as necessary to ensure a minimum sample size of 20.0 g. Samples were weighed to the nearest 0.1 g and the concentration COV was verified to not exceed 0.10.

Influent sample concentrations were determined using **Equation 1**.

$$\text{Average Influent Concentration} = \frac{\text{Total mass added}}{\text{Total volume of water flowing through MTD during sediment addition}} \qquad \textbf{Eq. 1}$$

The "total mass added" was determined as follows. The mass of test sediment to be added to the sediment hopper was weighed prior to initiating a given test run. At the conclusion of that test run, the remaining test sediment in the hopper was thoroughly removed and weighed again. Both the pre-run and post-run weights were measured to the nearest 0.02 lb and converted to milligrams. The difference between the pre-run sediment weight and the post-run sediment weight represents the mass of injected test sediment. Next, the sum of the weights (to the nearest milligram) of the six sediment feed calibration samples was subtracted from the weighed injected test sediment, which provides the "total mass added" during a test run. A minimum of 25 lbs of test sediment was fed to the test unit, unless the test duration first reached the 8-hour maximum time limit, as described in Section 4.C.3 of the protocol.

Background sampling was performed at the sample port location shown in **Figure 5**. Eight background samples were collected at evenly spaced intervals throughout each test run in accordance with Section 4.B.1. of the protocol. The sample port was purged of water immediately prior to collecting a background sample to minimize the potential for previously accumulated sediment within the sample port assembly being included in the background sample. The background sediment concentration for the test runs were not to exceed 20 mg/L. All background samples were time-stamped and the observer confirmed that each background sample was properly recorded.

The test unit was left idle after each test to allow for sediment settling in the sump. Pre-weighed non-ferrous trays were used in quantifying the captured sediment. All captured material was removed, placed into the pre-weighed trays, and dried in a convection oven at 100°C (212°F). Once cooled to room temperature, two successive weight measurements were taken no less than two hours apart. To confirm that the collected samples were thoroughly dried without being returned to the oven after the initial weighing, additional tests were performed for the 100% run and 25% runs such that samples were returned to the oven between successive weight measurements. These additional tests reasonably confirmed that the original data is valid by exhibiting masses within the specified tolerances of the protocol for successive weight measurements. Final weights were recorded when these two measurements differed by no more than 0.1% ± 10 grams. Removal efficiency was determined using **Equation 2** as follows:

$$\text{Removal Efficiency (\%)} = \frac{\text{Total mass collected}}{\text{Total sediment mass added during test run}} \qquad \textbf{Eq. 2}$$

2.6 Scour Testing Procedure

To simulate the 50% sediment storage depth, the XP-2 false floor was set to 43 inches below the invert and filled with four inches of scour test sediment. The sediment layer was leveled, and the

test unit was slowly filled with water to minimize disturbance to the scour test sediment. Scour testing commenced within 96 hours after the unit was pre-loaded with scour test sediment, as per the protocol. All scour test setup activities, measurements, testing, and sampling were performed in the presence of the independent observer.

Scour testing commenced by increasing the flow rate within three minutes to 396.6 gpm (0.88 cfs), which exceeds 200% MTFR. The flow rate was recorded once per minute. Effluent samples were collected, and time stamped every 2 minutes after the test commenced. A total of 15 effluent samples were collected over the duration of the scour test. Effluent samples were collected in clean, laboratory-provided plastic 1-liter bottles, using a single continuous sweeping motion through the entire flow stream. Water temperature was recorded every 60 seconds to ensure it did not exceed 80.0° F during the test run.

Eight background samples were collected at evenly spaced intervals to coincide with the times at which odd-numbered effluent samples were collected. The first background sample was collected to coincide with the first effluent sample. Representative background samples were collected through the 1-inch background sample port that was used for Sediment Removal Efficiency Testing (see **Figure 5**). Background samples were time stamped accordingly.

All samples were properly recorded, and a chain of custody form was completed for the scour test samples. The samples were analyzed by AIRL, Inc. of Cleveland, Tennessee in accordance with ASTM D3977 "Standard Test Methods for Determining Sediment Concentrations in Water Samples."

3. Performance Claims

In keeping with the NJCAT verification process, XCelerator® XP performance claims are cited below.

Total Suspended Solids Removal Rate

For the particle size distribution and weighted calculation method specified by the NJDEP HDS MTD protocol, the XCelerator® XP Model XP-2 will demonstrate at least 50% annualized weighted TSS removal efficiency at an MTFR of 0.44 cfs (195.6 gpm).

Maximum Treatment Flow Rate

The MTFR for the XCelerator® XP Model XP-2 was demonstrated to be 195.6 gpm (0.44 cfs) which corresponds to a surface area loading rate of 39.9 gpm/ft^2.

Sediment Storage Depth and Volume

The maximum (100%) sediment storage depth of the XCelerator® XP XP-2 is 14.5 inches. Available sediment storage volume varies with each XCelerator® XP model, as model dimensions increase in diameter. A sediment storage depth of 7.25 inches corresponds to 50% sediment storage capacity.

Effective Treatment Area

The effective treatment area of XCelerator® XP models vary with model size, as it corresponds to the surface area of the model diameter. The tested XP-2 has an effective treatment area of 4.91 ft^2.

Detention Time and Volume

The detention time of an XCelerator® XP is dependent on flow rate and model size. The detention time is calculated by dividing the treatment volume by the flow rate. The treatment volume is defined as the surface area multiplied by the depth from one inch below the high-flow bypass to the false floor. The tested XP-2 has a detention time of 44 seconds at the MTFR of 195.6 gpm (0.44 cfs).

On-line or Off-line

Based on the results of the scour test as described in Section 4.2, the XCelerator® XP qualifies for on-line installation.

4. Supporting Documentation

The NJDEP Procedure (NJDEP 2021) for obtaining verification of an MTD from NJCAT requires that copies of the laboratory test reports, including all collected and measured data, all data from performance test runs, all pertinent calculations, etc. be included in this section. It is the understanding of AquaShield™ that this was discussed with NJDEP and it was agreed that, if such documentation could be made available by NJCAT upon request, it would not be necessary to include all such supporting documentation in verification reports. AquaShield™ retains this documentation, and it has been provided to NJCAT.

4.1 Removal Efficiency Testing

In accordance with the NJDEP HDS MTD Protocol, sediment removal efficiency testing was conducted on the XCelerator® XP Model XP-2 unit in order to establish the ability of the device to remove the specified test sediment at 10%, 25%, 50%, 75%, 100%, 125%, and 150% of the target MTFR with the goal of demonstrating at least 50% annualized weighted sediment removal, as defined in the protocol. The target MTFR was 196 gpm (0.44 cfs).

All results reported in this section were obtained from test runs that comply with the protocol. None of the sediment feed calibration sample times exceeded one minute for any of the tests, except the 10% MTFR test (required to collect a minimum 20.0 g sample). The inlet feed concentration coefficient of variance (COV) did not exceed 0.10 for any test flow rate. The average influent sediment concentration was calculated using **Equation 1** from Section 2.4 herein. Flow continued for one detention time after stopping the sediment feed for each test. No background TSS concentration exceeded the 20.0 mg/L maximum allowed by the protocol. The water temperature did not exceed 80.0° F during any of the test runs. Note that background sample concentrations listed as 2 mg/L represent one half of the method detection limit of 4 mg/L (reported

by the laboratory as <4 mg/L). A summary of the removal efficiency test runs is provided in **Table 4**, below.

Table 4 Summary of TSS Removal Efficiency

% MTFR	10	25	50	75	100	125	150
Total Mass Added (lb)	16.22	27.86	27.91	27.29	28.12	28.07	29.57
Feed Sample Mass (lb)	0.41	0.49	1.10	1.43	1.93	1.08	1.53
Retained Inlet Pipe (lb)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delivered to MTD (lb)	15.81	27.37	26.81	25.86	26.19	26.99	28.04
Captured in MTD (lb)	11.21	17.99	14.38	11.43	9.47	7.49	6.88
Removal Efficiency (%)	70.90	65.72	53.64	44.20	36.16	27.75	24.54

The weighted sediment removal efficiency summary and third-order polynomial performance curve are presented in **Table 5** and **Figure 8**, respectively. The R^2 value of the removal efficiency curve was 0.998, exceeding the minimum requirement of 0.95. Using the removal efficiency curve equation, the XCelerator® XP Model XP-2 achieved a 50.01% annualized weighted TSS removal at an MTFR of 195.6 gpm (0.44 cfs).

Table 5 Weighted Sediment Removal Efficiency

% MTFR	Flow Rate (gpm)	Removal Efficiency (%)	Weighting Factor	Weighted Removal (%)
25	49.25	65.72	0.25	16.43
50	98.50	55.38	0.30	16.61
75	147.75	44.68	0.20	8.94
100	195.60	35.01	0.15	5.25
125	246.25	27.75	0.10	2.78
Annual Weighted Removal Efficiency (%)				50.01

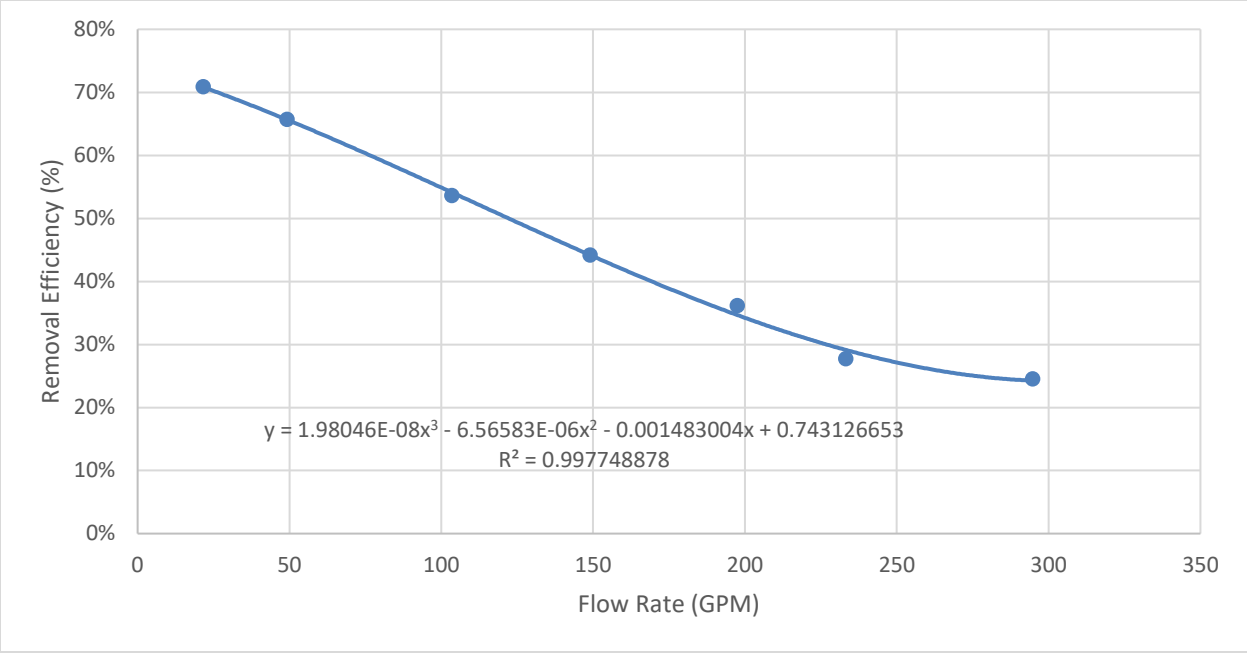

Figure 8 Removal Efficiency vs. Flow Rate Performance Curve

Details of individual test runs, including flow rates, temperatures, sampling schedules, sediment feed rates, and results, are provided in the following sections.

10% MTFR – 21.6 gpm

The 10% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 20 gpm (0.05 cfs). The feed rate and background sampling schedules are shown in **Table 6**. Flow rate and temperature data are shown in **Tables 7** and **8**. Background sampling results are shown in **Table 9**. **Table 10** shows the mass from the sediment feed samples. The sample time was 1.5 minutes (90 seconds). The relevant information for the mass balance method is presented in **Table 11**.

The XP-2 removed 70.90% of the test sediment at an average flow rate of 21.6 gpm (0.05 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 6 Sampling Schedule - 10% MTFR

10% MTFR		
Time (min)	**Feed Rate**	**Background**
1	1	1
67	2	2
134	3	3
201	4	4
268	5	5
335	6	6
402	7	7
470	8	8
472	Feed Stop	
480	END	
Detention Time = 438 s		

Table 7 Flow - 10% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	20	21.6	PASS	0.005	PASS
cfs	0.05	0.05			

Table 8 Temperature - 10% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
65	PASS

Table 9 Background SSC - 10% MTFR

Sample Number	**Concentration (mg/L)**	**QA/QC**
		≤ 20.0 mg/L
1	17	PASS
2	8	PASS
3	7	PASS
4	6	PASS
5	5	PASS
6	4	PASS
7	4	PASS
8	4	PASS

Table 10 Sediment Feed Mass - 10% MTFR

Sample Number	Mass (g)
1	24.211
2	25.017
3	22.122
4	22.051
5	24.194
6	20.604
7	23.521
8	23.392
Total	185.112
Average	23.139
QA/QC	
COV	0.06
COV ≤ 0.10	PASS

Table 11 Mass Balance Summary - 10% MTFR

Pre-Test Sediment Mass (lb)	80.00
Post-Test Sediment Mass (lb)	63.78
Total Sediment Mass Used (lb)	16.22
Sediment Mass to System (lb) (less feed rate samples)	15.81
Water Volume during Sediment Addition (L)	37,540.7
Average Sediment Concentration (mg/L)	191.1
QA/QC	
Total Sediment Mass Added ≥ 25 lb	N/A (test duration reached 8 hrs)
Average Sediment Concentration ± 10% of 200 mg/L	PASS

25% MTFR – 49.2 gpm

The 25% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 50 gpm (0.11 cfs). The feed rate and background sampling schedules are shown in **Table 12**. Flow rate and temperature data are shown in **Tables 13** and **14**, respectively. Background sampling results are shown in **Table 15**. **Table 16** shows the mass from the sediment feed samples. The sample time was 1.0 minute (60 seconds). The relevant information for the mass balance method is presented in **Table 17**.

The XP-2 removed 65.72% of the test sediment at an average flow rate of 49.2 gpm (0.11 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 12 Sampling Schedule - 25% MTFR

25% MTFR		
Time (min)	**Feed Rate**	**Background**
1	1	1
48		2
67	2	
96		3
134	3	
144		4
192		5
201	4	
240		6
268	5	
288		7
335	6	8
336	Feed Stop	
339	END	
Detention Time = 176 s		

Table 13 Flow - 25% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	50	49.2	PASS	0.004	PASS
cfs	0.11	0.11			

Table 14 Temperature - 25% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
66	PASS

Table 15 Background SSC - 25% MTFR

Sample Number	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	11	PASS
2	2	PASS
3	2	PASS
4	2	PASS
5	2	PASS
6	6	PASS
7	12	PASS
8	18	PASS

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L.*

Table 16 Sediment Feed Mass - 25% MTFR

Sample Number	Mass (g)
1	37.130
2	35.442
3	38.938
4	35.553
5	35.440
6	38.981
Total	221.484
Average	36.914
QA/QC	
COV	0.04
COV ≤ 0.10	PASS

Table 17 Mass Balance Summary - 25% MTFR

Pre-Test Sediment Mass (lb)	80.00
Post-Test Sediment Mass (lb)	52.14
Total Sediment Mass Used (lb)	27.86
Sediment Mass to System (lb) (less feed rate samples)	27.37
Water Volume during Sediment Addition (L)	61,355.9
Average Sediment Concentration (mg/L)	202.4
QA/QC	
Total Sediment Mass Added ≥ 25 lb	PASS
Average Sediment Concentration ± 10% of 200 mg/L	PASS

50% MTFR – 103.5 gpm

The 50% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 99 gpm (0.22 cfs). The feed rate and background sampling schedules are shown in **Table 18**. Flow rate and temperature data are shown in **Tables 19** and **20**, respectively. Background sampling results are shown in **Table 21**. **Table 22** shows the mass from the sediment feed samples. The sample time was 1.0 minute (60 seconds). The relevant information for the mass balance method is presented in **Table 23**.

The XP-2 removed 53.64% of the test sediment at an average flow rate of 103.5 gpm (0.23 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 18 Sampling Schedule - 50% MTFR

50% MTFR		
Time (min)	**Feed Rate**	**Background**
1	1	1
24		2
34	2	
48		3
68	3	
72		4
96		5
102	4	
120		6
136	5	
144		7
170	6	8
171	Feed Stop	
173	END	
Detention Time = 88 s		

Table 19 Flow - 50% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	99	103.5	PASS	0.026	PASS
cfs	0.22	0.23			

Table 20 Temperature - 50% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
65.5	PASS

Table 21 Background SSC - 50% MTFR

Sample Number	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	8	PASS
2	2	PASS
3	2	PASS
4	2	PASS
5	2	PASS
6	2	PASS
7	2	PASS
8	2	PASS

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L.*

Table 22 Sediment Feed Mass - 50% MTFR

Sample Number	Mass (g)
1	87.290
2	81.479
3	79.911
4	87.860
5	81.354
6	82.355
Total	500.249
Average	83.375
QA/QC	
COV	0.04
COV ≤ 0.10	PASS

Table 23 Mass Balance Summary - 50% MTFR

Pre-Test Sediment Mass (lb)	80.00
Post-Test Sediment Mass (lb)	52.09
Total Sediment Mass Used (lb)	27.91
Sediment Mass to System (lb) (less feed rate samples)	26.81
Water Volume during Sediment Addition (L)	64,556.2
Average Sediment Concentration (mg/L)	188.4
QA/QC	
Total Sediment Mass Added ≥ 25 lb	PASS
Average Sediment Concentration ± 10% of 200 mg/L	PASS

75% MTFR – 149.0 gpm

The 75% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 148 gpm (0.33 cfs). The feed rate and background sampling schedules are shown in **Table 24**. Flow rate and temperature data are shown in **Tables 25** and **26**, respectively. Background sampling results are shown in **Table 27**. **Table 28** shows the mass from the sediment feed samples. The sample time was 1.0 minute (60 seconds). The relevant information for the mass balance method is presented in **Table 29**.

The XP-2 removed 44.20% of the test sediment at an average flow rate of 149.0 gpm (0.33 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 24 Sampling Schedule - 75% MTFR

75% MTFR		
Time (min)	**Feed Rate**	**Background**
1	1	1
16		2
23	2	
32		3
46	3	
48		4
64		5
69	4	
80		6
92	5	
96		7
115	6	8
116	Feed Stop	
117	END	
Detention Time = 59 s		

Table 25 Flow - 75% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	148	149.0	PASS	0.008	PASS
cfs	0.33	0.33			

Table 26 Temperature - 75% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
66.5	PASS

Table 27 Background SSC - 75% MTFR

Sample Number	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	7	PASS
2	2	PASS
3	2	PASS
4	2	PASS
5	2	PASS
6	2	PASS
7	7	PASS
8	15	PASS

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L.*

Table 28 Sediment Feed Mass - 75% MTFR

Sample Number	Mass (g)
1	117.617
2	103.285
3	105.662
4	105.255
5	111.232
6	105.218
Total	648.269
Average	108.045
QA/QC	
COV	0.05
COV ≤ 0.10	PASS

Table 29 Mass Balance Summary - 75% MTFR

Pre-Test Sediment Mass (lb)	80.00
Post-Test Sediment Mass (lb)	52.71
Total Sediment Mass Used (lb)	27.29
Sediment Mass to System (lb) (less feed rate samples)	25.86
Water Volume during Sediment Addition (L)	61,943.5
Average Sediment Concentration (mg/L)	189.4
QA/QC	
Total Sediment Mass Added ≥ 25 lb	PASS
Average Sediment Concentration ± 10% of 200 mg/L	PASS

100% MTFR – 197.4 gpm

The 100% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 197 gpm (0.44 cfs). The feed rate and background sampling schedules are shown in **Table 30**. Flow rate and temperature data are shown in **Tables 31** and **32**, respectively. Background sampling results are shown in **Table 33**. **Table 34** shows the mass from the sediment feed samples. The sample time was 1.0 minute (60 seconds). The relevant information for the mass balance method is presented in **Table 35**.

The XP-2 removed 36.16% of the test sediment at an average flow rate of 197.4 gpm (0.44 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 30 Sampling Schedule - 100% MTFR

100% MTFR		
Time (min)	**Feed Rate**	**Background**
1	1	1
13		2
18	2	
26		3
36	3	
39		4
51		5
54	4	
64		6
72	5	
77		7
89	6	8
90	Feed Stop	
91	END	
Detention Time = 44 s		

Table 31 Flow - 100% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	197	197.4	PASS	0.005	PASS
cfs	0.44	0.44			

Table 32 Temperature - 100% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
71.5	PASS

Table 33 Background SSC - 100% MTFR

Sample Number	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	2	PASS
2	2	PASS
3	2	PASS
4	2	PASS
5	2	PASS
6	2	PASS
7	8	PASS
8	12	PASS

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L.*

Table 34 Sediment Feed Mass - 100% MTFR

Sample Number	Mass (g)
1	147.771
2	146.385
3	135.804
4	153.576
5	143.330
6	147.554
Total	874.420
Average	145.737
QA/QC	
COV	0.04
COV ≤ 0.10	PASS

Table 35 Mass Balance Summary - 100% MTFR

Pre-Test Sediment Mass (lb)	73.82
Post-Test Sediment Mass (lb)	45.70
Total Sediment Mass Used (lb)	28.12
Sediment Mass to System (lb) (less feed rate samples)	26.19
Water Volume during Sediment Addition (L)	62,686.8
Average Sediment Concentration (mg/L)	189.5
QA/QC	
Total Sediment Mass Added ≥ 25 lb	PASS
Average Sediment Concentration ± 10% of 200 mg/L	PASS

125% MTFR – 233.2 gpm

The 125% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 246 gpm (0.55 cfs). The feed rate and background sampling schedules are shown in **Table 36**. Flow rate and temperature data are shown in **Tables 37** and **38**, respectively. Background sampling results are shown in **Table 39**. **Table 40** shows the mass from the sediment feed samples. The sample time was 0.5 minutes (30 seconds). The relevant information for the mass balance method is presented in **Table 41**.

The XP-2 removed 27.75% of the test sediment at an average flow rate of 233.2 gpm (0.52 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 36 Sampling Schedule - 125% MTFR

125% MTFR		
Time (min)	**Feed Rate**	**Background**
1	1	1
10		2
14	2	
20		3
28	3	
30		4
40		5
42	4	
50		6
56	5	
60		7
69	6	8
78	Feed Stop	
80	END	
Detention Time = 36 s		

Table 37 Flow - 125% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	246	233.2	PASS	0.022	PASS
cfs	0.55	0.52			

Table 38 Temperature - 125% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
65	PASS

Table 39 Background SSC - 125% MTFR

Sample Number	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	6	PASS
2	2	PASS
3	2	PASS
4	2	PASS
5	2	PASS
6	4	PASS
7	9	PASS
8	17	PASS

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L.*

Table 40 Sediment Feed Mass - 125% MTFR

Sample Number	Mass (g)
1	81.576
2	80.712
3	80.477
4	80.033
5	83.422
6	82.778
Total	488.998
Average	81.500
QA/QC	
COV	0.02
COV ≤ 0.10	PASS

Table 41 Mass Balance Summary - 125% MTFR

Pre-Test Sediment Mass (lb)	80.00
Post-Test Sediment Mass (lb)	51.93
Total Sediment Mass Used (lb)	28.07
Sediment Mass to System (lb) (less feed rate samples)	26.99
Water Volume during Sediment Addition (L)	66,111.49
Average Sediment Concentration (mg/L)	185.2
QA/QC	
Total Sediment Mass Added ≥ 25 lb	PASS
Average Sediment Concentration ± 10% of 200 mg/L	PASS

150% MTFR – 294.8 gpm

The 150% MTFR test was conducted in accordance with the NJDEP protocol at a target flow rate of 295 gpm (0.66 cfs). The feed rate and background sampling schedules are shown in **Table 42**. Flow rate and temperature data are shown in **Tables 43** and **44**, respectively. Background sampling results are shown in **Table 45**. **Table 46** shows the mass from the sediment feed samples. The sample time was 0.5 minutes (30 seconds). The relevant information for the mass balance method is presented in **Table 47**.

The XP-2 removed 24.54% of the test sediment at an average flow rate of 294.8 gpm (0.66 cfs). The QA/QC results for flow rate, feed rate, influent concentration and background concentration are compliant with the protocol.

Table 42 Sampling Schedule - 150% MTFR

150% MTFR = 295 gpm		
Time (min)	**Feed Rate**	**Background**
1	1	1
8		2
11	2	
17		3
22	3	
25		4
33	4	5
41		6
44	5	
49		7
57	6	8
58	Feed Stop	
59	END	
Detention Time = 30 s		

Table 43 Flow - 150% MTFR

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	295	294.8	PASS	0.005	PASS
cfs	0.66	0.66			

Table 44 Temperature - 150% MTFR

Maximum Temperature (°F)	**QA/QC**
	T ≤ 80°F
66	PASS

Table 45 Background SSC - 150% MTFR

Sample Number	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	2	PASS
2	2	PASS
3	2	PASS
4	2	PASS
5	2	PASS
6	2	PASS
7	4	PASS
8	9	PASS

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L.*

Table 46 Sediment Feed Mass - 150% MTFR

Sample Number	Mass (g)
1	111.354
2	116.227
3	115.737
4	118.189
5	116.498
6	116.766
Total	694.771
Average	115.795
QA/QC	
COV	0.02
COV ≤ 0.10	PASS

Table 47 Mass Balance Summary - 150% MTFR

Pre-Test Sediment Mass (lb)	80.00
Post-Test Sediment Mass (lb)	50.43
Total Sediment Mass Used (lb)	29.57
Sediment Mass to System (lb) (less feed rate samples)	28.04
Water Volume during Sediment Addition (L)	61,284.7
Average Sediment Concentration (mg/L)	207.5
QA/QC	
Total Sediment Mass Added ≥ 25 lb	PASS
Average Sediment Concentration ± 10% of 200 mg/L	PASS

Excluded Data/Results

Three test runs had a single background sample exceeding the 20 mg/L limit and were considered invalid. These results were excluded, and the tests were repeated.

4.2 Scour Testing

Scour testing for the XCelerator® XP Model XP-2 was conducted in accordance with Section 5 of the NJDEP HDS protocol. The target scour test flow rate was 394 gpm (0.88 cfs). An average scour test flow rate of 396.6 gpm (0.88 cfs) was used to qualify the XCelerator® XP to be installed in an on-line configuration. Based on an MTFR of 195.6 gpm (0.44 cfs), the scour test flow rate represents 203% of the MTFR. The maximum water temperature recorded during the scour test was 68.5° F. The effluent and background sample schedules are shown in **Table 48**. Flow rate information is presented in **Table 49**.

Table 48 Sampling Schedule - Scour Test

Scour Test		
Time (min)	**Background**	**Effluent**
1	1	1
3		2
5	2	3
7		4
9	3	5
11		6
13	4	7
15		8
17	5	9
19		10
21	6	11
23		12
25	7	13
27		14
29	8	15

Table 49 Flow - Scour Test

Units	**Target Flow**	**Actual Flow**	**QA/QC**		
			±10%	COV	COV ≤ 0.03
gpm	394	396.6	PASS	0.003	PASS
cfs	0.88	0.88			

Unadjusted effluent sediment concentrations (inclusive of background concentrations) were below the analytical detection limit of 4 mg/L, except for the first sample equaling 4 mg/L. All background samples were below the detection limit. Adjusted effluent concentrations were calculated using **Equation 3**, below. **Table 50** summarizes effluent, background and adjusted effluent sediment concentrations. The average of the two adjacent background sample concentrations was used for even-numbered effluent samples (i.e., the effluent samples without coincidental background samples).

$$\text{Adjusted Conc. (mg/L)} = \text{Effluent Conc. (mg/L)} - \text{Background Conc. (mg/L)} \qquad \textbf{Eq. 3}$$

Table 50 Scour Test SSC Summary

Sample Number	Effluent Concentration (mg/L)	Background Concentration (mg/L)	QA/QC ≤ 20 mg/L	Adjusted Concentration (mg/L)
1	4	2	PASS	2
2	2	2	PASS	ND
3	2	2	PASS	ND
4	2	2	PASS	ND
5	2	2	PASS	ND
6	2	2	PASS	ND
7	2	2	PASS	ND
8	2	2	PASS	ND
9	2	2	PASS	ND
10	2	2	PASS	ND
11	2	2	PASS	ND
12	2	2	PASS	ND
13	2	2	PASS	ND
14	2	2	PASS	ND
15	2	2	PASS	ND
			Average:	<4

**Detection limit 4 mg/L. All samples < 4 mg/L reported as 2 mg/L, ND = Non-detect.*

Based on the results of this scour test, with the average adjusted effluent concentration being less than the maximum limit of 20.0 mg/L, the XCelerator® XP qualifies for on-line installation.

Excluded Data/Results

No data or results were excluded for the scour test.

4.3 Hydraulics

Hydraulic characteristic testing of the XP-2 was conducted on a clean unit without sediment injection or pre-loading. Flow and corresponding water levels were measured within the test unit, as well as in the influent and effluent pipes, to determine the head loss across the unit. Measurements covered the span of 10% to 200% of the MTFR and included the point at which bypass occurred (115% MTFR). Two Dwyer Instruments Series 1227 Dual Range Flex-Tube® U-Inclined Manometers were used to obtain pipe measurements. The manometers were placed in the influent and effluent pipes, approximately one pipe-diameter upstream and downstream of the treatment chamber, respectively. A metal ruler was secured to the internal structure of the test unit to measure water levels within the structure. Head loss measurements spanning flow rates from 10% to 200% of the MTFR are shown below in **Table 51**.

Table 51 Hydraulic Test Summary - Water Height and Head Loss

Flow Rate			Water Height (in)			
%MTFR	**gpm**	**cfs**	**h_{inlet}**	**h_{system}**	**h_{outlet}**	**Δh**
10%	20	0.04	1.2	1.3	0.8	0.4
30%	59	0.13	2.6	2.8	1.6	1.0
50%	99	0.22	4.2	4.0	2.4	1.8
70%	138	0.31	5.4	5.1	3.0	2.4
90%	177	0.40	6.6	6.3	3.2	3.4
115%*	225	0.50	8.0	7.5	3.9	4.2
130%	256	0.57	9.0	8.3	4.0	5.0
150%	296	0.66	9.8	9.0	4.2	5.6
170%	335	0.75	10.8	10.0	4.6	6.2
200%	394	0.88	14.4	13.0	5.6	8.8

**Flow rate at which bypass occurred*

5. Design Limitations

The Aqua-Swirl® XCelerator® XP is an engineered system designed to meet site-specific installation requirements. General terms of design parameters and limitations are cited below.

Soil Characteristics

The XCelerator® XP is a permanent, post-construction, flow-through modular device. AquaShield™ specifies that stone backfill material is to be used. Site-specific native soils can be used as backfill provided that the material substantially conforms to the backfill specification. AquaShield™ engineers can assist contractors with backfill information when using native soil.

Slope of Drainage Pipe

There is no specific drainage pipe slope limitation. Given that both the inlet and outlet pipe elevations are identical, the site design should consider piping configurations to accommodate the level flow-through piping design. AquaShield™ engineers can work with site designers to facilitate an appropriate conveyance configuration.

Maximum Water Quality Treatment Flow Rate

The maximum water quality treatment flow rate varies by XCelerator® XP model size and should be taken into consideration for site designs. AquaShield™ engineers can assist site designers with managing peak flow rates.

Maintenance Requirements

All XCelerator® XP stormwater treatment systems should be inspected and maintained following the recommendations and guidelines included in the Aqua-Swirl® XCelerator® XP Inspection and Maintenance Manual, available at:

https://www.aquashieldinc.com/uploads/1/3/6/1/13618853/xp_im_manual_08-25.pdfSection 6, herein, includes additional maintenance information.

Driving Head

XCelerator® XP technology does not require a driving head beyond that required to achieve flow conveyance and operating conditions.

Installation Limitations

Pick weights vary by XCelerator® XP model size. AquaShield™ can provide contractors with model-specific pick weights prior to delivery.

Configurations

XCelerator® XP technology can be installed in both off-line and on-line configurations.

Loading

XCelerator® XP systems are designed for HS-25 or greater loading. Contact AquaShield™ engineering staff when heavier loading conditions are anticipated.

Pre-treatment Requirements

The XCelerator® XP has no pre-treatment requirements.

Depth to Seasonal High-Water Table

XCelerator® XP performance is independent of high groundwater conditions. AquaShield™ performs buoyancy calculations as warranted for system installations to ensure long term functionality. Anti-floatation controls can be added for system installations when necessary.

6. Maintenance Plan

The Aqua-Swirl® XCelerator® XP Inspection and Maintenance Manual provided at all installation sites is available at:

https://www.aquashieldinc.com/uploads/1/3/6/1/13618853/xp_im_manual_08-25.pdf

The XCelerator® XP is designed to remove suspended sediment from stormwater runoff using a single chamber for both treatment and pollutant storage. As with any post-construction water quality treatment device, periodic removal of captured materials is essential to ensure long term functionality. XCelerator® XP performance may be diminished when sediment storage capacities

are reached. An Inspection and Maintenance manual is provided for each site delivery to track and document system operations.

Both inspection and maintenance activities of the XCelerator® XP are accomplished from the surface. There are no moving parts, no internal components that need replacement, and no product-specific tools needed from AquaShield™ to complete maintenance activities. A typical maintenance event for the cleaning of the swirl chamber utilizes a vacuum truck. XCelerator® XP units include one or two access risers per structure, depending on model size, to facilitate inspection and maintenance events.

Inspection

Upon installation and during construction activities, AquaShield™ recommends that an XCelerator® XP be inspected quarterly for the first year of operation to develop an appropriate schedule of maintenance. Essential elements of a facility inspection include observing floating materials and measuring the accumulated sediment at the base of the swirl chamber. The system should be inspected and cleaned at the end of construction, regardless of whether it has reached its capacity for sediment storage and/or other captured materials. During the first-year post-construction, the facility should again be inspected quarterly and cleaned as needed, depending on site conditions. The ultimate inspection frequency will be determined by site-specific runoff conditions. AquaShield™ recommends a minimum facility inspection frequency of once per year post-construction. Off-line installations should also consider the inspection and cleaning of external conveyance structures to ensure proper operation of the whole facility.

AquaShield™ recommends that the units be cleaned when sediment depth reaches 7.25 inches, representing 50% sediment storage capacity. The full sediment storage depth in the XCelerator® XP is 14.5 inches.

Maintenance

Cleanout frequency will ultimately be determined by post-installation and post-construction runoff conditions. Generally, AquaShield™ recommends that XCelerator® XP systems be maintained at a minimum of once per year. There is no need to enter an XCelerator® XP chamber for inspections or maintenance activities. Confined space entry techniques are recommended should entry to the device be necessary based on site conditions.

Cleaning is performed from the surface by a vacuum truck, though it may be necessary to remove gross debris and floatable objects by an alternate suitable method (i.e., skimming pole with net). Any accumulated oil can be vacuumed from the surface. Accumulated sediment at the base of the chamber can be removed from the surface via vacuum through the manhole opening(s).

The manhole lid(s) should be replaced at the conclusion of inspection and maintenance activities. AquaShield™ advises that all removed pollutants be disposed of in accordance with all applicable local regulations and ordinances.

7. Statements

The following signed statements from the manufacturer, third party observer and NJCAT are required to complete the NJCAT verification process. Additionally, this report has been subjected to public review and all comments and concerns have been satisfactorily addressed.

AquaShield™
STORMWATER TREATMENT SOLUTIONS

May 1, 2025

Dr. Richard Magee, Sc.D., P.E., BCEE
Executive Director
New Jersey Corporation for Advanced Technology
Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

Re: Verification of Aqua-Swirl® XCelerator® High Performance Stormwater Treatment System to NJDEP Laboratory Testing Protocol for a Hydrodynamic Sedimentation Device

The AquaShield™, Inc. Aqua-Swirl® XCelerator® High Performance Stormwater Treatment System (XCelerator® XP) hydrodynamic separator recently completed verification testing in compliance with the NJDEP HDS Laboratory Testing Protocol. As specified by the "*Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology*," this letter serves as the AquaShield™, Inc. statement that all procedures and requirements identified in the above-cited protocol and process document were met or exceeded. All XCelerator® XP Model XP-2 sediment removal efficiency and scour tests were conducted at the AquaShield™ laboratory facility in Chattanooga, Tennessee under the direct and independent supervision of Nicholas Tovar of Southern Environmental Technologies, Inc., Sewanee, Tennessee. The observer was approved per the Quality Assurance Project Plan dated March 2025. Preparation of the verification report and the supporting documentation fulfill the submission requirements of the process document and protocol.

Sincerely,

AquaShield™, Inc.

Mark B. Miller

Mark B. Miller, P.G.
Senior Research Scientist

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Southern Environmental Technologies, Inc.

900 Old Sewanee Road, Sewanee, TN 37375

Phone: 423-605-5569 Fax: 423-710-3094

www.southernenvironmental.us

May 1, 2025

Dr. Richard Magee
Executive Director
New Jersey Corporation for Advanced Technology

RE: Third party observation of testing of the Aqua-Swirl XCelerator High Performance Model XP-2 according to the New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device, January 01, 2021 (updated April 25, 2023).

Dear Dr. Magee,

The purpose of this letter is to confirm that I directly witnessed all of the Aqua-Swirl XCelerator High Performance Model XP-2 proficiency testing, particle size distribution, and the management of test sediment runs conducted at the AquaShield facility in Chattanooga, Tennessee from December 2024 through March 2025. I can attest that the testing was done in accordance with the above referenced protocol, as required by the Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology, for use in accordance with the Stormwater Management Rules N.J.A.C. 7:8 (January 25, 2013).

Prior to testing, I obtained PSD samples from the sediment blended by AquaShield for Removal Efficiency Testing. I also witnessed the unsealing of the test sediment for Scour Testing that had been mixed and supplied to AquaShield by Good Harbour Laboratories of Mississauga, Ontario.

During the testing, I witnessed the sampling during every run and personally weighed all sediment feed samples. I also inspected all sample bottle labels and confirmed the chains of custody for all analyzed samples. I have retained copies of the field notes and this supporting information is available to you upon request.

Sincerely,

Nicholas Tovar
Project Manager

CC: Mark Miller, Zachary Cavitt, & Stuart Ellis, AquaShield, Inc.

Southern Environmental Technologies, Inc.

900 Old Sewanee Road, Sewanee, TN 37375
Phone: 423-605-5569 Fax: 423-710-3094
www.southernenvironmental.us

May 1, 2025

Dr. Richard Magee
Executive Director
New Jersey Corporation for Advanced Technology

RE: Performance Verification of the Aqua-Swirl XCelerator High Performance Stormwater Treatment System Model XP-2

Dear Dr. Magee,

I have been contracted, as a representative of Southern Environmental Technologies, Inc., by AquaShield, Inc., to witness the performance testing of their Aqua-Swirl XCelerator High Performance Stormwater Treatment System using a Model XP-2, in accordance with the New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device, January 1, 2021 (updated April 25, 2023).

Southern Environmental Technologies, Inc. (SET) is an independent Environmental and Civil Engineering Field Services Company located in Sewanee, Tennessee.

I, the undersigned, on behalf of SET, confirm:

- that I do not have any conflict of interest in witnessing the contracted testing. Potential conflict of interest may arise, in particular, as a result of economic interests, political or national affinities, family or emotional ties, or any other relevant connection or shared interest;

- that I will inform NJCAT, without delay, of any situation constituting a conflict of interest or potentially giving rise to a conflict of interest;

- that I have not granted, sought, attempted to obtain or accepted and will not grant, seek, attempt to obtain, or accept any advantage, financial or in kind, to or from any party whatsoever, constituting an illegal or corrupt practice, either directly or indirectly, as an incentive or reward relating to the award of the contract.

Sincerely,

Date

Nicholas Tovar
Project Manager
Southern Environmental Technologies, Inc.

May 1, 2025

CC: Mark Miller, Zachary Cavitt, & Stuart Ellis, AquaShield, Inc.

Center for Environmental Systems
Stevens Institute of Technology
One Castle Point
Hoboken, NJ 07030-0000

May 12, 2025

Gabriel Mahon, Chief
NJDEP
Bureau of Non-Point Pollution Control
Bureau of Water Quality
401 E. State Street
Mail Code 401-02B, PO Box 420
Trenton, NJ 08625-0420

Dear Mr. Mahon,

Based on my review, evaluation and assessment of the testing conducted on the Aqua-Swirl® XCelerator® High Performance Model XP-2 Stormwater Treatment System by AquaShield conducted in Chattanooga, Tennessee at the hydraulics laboratory of AquaShield™, Inc. under the supervision of Southern Environmental Technologies, Inc. of Sewanee, Tennessee, the test protocol requirements contained in the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device", January 1, 2021, updated April 25, 2023 (NJDEP HDS Protocol) were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of the AquaShield test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The AquaShield removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be finer than the sediment blend specified by the protocol (<75µm); the test sediment d_{50} was approximately 54 microns, significantly finer than the protocol specification. The scour test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification and shown to be finer than specified by the protocol.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on the XCelerator® HP XP Model XP-2, a 2.5 ft. diameter commercially available unit, at 10%, 25%,

50%, 75%, 100%, 125% and 150% of the target MTFR to establish a third-order polynomial curve from which an MTFR could be selected that would achieve a >50% annualized weighted TSS removal, at 25%, 50%, 75%, 100% and 125% of the selected MTFR (0.88 cfs). The Aqua-Swirl® Model XP-2 demonstrated 50.01% annualized weighted solids removal as defined in the NJDEP HDS Protocol at the selected MTFR. The flow rates, sediment feed rates and influent concentration all met the NJDEP HDS test protocol's coefficient of variance requirements and the background concentration for all five test runs never exceeded 20 mg/L.

Scour Testing

In order to demonstrate the ability of the Aqua-Swirl XP-2 to be used as an on-line treatment device, scour testing was conducted at greater than 200% of the selected MTFR in accordance with the NJDEP HDS Protocol. The average flow rate during the on-line scour test was 0.88 cfs (396.6 gpm), which represents 201% of the MTFR (MTFR = 0.88 cfs). When adjusted for background concentrations, adjusted effluent concentrations were non-detect throughout the scour testing. These results confirm that the Aqua-Swirl® XCelerator® HP Model XP-2 did not scour at 201% MTFR and meets the criteria for on-line use.

Maintenance Frequency

The predicted maintenance frequency for all models is 48 months.

Sincerely,

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

8. References

ASTM D2216. *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

D 3977-97 (re-approval 2019). *Standard Test Methods for Determining Concentrations in Water Samples.*

ASTM D 6913. *Standard Test Methods for Particle Size Distribution (Gradation) of Soils Using Sieve Analysis.*

ASTM D7928. *Standard Test Method for Particle Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.*

New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device, January 1, 2021, Updated April 25, 2023. https://dep.nj.gov/wp-content/uploads/stormwater/hds-protocol-04252023-final.pdf.

VERIFICATION APPENDIX

Introduction

- Manufacturer: AquaShield™, Inc., 2733 Kanasita Drive, Suite 111, Chattanooga, Tennessee 37343. *General Phone: (423) 870-8888*. Website: www.aquashieldinc.com.

- MTD: Aqua-Swirl® XCelerator® High Performance Stormwater Treatment System (XCelerator® XP). Verified XCelerator® XP models are shown in **Table A-1**.

- TSS Removal Rate: 50%

- Off-line or On-line installation

Detailed Specification

- NJDEP sizing and dimension tables are attached as **Table A-1** and Table **A-2**, respectively.

- Pick weights and installation procedures vary with model size. AquaShield™ provides contractors with project-specific unit pick weights and installation instructions as warranted prior to delivery.

- AquaShield™ recommends that the units be cleaned when sediment depth reaches 7.25 inches, representing 50% sediment storage capacity.

- An Inspection and Maintenance Manual is provided for each project installation and is available at:

  https://www.aquashieldinc.com/uploads/1/3/6/1/13618853/xp_im_manual_08-25.pdf

- According to N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow a hydrodynamic separator such as the XCelerator® XP to be used in series with another hydrodynamic separator to achieve an enhanced TSS removal rate.

Table A-1 MTFRs and Required Sediment Removal Intervals for Aqua-Swirl® XCelerator® High Performance XP Models

Model	Manhole Diameter (ft)	NJDEP 50% TSS Maximum Treatment Flow Rate (cfs)	Treatment Area (ft^2)	Hydraulic Loading Rate (gpm/ft^2)	50% Maximum Sediment Storage Volume (ft^3)	Required Sediment Removal Interval[1] (months)
XP-2	2.5	0.44	4.91	39.9	2.95	48
XP-3	3.5	0.85	9.62	39.9	5.77	48
XP-4	4.5	1.41	15.90	39.9	9.54	48
XP-5	5.5	2.11	23.76	39.9	14.25	48
XP-6	6.5	2.94	33.18	39.9	19.91	48
XP-7	7.5	3.92	44.18	39.9	26.51	48
XP-8	8.5	5.03	56.75	39.9	34.05	48
XP-9	9.5	6.29	70.88	39.9	42.53	48
XP-10	10.5	7.68	86.59	39.9	51.95	48
XP-11	11.5	9.21	103.87	39.9	62.32	48
XP-12	12.5	10.88	122.72	39.9	73.63	48
XP-13	13.0	11.77	132.73	39.9	79.64	48

$$\text{Sediment Removal Interval (months)} = \frac{(\text{50\% HDS MTD Max Sediment Storage Volume} * 3.57)}{(\text{MTFR} * \text{TSS Removal Efficiency})}$$

Required sediment removal interval calculated using equation specified in Appendix A, Part B of the NJDEP Laboratory Protocol for HDS MTDs.

Table A-2 Standard Dimensions for Aqua-Swirl® XCelerator® High Performance XP Models

Model	Maximum Treatment Flow Rate (cfs)	Depth Below Invert (DBI)[1] (ft)	Scaling Depth[2] (ft)	Aspect Ratio Depth: Dia[3]	Sediment Sump Depth (ft)
XP-2	0.44	3.85	3.25	1.30	1.2
XP-3	0.85	4.47	3.87	1.11	1.2
XP-4	1.41	5.57	4.97	1.11	1.2
XP-5	2.11	6.68	6.08	1.11	1.2
XP-6	2.94	7.78	7.18	1.11	1.2
XP-7	3.92	8.89	8.29	1.11	1.2
XP-8	5.03	9.99	9.39	1.11	1.2
XP-9	6.29	11.10	10.50	1.11	1.2
XP-10	7.68	12.20	11.60	1.11	1.2
XP-11	9.21	13.31	12.71	1.11	1.2
XP-12	10.88	14.41	13.81	1.11	1.2
XP-13	11.77	14.97	14.37	1.11	1.2

[1] DBI is the depth from the invert of inlet pipe to the bottom of the unit.

[2] Scaling depth is the DBI minus 0.60 feet (7.25 inches), the location of the false floor of the tested unit.

[3] The aspect ratio of scaling depth/model diameter for the tested unit is 1.30. An aspect ratio of 1.30 ± 15% indicates that the treatment depth of the model is proportional as required by the protocol based on the tested model ratio of scaling depth to manhole diameter.