NJCAT TECHNOLOGY VERIFICATION

Stormwater Management StormFilter® (StormFilter) With Perlite Media

Contech Engineered Solutions LLC

November, 2016

TABLE OF CONTENTS

List of Figures

Page

List of Tables

Page

1. Description of Technology

The Stormwater Management StormFilter® (StormFilter) is a manufactured treatment device that is provided by Contech Engineered Solutions LLC (Contech). The StormFilter improves the quality of stormwater runoff before it enters receiving waterways through the use of its customizable filter media, which removes non-point source pollutants. As illustrated in **Figure 1**, the StormFilter is typically comprised of a vault or manhole structure that houses rechargeable, media-filled filter cartridges. Stormwater entering the system percolates through these media-filled cartridges, which trap particulates and remove pollutants. Once filtered through the media, the treated stormwater is discharged through an outlet pipe to a storm sewer system or receiving water.

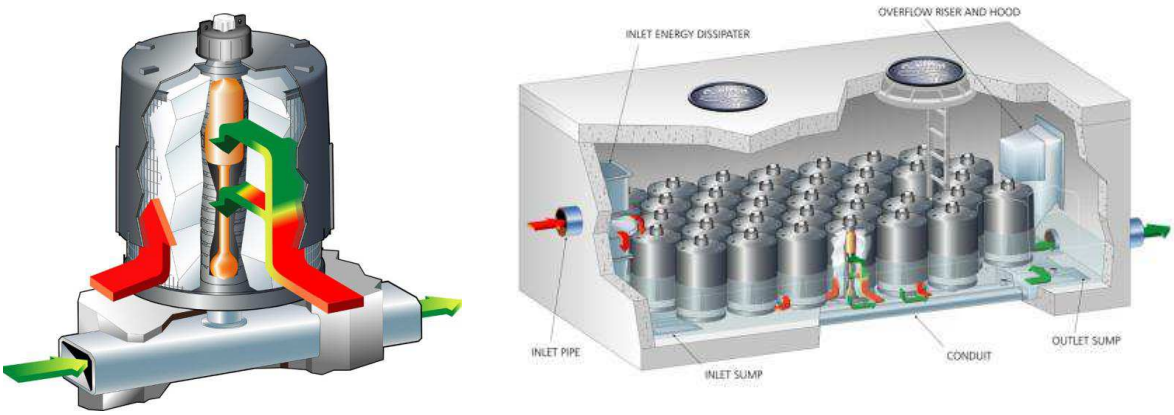

Figure 1 Individual StormFilter Cartridge (Left) and Typical Vault StormFilter Installation (Right)

Depending on the treatment requirements and expected pollutant characteristics at an individual site, the per cartridge filtration flow rate and driving head can be adjusted. The flow rate is individually controlled for each cartridge by a restrictor disc located at the connection point between the cartridge and the underdrain manifold. Driving head is managed by positioning of the inlet, outlet, and overflow elevations. The StormFilter is typically designed so that the restrictor disc passes the design treatment rate once the water surface reaches the shoulder of the cartridge which is equivalent to the cartridge height. Since the StormFilter uses a restrictor disc to restrict treatment flows below the hydraulic capacity of the media the system typically operates under consistent driving head for the useful life of the media. Site specific head constraints are also addressed by three different cartridge heights (low drop (effective height of 12 inches), 18, and 27 inches) which operate on the same principal and surface area specific loading rates. The StormFilter requires a minimum of 1.8 ft, 2.3 ft and 3.05 ft of drop between inlet invert and outlet invert to accommodate the low drop, 18 and 27 inch cartridges, respectively, without backing up flow into the upstream piping during operation. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up into the upstream piping during operation to ensure sufficient driving head is provided. If desirable the StormFilter can be designed to operate under additional driving head.

The StormFilter is offered in multiple configurations including plastic, steel, and concrete catch basins; and precast concrete manholes, and vaults. Other configurations include panel vaults, CON/SPAN®, box culverts, and curb inlets. The filter cartridges operate consistently and act independently regardless of housing which enables linear scaling.

The StormFilter cartridge can house different types of media including perlite, zeolite, granular activated carbon (GAC), CSF® leaf media, MetalRx™, PhosphoSorb® or various media blends such as ZPG™ (perlite, zeolite and GAC). All of the media use processes associated with depth filtration to remove solids. Some media configurations also provide additional treatment mechanisms such as cation exchange, and/or adsorption, chelation, and precipitation. This verification is specific to perlite media.

2. Laboratory Testing

The test program was conducted at Contech's Portland, Oregon laboratory under the direct supervision of Scott A. Wells, Ph.D. and Associates. Scott A. Wells and Associates provide environmental consulting services focusing on water quality and hydrodynamic models of hydraulic structures, rivers, reservoirs, and estuary systems. All particle size distribution (PSD) analysis and all water quality samples collected during this testing process were analyzed by Apex Labs, 12232 S.W. Garden Place, Tigard, OR 97223, an independent analytical testing facility.

Laboratory testing was done in accordance with the New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January, 2013) (NJDEP Filtration Protocol). Prior to starting the performance testing program, a quality assurance project plan (QAPP) was submitted to and approved by the New Jersey Corporation for Advanced Technology (NJCAT).

2.1 Test Setup

The laboratory test used a full-scale, 18-inch StormFilter cartridge filled with perlite media that was installed in a test tank in a manner consistent with commercial installations and meeting the criteria established in the NJDEP Filtration Protocol. An illustration of the test apparatus is shown in **Figure 2**. The test tank floor dimension is 3 ft^2, which is equivalent to the least amount of floor surface area per cartridge in a typical commercial installation.

A Zoeller M76 submersible pump delivered water from a source water storage tank to the test unit through PVC piping that included energy dissipation at the points of discharge to deliver water to the test tank in a manner consistent with commercial installations. The flow rate was controlled with a globe valve and monitored with a Seametrics EX810P flow meter and a Seametrics FT420 flow computer, and FlowInspector software. Sediment was dry-fed from a hopper and auger assembly (Acrison 170-M15) through a 2-inch diameter port located upstream of the test unit.

Effluent from the StormFilter was directed into an effluent water tank equipped with a submersible pump. The effluent passed through a particulate filter before being recycled back to

the source water tank (see **Figure 3**). As needed, potable water was brought into the source water tank to supply make-up water.

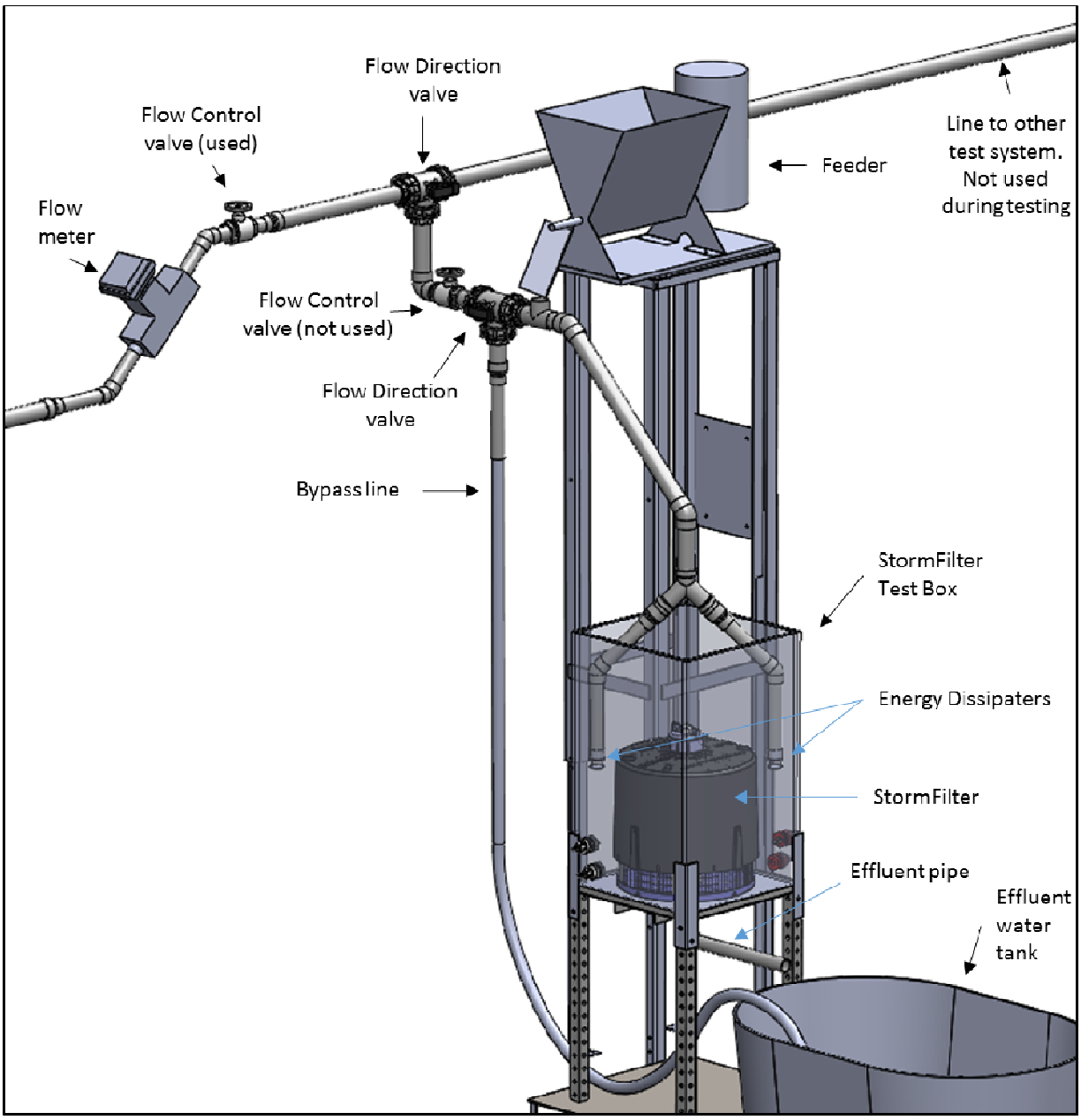

Figure 2 Graphic of StormFilter Test Apparatus

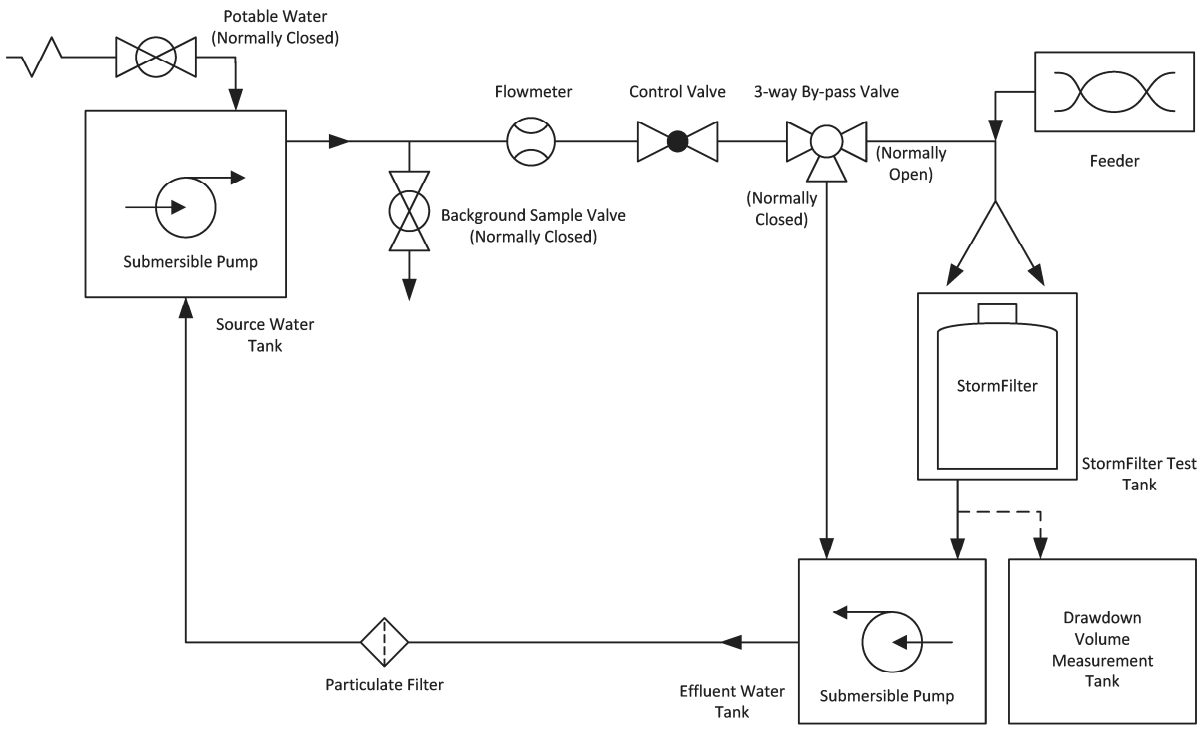

Figure 3 Schematic of StormFilter Laboratory Test Setup

2.2 Test Sediment

Sediment used for solids removal efficiency testing was high-purity silica (SiO_2 99.8%) material with a PSD consisting of approximately 55% sand, 40% silt, and 5% clay. A large batch of sediment meeting the NJDEP Filtration Protocol PSD criteria was purchased and stored in 50 lb. bags. Three of the 50 lb. bags were set aside and utilized for this testing. The sediment PSD in the three bags was verified by a randomized sample collection routine. First, the bags of sediment were mixed by rolling the bags several times both end over end in both directions on the laboratory floor. Each bag had a numbered six-section grid overlaid on it. The Microsoft Excel randomizer function was used to select one grid section from each bag. A subsample (three level tablespoons) was selected from the appropriate section of each bag. The subsamples were mixed together to create one sample. The grid section selection and subsample collection was repeated two more times for a total of three composite samples which were submitted for PSD analyses. Finally, after completion of the PSD sampling process the bags were then mixed into a single container and set aside for the verification testing.

The three composite PSD samples were sent to Apex Labs for PSD analysis in accordance with ASTM D422-63 (reapproved 2007). The mean of the three PSD samples was calculated and plotted as a single representative PSD curve. This representative curve is plotted alongside the "Test Sediment PSD" curve specified in section 5, subsection B of the NJDEP Filtration Protocol in Section 4.1. Sediment sampling for PSD analysis was conducted in-house with oversight from Scott Wells, Ph.D. and Associates.

2.3 Removal Efficiency Testing Procedure

Removal efficiency (RE) testing was performed at a target influent sediment concentration of 200 mg/L (±10%). The StormFilter was tested at a maximum treatment flow rate (MTFR) of 15 gallons per minute (gpm) which for the 18" cartridge is equivalent to a surface area specific loading rate of 2.12 gpm/ft^2 of filter media surface area. Three water temperature readings were taken per trial to verify the water did not exceed 80 degrees Fahrenheit.

Removal efficiency testing was carried out according to the "Effluent Grab Sampling Method," as described in section 5G of the NJDEP Filtration Protocol. Prior to each test, the flow rate was stabilized while being routed through a bypass line. Once the flow rate was stabilized, the bypass valve was turned to direct flow to the test tank, and feeding of the dry sediment commenced, initiating the testing procedure. The feeder delivered sediment into the flow stream at a rate calculated to yield a target concentration of 200 mg/L (±10%).

Sediment feed rate, background, effluent, and drawdown samples were collected via grab sampling, see **Table 1**. Three sediment feed samples were collected per trial including one sample at the start of dosing, one in the middle of the trial and one toward the end of dosing to allow for 3 residence times to pass before drawdown began. Sediment feed rate samples were collected from the injection point using a clean container and collected for one minute.

Background water quality samples were collected from a 1/4 inch valved sample port (**Figure 3**) in the water supply line located upstream of the test sediment injection point. Background samples were taken in correspondence with the odd-numbered effluent samples (first, third, and fifth).

Five effluent water quality samples were collected during each test run by sampling the free outflow from the discharge pipe. The first effluent sample collection time was scheduled at 7 minutes and the four subsequent effluent samples were scheduled at 6 to 7 minute intervals thereafter. Once the test sediment feed was diverted for measurement, the next effluent sample was collected after a minimum of three detention times had passed. During the first removal efficiency test run (test 1), 7 drawdown samples were collected spanning the entire drawdown time. The two samples collected nearest the correct evenly-spaced drawdown times were sent to Apex lab for TSS analysis and the remaining 5 samples were discarded. Once the appropriate drawdown sample times had been established using the total drawdown time from the first test those same sample times were applied to subsequent test runs. To address changing drawdown times as sediment accumulated in the test box, actual drawdown time data collected from each test was used to predict the drawdown sampling times for the following test. Tests and drawdown were considered complete when the effluent flow slowed to a drip, allowing the next test to begin. Although not included in the total drawdown volume, it is estimated that less than 1 liter of water remains in the test tank after test completion.

The drawdown volume was determined by diverting the effluent to a calibrated drawdown capture tank at the same time the influent was shut off. As the influent flow was shut off, a 4-inch PVC open pipe channel was placed under the effluent pipe to direct the discharge to the drawdown capture tank. Drawdown samples were collected by moving the diversion pipe aside

and capturing the effluent directly in the sample container. After the test was completed, the volume drained from the system was measured and used in the removal efficiency calculation.

Table 1 Test Run Sampling Plan

Scheduled Time (min:sec)	Sample or Reading				
	Sediment Feed Rate	Effluent TSS	Background TSS	Drawdown TSS	Additional Actions
0:00					Start sediment feed and introduce influent flow to test tank
1:00	X				
7:00		X	X		
13:00		X			
14:00	X				
20:00		X	X		
26:00		X			
27:00	X				
33:00		X	X		
34:00					Stop sediment feed and divert influent flow from test tank. Divert drawdown flow to drawdown capture tank
TBD*				X	
TBD*				X	
TBD**					End of test run

** Times for drawdown TSS samples were determined before each trial, using the previous trial's drawdown duration to determine appropriate spacing*

*** The end of a test run is the time at which the drawdown effluent stream transitions to a drip. The end time varied from trial to trial.*

Flow rate readings were logged every 15 seconds using a Seametrics DL76 data logger and accessed using Seametrics FlowInspector software. The flow meter was calibrated in accordance with the manufacturer's instructions before testing began and the calibration was verified with manual flow measurements (timed bucket method). The entire calibration process was completed in the presence of the third-party observer. A sight tube manometer connected to the test tank was used to take head measurements. Head readings were taken at the beginning and end of each test run, during sample collection, when water temperature was taken and at three minute intervals between sampling (**Table 2**). The driving head readings had an accuracy of ±0.0625 inches.

Table 2 Water Surface Elevation and Temperature Sampling Times

Time (min:sec)	Measurement
0:00	WSE
1:00	WSE
4:00	WSE
7:00	WSE
9:00	Temperature
10:00	WSE
13:00	WSE
14:00	WSE
17:00	WSE
18:00	Temperature
20:00	WSE
23:00	WSE
26:00	WSE
27:00	WSE
28:00	Temperature
30:00	WSE
33:00	WSE
34:00	WSE
37:00	WSE
40:00	WSE
43:00	WSE
46:00	WSE
49:00	WSE
52:00	WSE
55:00 ***	WSE
58:00 ***	WSE
61:00 ***	WSE
64:00 ***	WSE
67:00 ***	WSE
70:00 ***	WSE
73:00 ***	WSE
76:00 ***	WSE
79:00 ***	WSE
TBD *	WSE with drawdown sample
TBD *	WSE with drawdown sample
TBD **	WSE at end of trial
TBD **	Drawdown volume at end of trial

Time (min:sec)	Measurement

**** These measurements may be unnecessary if the drawdown flow has already slowed to a drip and the trial is over*

Following each test, all sediment feed rate samples were weighed in-house on a calibrated balance. The resultant mass of each sample was divided by the duration required to obtain the sample in order to establish the sediment feed rate and ultimately determine the influent concentration. Scott Wells, Ph.D. and Associates oversaw all in-house measurements and calculations. Effluent, background and drawdown samples were sent to Apex labs for TSS analysis in accordance with ASTM D3977-97 (re-approved 2007). The procedure was repeated for 10 test runs and each test had a sediment feed time of 34 minutes, with three 1-minute sample collections, for a total of 31 minutes of sediment injection.

2.4 Sediment Mass Loading Capacity Testing Procedure

Sediment mass load capacity testing of the StormFilter was conducted in accordance with the NJDEP Filtration Protocol. After performing the removal efficiency evaluation, additional tests were conducted using a target influent TSS concentration of 200 mg/L until trial 46 at which time the loading concentration was increased to 400 mg/L (±10%). Samples were collected in the same manner as the TSS removal efficiency testing.

Background, effluent and drawdown samples from the sediment mass load trials were transported to the third party analytical laboratory (Apex Labs) for TSS analysis in accordance with ASTM D3977-97 (re-approved 2007).

2.5 Scour Testing

No scour testing was conducted, since the StormFilter is only offered for off-line installation at this time.

3. Performance Claims

Per the NJDEP verification procedure, the following are the performance claims for the StormFilter based on the results of the laboratory testing conducted.

Total Suspended Solids (TSS) Removal Efficiency

Based on the laboratory testing conducted in accordance with the NJDEP Filter Protocol, the Stormwater Management StormFilter® (StormFilter) achieved greater than 80% removal efficiency of suspended solids. In accordance with the NJDEP Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from NJCAT (January, 2013) (NJDEP Verification Procedure) the TSS removal efficiency is rounded down to 80%.

Maximum Treatment Flow Rate (MTFR)

For all the commercially available model sizes, the hydraulic loading rate used to calculate the MTFR is 2.12 gpm/ft^2 of filter media surface area. This results in an MTFR of 10, 15 and 22.5 gpm for each low drop (effective height is 12 inches), 18 and 27-inch tall filter cartridge respectively.

Effective treatment/Sedimentation Area

The single 18-inch cartridge StormFilter test unit had an effective sedimentation area (horizontal footprint) of 3 ft^2. All commercially available StormFilter models have a minimum of 3 ft^2 of effective (horizontal) sedimentation area per 18" filter cartridge. This is equivalent to 0.42 ft^2 of sedimentation area per square foot of filtration surface area.

Detention Time and Wet Volume

Detention time of the StormFilter will vary with model size and configuration. The detention time of the 18-inch single cartridge test unit was 1 minute and 20 seconds. Since the test unit represents the smallest allowable ratio of effective sedimentation area per filter cartridge and the surface area specific hydraulic loading rate of all cartridges remains constant at 2.12 gpm/ft^2 of media surface area the detention time for commercially available units will be the same or longer than the detention time of the tested unit.

The StormFilter does not maintain a permanent wet volume. The operational wet volume for the test unit was approximately 20 gallons. The system drains down between each storm event.

Effective Filtration Treatment Area

The effective filtration treatment area of the 18" StormFilter cartridge used during the testing is 7.07 ft^2.

Sediment Mass Load Capacity

The sediment mass loading capacity varies with the StormFilter model size, the number of cartridges and the size of cartridges installed. Based on the laboratory testing results, the 18 inch StormFilter cartridge has a mass loading capacity of 54.5 lbs. This is equivalent to a sediment mass loading capacity of 7.71 lbs/ft^2 of filter surface area.

Maximum Allowable Inflow Drainage Area

Based on the NJDEP requirement to determine maximum allowable inflow area using 600 lbs of sediment per acre annually and the tested sediment mass loading capacity for the StormFilter of 54.5 lbs per 18-inch cartridge (7.71 lbs/ft^2 of filter surface area), the StormFilter has a maximum allowable inflow drainage area of 0.09 acres per 18-inch cartridge. This is equivalent to a maximum allowable inflow drainage area of 0.061 acres for each low drop (12 inch) cartridge and 0.136 acres for each 27-inch cartridge.

4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013a) for obtaining verification of a stormwater manufactured treatment device (MTD) from the New Jersey Corporation for Advanced Technology (NJCAT) requires that "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." be included in this section. This was discussed with NJDEP and it was agreed that as long as such documentation could be made available by NJCAT upon request that it would not be prudent or necessary to include all this information in this verification report. This information was provided to NJCAT and is available upon request.

4.1 Test Sediment PSD Analysis

The PSD's of the three randomly collected sediment samples are shown in **Table 3** and plotted in **Figure 4**. The test sediment met or exceeded the NJDEP PSD sediment specifications across the entire distribution. The average median particle size (d_{50}) of the three samples is ~70 microns.

Table 3 Sediment Particle Size Distribution Analysis on Contech Test Sediment

NJDEP Sediment Specifications			Contech Test Sediment						
			Sample 1		Sample 2		Sample 3		
Particle size (um)	Percent Finer	Allowable error Percent Finer	Particle size (um)	Percent Finer	Particle size (um)	Percent Finer	Particle size (um)	Percent Finer	Percent Finer Mean
1000	100	98	1000.0	98.2	1000	98.16	1000	98.3	98.2
500	95	93	500.0	96.0	500	95.78	500	95.8	95.9
250	90	88	250.0	90.8	250	90.59	250	90.8	90.7
150	75	73	150.0	76.3	150	76.11	150	76.4	76.3
100	60	58	106.0	65.1	106	65.15	106	65.1	65.1
75	50	48	75.0	51.6	75	51.34	75	51.2	51.4
50	45	43	63.0	48.5	63	48.2	63	48.3	48.3
20	35	33	53.0	46.3	53	45.87	53	46.0	46.0
8	20	18	44.7	42.9	45	41.5	45	41.0	41.8
5	10	8	31.9	40.1	33	38.59	32	39.1	39.1
2	5	3	22.8	36.3	23	34.7	23	37.2	36.1
			16.4	33.4	17	30.82	16	32.5	32.0
			12.2	27.7	12	26.93	12	27.7	27.5
			8.7	24.0	9	21.16	9	22.2	22.4
			6.3	17.4	6	17.37	6	16.6	17.1
			5.2	14.6	5	14.6	5	14.8	14.7
			4.5	13.0	5	12.71	5	13.1	12.9
			3.2	10.7	3	11.21	3	10.9	10.9

2.6	8.5	3	8.83	3	8.6	8.7
1.3	5.1	1	4.69	1	5.2	5.0

*Linear interpolation was used to determine percent finer results when particle sizes differed from sample to sample.

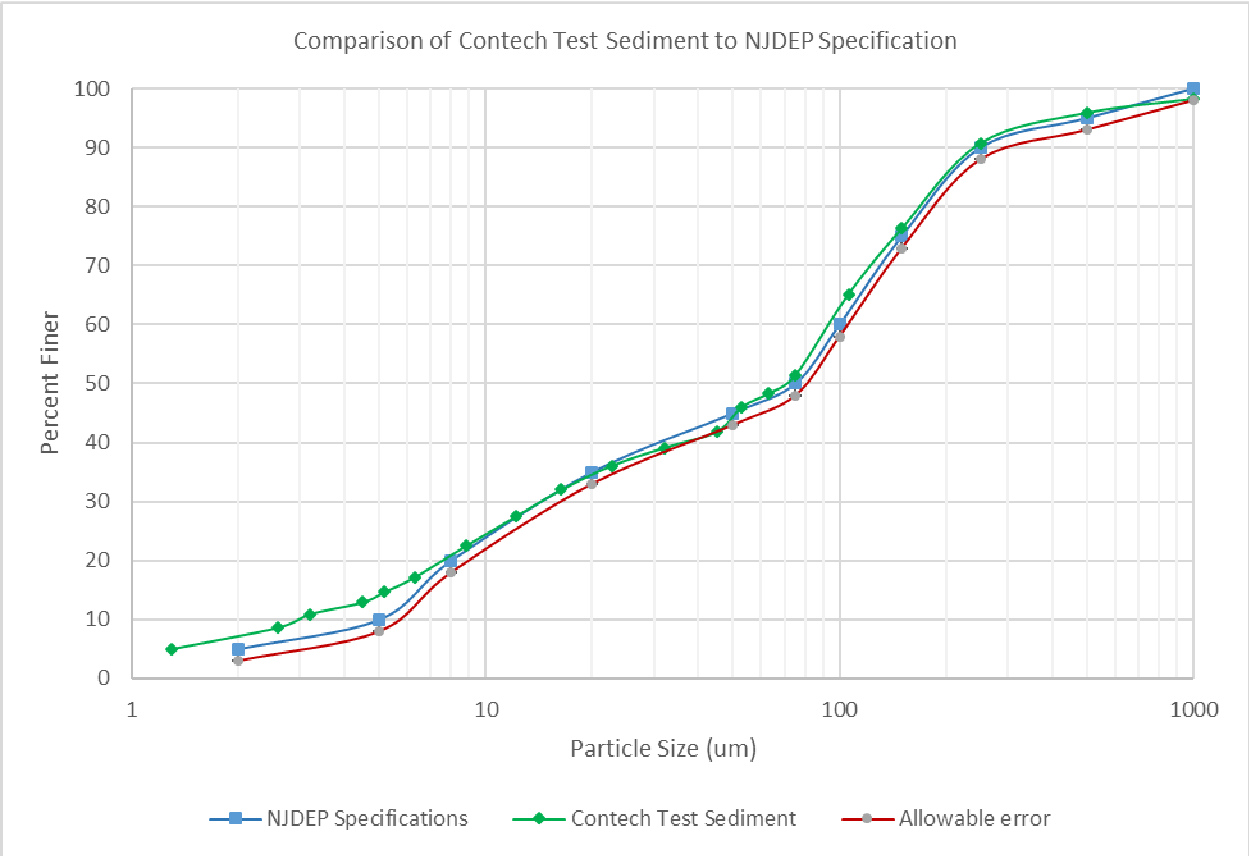

Figure 4 Comparison of Contech Test Sediment to NJDEP PSD Specification

4.2 Removal Efficiency (RE) Testing

Ten (10) test runs were completed as part of the removal efficiency testing following the procedures detailed in Section 2.0 of this report. The results from all 10 runs were used to calculate the average removal efficiency of the 18-inch StormFilter test system. Average removal efficiency and RE for each trial is listed in **Table 8** and shown in **Figure 5**.

Test Water Flow Rate, Temperature and Driving Head

The target flow rate for each test run was 15.0 gpm. The average flow rate during each test run was within ±10% of the target, with a maximum coefficient of variation (COV) of 0.01. The highest test water temperature measured during any test run was 74.6 °F, which is below the maximum allowed 80°F. Reported driving head measurements represent the distance from the

crown of the effluent pipe to the water surface elevation. The system did not exceed the maximum available driving head for the test unit of 27.6 inches during any of the test runs. As intended, the system operated at relatively consistent driving head throughout the test process. Summary flow data, water temperature, driving head and QA/QC compliance results are summarized in **Table 4**. Average flow rate and maximum driving head are shown graphically in **Figure 6** and **Figure 7**.

Table 4 Removal Efficiency Water Flow Rate, Temperature and Driving Head

Test Run	Average Flow Rate (gpm)	Flow Rate COV	Maximum Water Temperature (°F)	Maximum Driving Head (in)	QA/QC Compliant (YES/NO)	
-	Target: 15.0 gpm	-	≤ 80 °F	-	-	*Target or QA/QC Requirement*
1	14.9	0.01	73.7	23.7	YES	
2	15.0	0.01	73.5	23.8	YES	
3	14.9	0.01	73.9	23.7	YES	
4	14.9	0.01	74.2	23.6	YES	
5	14.9	0.01	74.1	23.8	YES	
6	15.0	0.01	74.6	24.0	YES	
7	15.0	0.01	74.5	23.7	YES	
8	14.9	0.01	74.2	23.5	YES	
9	14.9	0.01	74.2	23.4	YES	
10	15.0	0.01	74.2	23.9	YES	

Sediment Feed Rate and Influent Concentration

Sediment was fed into the test water stream at a rate calculated to yield a target influent concentration of 200 mg/L. Three feed rate samples were collected per trial to verify the sediment delivery rate and resulting influent concentration. All sediment feed rate samples were collected in clean sampling containers over an interval of 1 minute. Average influent TSS was calculated using **Equation 1** and **Equation 2**. During all test runs, influent TSS was maintained within ±10% of target, with a maximum COV of 0.03. The total sediment injection time during each run was 31 minutes, exceeding the minimum test length requirement of 30 minutes. Sediment feed rates, resulting influent TSS and QA/QC compliance results are summarized in **Table 5**.

Equation 1: Average Feed Rate

Average Feed Rate (g/min) = Sediment Moisture Correction Factor x Average Measured Feed Rate (g/min)

Equation 2: Average Influent TSS

$$Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) = \frac{Average\ Feed\ Rate\ \left(\frac{g}{min}\right) \times \frac{1000\ mg}{g}}{Average\ Water\ Flow\ Rate\ \left(\frac{gal}{min}\right) \times \frac{3.785\ L}{gal}}$$

Table 5 Removal Efficiency Sediment Feed Rate and Influent Concentration

Test Run	Sediment Injection Time (min)	Average Feed Rate (g/min)	Feed Rate COV	Feed Rate Sampling Duration (min)	Average Influent TSS (mg/L)	Minimum Influent TSS (mg/L)	Maximum Influent TSS (mg/L)	QA/QC Compliant (YES/NO)	
-	**≥ 30 min**	**Target: 11.4 g/min**	**≤ 0.1**	**≤ 1 min**	**Target: 200 mg/L**	**≥ -10% of Target: 180 mg/L**	**≤ +10% of Target: 220 mg/L**	**-**	***Target or QA/QC Requirement***
1	31.0	11.5	0.02	1.0	203	198	205	YES	
2	31.0	11.9	0.02	1.0	210	206	213	YES	
3	31.0	11.7	0.01	1.0	207	204	210	YES	
4	31.0	12.0	0.02	1.0	213	209	216	YES	
5	31.0	12.0	0.01	1.0	212	210	216	YES	
6	31.0	11.8	0.03	1.0	208	203	213	YES	
7	31.0	12.0	0.02	1.0	212	208	215	YES	
8	31.0	11.5	0.01	1.0	203	202	205	YES	
9	31.0	11.7	0.01	1.0	206	203	208	YES	
10	31.0	11.8	0.03	1.0	207	202	213	YES	

Drawdown Sampling and Duration

Drawdown TSS sampling and drawdown volume quantification were performed to determine the amount of influent mass that exited the system during the drawdown period. Drawdown TSS sampling times were determined using the drawdown duration from the previous trial. Sampling times and drawdown durations are presented in **Table 6**.

Table 6 Removal Efficiency Testing Drawdown Duration and Drawdown Sampling Times

Test Run	Drawdown Duration (min from pump shutoff)	Drawdown TSS Sample 1 Time (min from pump shutoff)	Drawdown TSS Sample 2 Time (min from pump shutoff)
1	38	12	21
2	34	13	25
3	30	11	23
4	27	10	20
5	26	10	20
6	26	9	17
7	26	9	18
8	26	9	17
9	26	9	17
10	26	9	17

Background, Effluent and Drawdown TSS

Background, effluent and drawdown TSS samples were collected in clean 1-liter bottles, with each sample exceeding the minimum required 500 mL sample volume. With the exception of test run 10, effluent and drawdown TSS samples were collected no less than three residence times, or 4 total minutes after the sediment injection stream was interrupted for feed rate sampling. During test run 10, an effluent sample was collected 5 seconds early; as this was such a small error in timing, no data from this test run was excluded from calculations. Background TSS samples were taken with odd numbered effluent TSS samples as required by the NJDEP Filtration Protocol. The highest measured background TSS was 4 mg/L, which is below the maximum allowed concentration of 20 mg/L. Average effluent TSS and average drawdown TSS values were adjusted for background levels using **Equation 3** and **Equation 4,** respectively. Background TSS, effluent TSS, drawdown TSS and QA/QC compliance results are presented in **Table 7**.

Equation 3: Average Adjusted Effluent TSS

$$Average\ Adjusted\ Effluent\ TSS\left(\frac{mg}{L}\right) = Average\ Effluent\ TSS\ \left(\frac{mg}{L}\right) - Average\ Background\ TSS\ \left(\frac{mg}{L}\right)$$

Equation 4: Average Adjusted Drawdown TSS

$$Average\ Adjusted\ Drawdown\ TSS\ \left(\frac{mg}{L}\right) = Average\ Drawdown\ TSS\ \left(\frac{mg}{L}\right) - Average\ Background\ TSS\ \left(\frac{mg}{L}\right)$$

Table 7 Removal Efficiency Background, Effluent and Drawdown TSS

Test Run	Average Background TSS (mg/L)	Maximum Background TSS (mg/L)	Minimum Background Sample Volume (mL)	Average Adjusted Effluent TSS (mg/L)	Minimum Effluent Sample Volume (mL)	Average Adjusted Drawdown TSS (mg/L)	Minimum Drawdown Sample Volume (mL)	QA/QC Compliant (YES/NO)	
-	-	≤ 20 mg/L	≥ 500 mL	-	≥ 500 mL	-	≥ 500 mL	-	*Target or QA/QC Requirement*
1	2	3	740	38	930	20	590	YES	
2	2	2	790	35	820	8	580	YES	
3	3	3	770	41	880	8	580	YES	
4	2	2	730	37	870	8	600	YES	
5	2	2	700	36	910	6	560	YES	
6	2	3	720	38	830	10	540	YES	
7	2	2	720	38	780	11	545	YES	
8	2	3	750	36	850	9	550	YES	
9	3	3	780	35	880	8	580	YES	
10	3	4	740	36	850	9	560	YES	

Removal Efficiency (RE) Results

Average RE at the end of the test run 10 was 83%. **Equation 5** through **Equation 7** were used to calculate RE for each test run. Sediment mass loading per trial and mass captured per trial were calculated using **Equation 8** and **Equation 9**, respectively. Cumulative sediment mass loading and cumulative mass captured by the StormFilter were calculated by summing the mass loading per trial and mass captured per trial values. The total mass loading for the removal efficiency test runs was 8.0 lbs and the mass captured by the system was 6.7 lbs. The summary of RE results is reported in **Table 8**.

Equation 5: Influent Volume

$$Influent\ Volume\ (L) = Sediment\ Injection\ Time\ (min) \times Average\ Flow\ Rate\ \left(\frac{gal}{min}\right) \times \frac{3.785\ L}{gal}$$

Equation 6: Effluent Volume

$$Effluent\ Volume\ (L) = Influent\ Volume\ (L) - Drawdown\ Volume\ (L)$$

Equation 7: Removal Efficiency (RE)

$$RE\ (\%) = (100\%) \times \frac{\left[\begin{matrix}Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) \\ \times\ Influent\ Volume\ (L)\end{matrix}\right] - \left[\begin{matrix}Average\ Adjusted\ Effluent\ TSS\ \left(\frac{mg}{L}\right) \\ \times\ Effluent\ Volume\ (L)\end{matrix}\right] - \left[\begin{matrix}Average\ Adjusted\ Drawdown\ TSS\ \left(\frac{mg}{L}\right) \\ \times\ Drawdown\ Volume\ (L)\end{matrix}\right]}{\left[\begin{matrix}Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) \\ \times\ Influent\ Volume\ (L)\end{matrix}\right]}$$

Equation 8: Sediment Mass Loading per Trial

$$Sediment\ Mass\ Loading\ per\ Trial\ (lb) = Average\ Influent\ TSS\ \left(\frac{mg}{L}\right) \times Influent\ Volume\ (L) \times \frac{2.20\text{E-}6\ mg}{lb}$$

Equation 9: Mass Captured per Trial

$$Mass\ Captured\ per\ Trial\ (lb) = \frac{Sediment\ Mass\ Loading\ per\ Trial\ (lb) \times RE\ (\%)}{(100\%)}$$

Table 8 Removal Efficiency Results

Test Run	Average Influent TSS (mg/L)	Average Adjusted Effluent TSS (mg/L)	Average Adjusted Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Mass Loading (lb)	Mass Captured (lb)	Trial Removal Efficiency (%)	Average Removal Efficiency (%)
1	203	38	20	1751	1673	78	0.8	0.6	82%	82%
2	210	35	8	1758	1677	81	1.6	1.3	84%	83%
3	207	41	8	1745	1666	79	2.4	2.0	81%	82%
4	213	37	8	1753	1674	79	3.2	2.6	83%	83%
5	212	36	6	1754	1679	75	4.0	3.3	84%	83%
6	208	38	10	1757	1678	79	4.8	4.0	82%	83%
7	212	38	11	1758	1679	79	5.6	4.7	82%	83%
8	203	36	9	1753	1674	79	6.4	5.3	83%	83%
9	206	35	8	1754	1675	79	7.2	6.0	84%	83%
10	207	36	9	1766	1686	79	8.0	6.7	83%	83%

4.3 Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency (RE) testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the RE runs, the only change was to increase the target influent concentration to 400 mg/L after test run 45. Testing concluded after 67 test runs, 57 of which were completed during mass loading and 10 during RE testing. The system did not occlude or reach maximum driving head during the test process, but the average removal efficiency (on a mass basis) dropped below 80% so testing was suspended and deemed complete at trial 66 as per the QAPP and protocol. The mass loading test data and QA/QC compliance results are summarized in **Table 9** through **Table 13**.

Test Water Flow Rate, Temperature and Driving Head

The average flow rate during each test run was within ±10% of the target 15 gpm and the maximum observed COV was 0.01 (excluding test run 14, see Section 4.4 for discussion). The test water temperature remained below the maximum allowed 80°F during all runs and the

maximum available driving head was not reached or exceed at any time. During test run 15, driving head readings were not taken with drawdown TSS samples. The missing data points do not affect any computations, (including maximum driving head), so all data for test run 15 is included in calculations. Test run 29 did not include a driving head measurement at the scheduled time of 10 minutes, which caused the measurement spacing to exceed the maximum 5-minute interval. The driving head readings prior to and following the missing measurement show the driving head remained consistent and indicate that the system was not operating at or near the maximum design driving head, so all data from test run 29 is included in reported results.

Table 9 includes summary flow data, water temperature and driving head results. Average flow rate and maximum driving head are also shown in **Figure 6** and **Figure 7**.

Table 9 Sediment Mass Loading Trial Flow Rate, Temperature and Driving Head

Test Run	Average Flow Rate (gpm)	Flow Rate COV	Maximum Water Temperature (°F)	Maximum Driving Head (in)	QA/QC Compliant (YES/NO)
-	Target: 15.0 gpm	-	≤ 80 °F	-	-
11	15.0	0.01	71.1	23.8	YES
12	15.0	0.01	70.5	24.2	YES
13	15.0	0.01	71.6	23.9	YES
14	14.9	0.07	70.5	23.7	NO*
15	14.8	0.01	71.4	23.0	NO
16	14.9	0.01	71.1	23.6	YES
17	14.9	0.01	71.1	23.7	YES
18	14.9	0.01	71.2	23.6	YES
19	15.0	0.01	71.3	23.9	YES
20	15.0	0.01	71.6	23.7	YES
21	15.0	0.01	71.4	23.7	YES
22	14.9	0.01	72.1	23.5	YES
23	14.9	0.01	71.2	23.6	YES
24	15.0	0.01	71.4	24.0	YES
25	15.0	0.01	71.8	23.7	YES
26	15.0	0.01	71.0	23.6	YES
27	15.0	0.01	71.4	23.7	YES
28	14.9	0.01	71.4	23.4	YES
29	15.0	0.01	71.9	23.7	NO
30	15.0	0.01	71.8	24.0	YES
31	15.0	0.01	71.0	23.7	YES
32	15.0	0.01	71.4	23.7	YES
33	15.0	0.01	71.1	23.8	YES
34	15.0	0.01	71.3	24.3	YES
35	15.0	0.01	71.0	23.9	YES

Test Run	Average Flow Rate (gpm)	Flow Rate COV	Maximum Water Temperature (°F)	Maximum Driving Head (in)	QA/QC Compliant (YES/NO)
36	15.0	0.01	73.6	23.7	YES
37	15.0	0.01	73.0	24.0	YES
38	15.0	0.01	72.9	23.8	YES
39	15.0	0.01	73.0	23.6	YES
40	14.9	0.01	73.1	23.5	YES
41	15.0	0.01	72.7	23.7	YES
42	15.0	0.01	72.2	23.7	YES
43	15.0	0.01	71.0	23.7	YES
44	15.0	0.01	71.4	23.8	YES
45	15.0	0.01	71.1	24.3	YES
46	14.9	0.01	73.0	23.4	YES
47	14.9	0.01	72.1	23.6	YES
48	15.0	0.01	72.1	23.8	YES
49	14.9	0.01	71.6	23.4	YES
50	15.0	0.01	72.2	23.6	YES
51	14.9	0.01	72.4	23.4	YES
52	14.9	0.01	72.6	23.7	YES
53	15.0	0.01	72.4	23.5	YES
54	15.0	0.01	72.5	23.5	YES
55	14.9	0.01	72.5	23.5	YES
56	15.0	0.01	72.9	23.7	YES
57	15.0	0.01	72.4	23.7	YES
58	15.0	0.01	72.2	23.7	YES
59	15.0	0.01	71.2	23.7	YES
60	15.0	0.01	71.3	23.7	YES
61	15.0	0.01	71.4	23.7	YES
62	15.0	0.01	71.7	23.7	YES
63	15.0	0.01	72.4	23.7	YES
64	15.0	0.01	71.9	23.5	YES
65	15.0	0.01	72.1	23.7	YES
66	15.0	0.01	72.1	23.6	YES
67	15.0	0.01	72.5	23.4	YES

See Section 4.4 for discussion

Sediment Feed Rate and Influent Concentration

During test runs 11 through 45, sediment was introduced at a target feed rate of 11.4 g/min to yield a 200 mg/L influent concentration. All feed rates and resulting influent concentrations during these trials were within ±10% of target, with a maximum COV of 0.05. The target feed

rate was increased to 22.7 g/min for test runs 46 through 67 in order to provide a 400 mg/L influent concentration. Feed rates during runs 46 through 67 were also within ±10% of target and the maximum COV was 0.04. The influent TSS data for test run 27 was excluded from calculations (see Section 4.4 for discussion). **Table 10** shows the feed rate data, influent concentration data and QA/QC results for all mass loading test runs.

Table 10 Sediment Mass Loading Sediment Feed Rate and Influent Concentration

Test Run	Sediment Injection Time (min)	Average Feed Rate (g/min)	Feed Rate COV	Maximum Feed Rate Sampling Duration (min)	Average Influent TSS (mg/L)	Minimum Influent TSS (mg/L)	Maximum Influent TSS (mg/L)	QA/QC Compliant (YES/NO)
-	≥ 30 min	Target: 11.4 or 22.7 g/min	≤ 0.1	≤ 1 min	Target: 200 or 400 mg/L	≥ -10% of Target	≤ +10% of Target	-
11	31.0	11.3	0.02	1.0	200	196	205	YES
12	31.0	11.9	0.01	1.0	209	206	212	YES
13	31.0	12.0	0.01	1.0	211	210	213	YES
14	31.0	11.7	0.02	1.0	206	203	212	YES
15	31.0	11.7	0.01	1.0	209	205	210	YES
16	31.0	11.4	0.01	1.0	202	200	205	YES
17	31.0	11.7	0.01	1.0	206	203	209	YES
18	31.0	11.5	0.01	1.0	203	202	205	YES
19	31.0	11.6	0.01	1.0	204	202	206	YES
20	31.0	11.9	0.01	1.0	210	208	212	YES
21	31.0	11.3	0.05	1.0	199	192	210	YES
22	31.0	11.6	0.03	1.0	206	198	211	YES
23	31.0	11.5	0.01	1.0	203	202	204	YES
24	31.0	11.7	0.01	1.0	206	204	207	YES
25	31.0	11.5	0.02	1.0	203	197	206	YES
26	31.0	11.6	0.02	1.0	204	201	210	YES
27	31.0	11.8	0.04	1.0	208	198	215	NO*
28	31.0	11.2	0.02	1.0	199	195	200	YES
29	31.0	11.3	0.03	1.0	199	192	203	YES
30	31.0	11.5	0.01	1.0	202	199	204	YES
31	31.0	11.3	0.01	1.0	200	198	201	YES
32	31.0	11.5	0.01	1.0	202	201	203	YES
33	31.0	11.6	0.02	1.0	204	201	208	YES
34	31.0	11.4	0.02	1.0	200	196	204	YES
35	31.0	11.2	0.02	1.0	198	194	201	YES
36	31.0	11.6	0.01	1.0	204	203	206	YES
37	31.0	11.5	0.01	1.0	203	202	204	YES

Test Run	Sediment Injection Time (min)	Average Feed Rate (g/min)	Feed Rate COV	Maximum Feed Rate Sampling Duration (min)	Average Influent TSS (mg/L)	Minimum Influent TSS (mg/L)	Maximum Influent TSS (mg/L)	QA/QC Compliant (YES/NO)
38	31.0	11.5	0.02	1.0	202	201	206	YES
39	31.0	11.5	0.02	1.0	203	199	208	YES
40	31.0	11.5	0.01	1.0	203	201	205	YES
41	31.0	11.3	0.01	1.0	199	196	201	YES
42	31.0	11.3	0.03	1.0	199	195	206	YES
43	31.0	11.4	0.01	1.0	200	199	202	YES
44	31.0	11.5	0.01	1.0	203	201	206	YES
45	31.0	11.5	0.01	1.0	202	201	202	YES
46	31.0	22.6	0.02	1.0	401	395	410	YES
47	31.0	22.7	0.02	1.0	402	398	410	YES
48	31.0	22.7	0.00	1.0	401	399	403	YES
49	31.0	22.4	0.01	1.0	396	393	398	YES
50	31.0	23.3	0.01	1.0	412	410	415	YES
51	31.0	22.4	0.01	1.0	396	394	400	YES
52	31.0	22.4	0.02	1.0	396	389	405	YES
53	31.0	22.8	0.02	1.0	403	393	411	YES
54	31.0	22.8	0.01	1.0	403	399	408	YES
55	31.0	22.6	0.02	1.0	400	394	408	YES
56	31.0	22.7	0.01	1.0	400	395	405	YES
57	31.0	22.9	0.02	1.0	403	399	411	YES
58	31.0	23.1	0.02	1.0	407	398	417	YES
59	31.0	22.4	0.01	1.0	395	389	400	YES
60	31.0	22.9	0.01	1.0	404	401	408	YES
61	31.0	23.3	0.03	1.0	410	401	422	YES
62	31.0	22.6	0.03	1.0	398	388	411	YES
63	31.0	22.8	0.02	1.0	401	394	410	YES
64	31.0	22.8	0.03	1.0	402	389	412	YES
65	31.0	22.9	0.01	1.0	403	402	407	YES
66	31.0	22.8	0.02	1.0	402	395	409	YES
67	31.0	23.0	0.01	1.0	405	402	409	YES

See Section 4.4 for discussion

Drawdown Sampling and Duration

Drawdown TSS sampling times and drawdown durations are presented in **Table 11**. Sampling times were determined prior to each test run using the drawdown duration from the previous trial.

Table 11 Sediment Mass Loading Drawdown Sampling Times

Test Run	Drawdown Duration (min from pump shutoff)	Drawdown TSS Sample 1 Time (min from pump shutoff)	Drawdown TSS Sample 2 Time (min from pump shutoff)
11	24	9	17
12	27	8	16
13	26	9	19
14	26	9	17
15	24	9	17
16	25	8	16
17	25	8	16
18	24	8	17
19	25	8	16
20	25	8	16
21	23	8	16
22	24	8	16
23	23	8	16
24	24	8	15
25	23	8	16
26	22	8	15
27	23	7	15
28	21	8	15
29	22	7	14
30	21	7	14
31	20	7	14
32	21	7	14
33	21	7	14
34	21	7	14
35	21	7	14
36	21	7	14
37	20	7	14
38	21	7	13
39	20	7	14

Test Run	Drawdown Duration (min from pump shutoff)	Drawdown TSS Sample 1 Time (min from pump shutoff)	Drawdown TSS Sample 2 Time (min from pump shutoff)
40	21	7	14
41	20	7	14
42	19	7	13
43	18	6	12
44	19	6	12
45	18	6	13
46	18	6	12
47	18	6	12
48	19	6	12
49	19	6	13
50	17	6	12
51	18	6	11
52	16	6	12
53	17	5	10
54	17	6	11
55	15	6	11
56	15	5	10
57	16	5	10
58	15	5	10
59	16	5	10
60	15	5	11
61	10	5	(not sampled)
62	16	5	10
63	15	5	11
64	15	5	10
65	15	5	10
66	15	5	10
67	15	5	10

Background, Effluent and Drawdown TSS

Background, effluent and drawdown TSS samples were collected in clean 1-liter bottles and all samples exceeded the minimum required volume. Effluent and drawdown TSS samples were taken no less than three residence times (4 minutes) after the sediment injection stream was interrupted for feed rate sampling. Background TSS samples were taken concurrently with odd numbered effluent samples. The highest background TSS level was 9 mg/L, which is below the allowable concentration of 20 mg/L. Data from test run 61 was excluded from calculations (see Section 4.4 for discussion).

Table 12 Sediment Mass Loading Background, Effluent and Drawdown TSS

Test Run	Average Background TSS (mg/L)	Maximum Background TSS (mg/L)	Minimum Background Sample Volume (mL)	Average Adjusted Effluent TSS (mg/L)	Minimum Effluent Sample Volume (mL)	Average Adjusted Drawdown TSS (mg/L)	Minimum Drawdown Sample Volume (mL)	QA/QC Compliant (YES/NO)
-	-	≤ 20 mg/L	≥ 500 mL	-	≥ 500 mL	-	≥ 500 mL	-
11	2	2	750	37	900	11	560	YES
12	2	2	720	36	820	12	580	YES
13	2	3	740	41	880	11	540	YES
14	2	2	710	38	900	11	510	YES
15	2	3	850	36	880	10	570	YES
16	2	2	840	36	850	11	600	YES
17	2	2	590	40	770	12	670	YES
18	3	4	500	35	600	13	690	YES
19	3	3	625	37	600	10	680	YES
20	3	3	750	36	535	10	670	YES
21	3	4	640	40	700	12	700	YES
22	3	3	700	41	610	12	670	YES
23	3	4	680	37	570	12	680	YES
24	3	3	680	39	570	14	610	YES
25	3	4	640	37	730	11	690	YES
26	3	3	600	40	540	14	660	YES
27	3	3	640	29	790	8	680	YES
28	2	3	640	38	690	14	660	YES
29	4	4	730	38	550	14	660	YES
30	4	4	730	38	630	12	660	YES
31	3	4	680	42	750	19	690	YES
32	3	3	700	43	650	18	710	YES
33	5	5	620	43	720	15	690	YES

Test Run	Average Background TSS (mg/L)	Maximum Background TSS (mg/L)	Minimum Background Sample Volume (mL)	Average Adjusted Effluent TSS (mg/L)	Minimum Effluent Sample Volume (mL)	Average Adjusted Drawdown TSS (mg/L)	Minimum Drawdown Sample Volume (mL)	QA/QC Compliant (YES/NO)
34	5	5	670	40	670	14	680	YES
35	4	4	600	44	720	18	680	YES
36	4	4	670	43	860	20	600	YES
37	5	5	690	43	890	16	590	YES
38	5	6	750	41	840	19	600	YES
39	6	6	680	35	870	15	610	YES
40	6	7	720	40	870	15	570	YES
41	4	4	690	43	890	21	630	YES
42	3	3	720	45	870	22	610	YES
43	3	3	690	41	760	17	740	YES
44	3	4	700	40	780	16	620	YES
45	4	4	670	47	850	24	610	YES
46	2	2	720	79	630	31	660	YES
47	2	2	720	82	660	35	660	YES
48	2	3	685	86	791	37	630	YES
49	3	5	640	87	660	38	670	YES
50	2	2	720	86	670	45	670	YES
51	4	4	650	88	770	48	700	YES
52	4	4	740	90	650	56	690	YES
53	4	4	680	92	700	62	690	YES
54	5	6	770	90	690	50	670	YES
55	4	4	700	86	660	53	660	YES
56	2	2	730	89	830	50	670	YES
57	2	3	770	89	830	40	650	YES
58	3	3	760	90	910	67	640	YES
59	3	4	740	93	890	65	670	YES
60	3	3	690	88	860	58	640	YES
61	2	2	730	91	900	58	555	NO*
62	2	2	750	87	900	51	610	YES
63	3	3	770	88	860	56	600	YES
64	3	3	710	91	860	62	630	YES
65	4	4	740	89	890	63	630	YES
66	4	4	780	89	850	82	560	YES
67	4	4	770	95	680	67	740	YES

See Section 4.4 for discussion

Mass Loading Results

The total influent mass loaded at the conclusion of the testing process (Trial 66) was 68.1 lbs and the total mass captured by the StormFilter was 54.5 lbs. There was an average of 3-3.5 inches of sediment on the bottom of the test tank after testing. No maintenance was performed on the test system during the entire testing program. The average TSS RE (on a mass basis) was 80% after all testing was complete. The RE results were excluded from test runs 14, 27 and 61 due to equipment issues and one sampling error (see Section 4.4 for discussion), so the average TSS RE from the trial before and following trials 14, 27 and 61 was used to determine the mass captured. **Table 13** and **Figure 5** summarize the removal efficiency and mass loading results.

Table 13 Sediment Mass Loading Results

Test Run	Average Influent TSS (mg/L)	Average Adjusted Effluent TSS (mg/L)	Average Adjusted Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Mass Loading (lb.)	Mass Captured (lb.)	Trial Removal Efficiency (%)	Average Removal Efficiency by Mass (%)
11	200	37	11	1758	1681	77	8.8	7.3	81.8%	82.8%
12	209	36	12	1756	1674	82	9.6	8.0	83.4%	82.8%
13	211	41	11	1758	1677	81	10.4	8.6	81.3%	82.7%
14	206	38	11	1754	1674	79	11.2	9.3	*82.2%***	82.7%
15	209	36	10	1738	1663	75	12.0	9.9	83.2%	82.7%
16	202	36	11	1750	1671	79	12.8	10.6	82.6%	82.7%
17	206	40	12	1753	1672	81	13.6	11.2	81.3%	82.6%
18	203	35	13	1750	1670	79	14.4	11.9	83.2%	82.6%
19	204	37	10	1760	1678	82	15.2	12.5	82.4%	82.6%
20	210	36	10	1757	1677	80	16.0	13.2	83.6%	82.7%
21	199	40	12	1757	1679	77	16.8	13.8	80.7%	82.6%
22	206	41	12	1749	1669	79	17.5	14.5	80.9%	82.5%
23	203	37	12	1749	1673	76	18.3	15.1	82.3%	82.5%
24	206	39	14	1763	1682	81	19.1	15.8	81.8%	82.5%
25	203	37	11	1758	1679	79	19.9	16.4	82.1%	82.5%
26	204	40	14	1758	1679	79	20.7	17.1	80.8%	82.4%
27	208	29	8	1756	1679	77	21.5	17.7	*81.2%***	82.3%
28	199	38	14	1748	1671	77	22.3	18.3	81.5%	82.3%
29	199	38	14	1756	1675	80	23.0	19.0	81.6%	82.3%
30	202	38	12	1761	1679	81	23.8	19.6	82.0%	82.3%
31	200	42	19	1754	1678	76	24.6	20.2	79.3%	82.2%
32	202	43	18	1757	1680	77	25.4	20.8	79.1%	82.1%
33	204	43	15	1758	1678	80	26.2	21.5	79.8%	82.0%
34	200	40	14	1759	1680	78	26.9	22.1	80.6%	82.0%

Test Run	Average Influent TSS (mg/L)	Average Adjusted Effluent TSS (mg/L)	Average Adjusted Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Mass Loading (lb.)	Mass Captured (lb.)	Trial Removal Efficiency (%)	Average Removal Efficiency by Mass (%)
35	198	44	18	1760	1680	79	27.7	22.7	78.1%	81.9%
36	204	43	20	1758	1678	80	28.5	23.3	79.5%	81.8%
37	203	43	16	1762	1682	80	29.3	23.9	79.4%	81.7%
38	202	41	19	1762	1683	79	30.1	24.6	80.0%	81.7%
39	203	35	15	1760	1682	78	30.8	25.2	83.3%	81.7%
40	203	40	15	1754	1676	78	31.6	25.8	80.9%	81.7%
41	199	43	21	1758	1677	80	32.4	26.4	78.7%	81.6%
42	199	45	22	1762	1683	79	33.2	27.0	77.9%	81.6%
43	200	41	17	1761	1682	79	33.9	27.7	80.1%	81.5%
44	203	40	16	1759	1679	80	34.7	28.3	80.9%	81.5%
45	202	47	24	1760	1681	79	35.5	28.9	77.4%	81.4%
46	401	79	31	1747	1672	75	37.1	30.2	80.8%	81.4%
47	402	82	35	1754	1678	76	38.6	31.4	80.2%	81.3%
48	401	86	37	1754	1677	78	40.2	32.6	79.2%	81.3%
49	396	87	38	1753	1676	76	41.7	33.8	78.5%	81.2%
50	412	86	45	1754	1678	76	43.3	35.1	79.6%	81.1%
51	396	88	48	1752	1677	75	44.8	36.3	78.3%	81.0%
52	396	90	56	1754	1679	75	46.3	37.5	77.6%	80.9%
53	403	92	62	1757	1681	75	47.9	38.7	77.4%	80.8%
54	403	90	50	1757	1681	75	49.4	39.9	78.1%	80.7%
55	400	86	53	1754	1679	75	51.0	41.1	78.8%	80.6%
56	400	89	50	1759	1684	75	52.5	42.3	78.2%	80.6%
57	403	89	40	1757	1680	76	54.1	43.5	78.5%	80.5%
58	407	90	67	1760	1684	75	55.7	44.8	78.2%	80.4%
59	395	93	65	1759	1682	76	57.2	45.9	76.9%	80.3%
60	404	88	58	1756	1683	73	58.7	47.2	78.5%	80.3%
61	410	91	58	1762	1687	76	60.3	48.4	*78.5%***	80.2%
62	398	87	51	1755	1680	75	61.9	49.6	78.6%	80.2%
63	401	88	56	1763	1690	72	63.4	50.8	78.3%	80.2%
64	402	91	62	1759	1685	73	65.0	52.1	77.6%	80.1%
65	403	89	63	1759	1686	73	66.5	53.3	78.2%	80.1%
66	402	89	82	1759	1686	73	68.1	54.5	77.8%	80.0%
67	405	95	67	1756	1686	70	69.7	55.7	76.9%	79.9%

See Section 4.4 for discussion

***** RE value assigned using the average of the trial immediately before and following this trial***

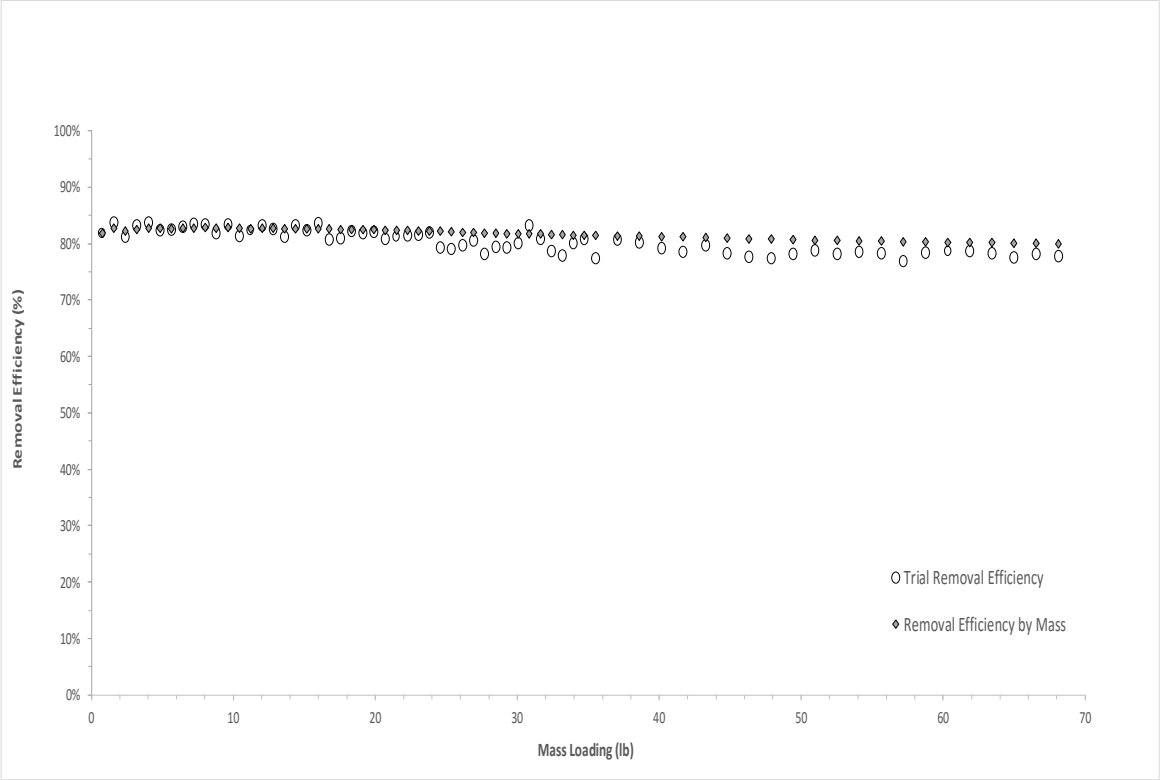

Figure 5 Average Removal Efficiency (by mass) and Trial Removal Efficiency vs. Sediment Mass Loading

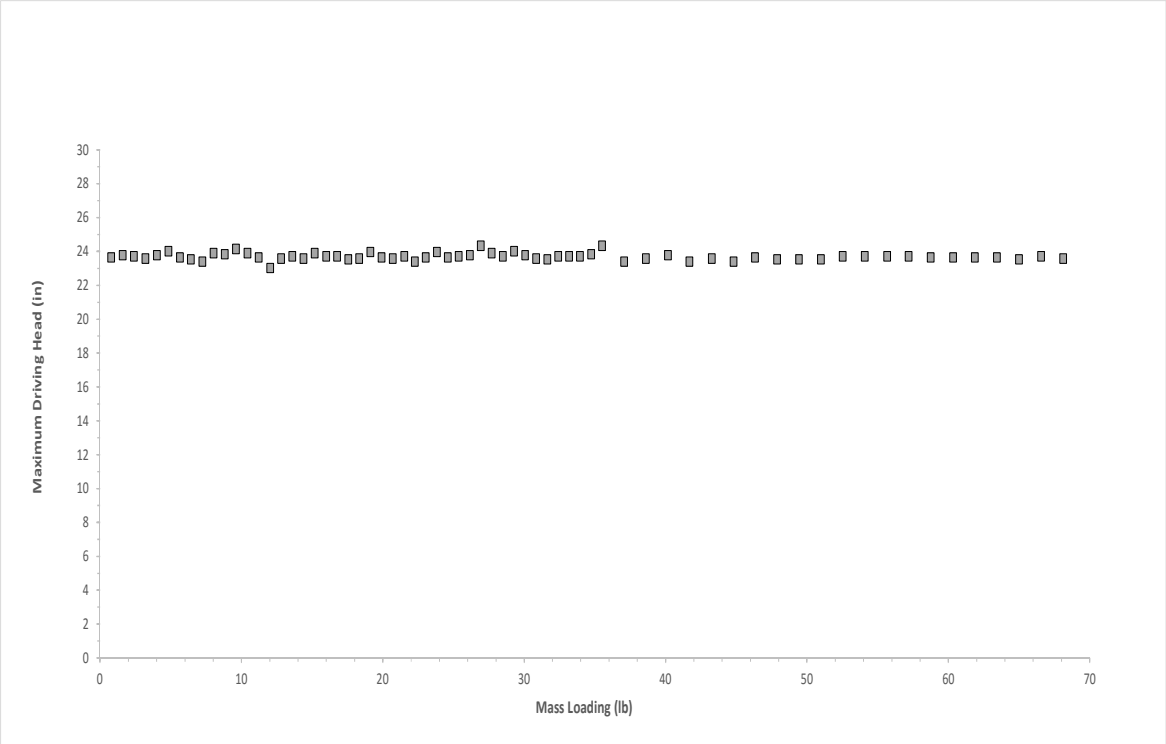

Figure 6 Maximum Driving Head vs. Sediment Mass Loading

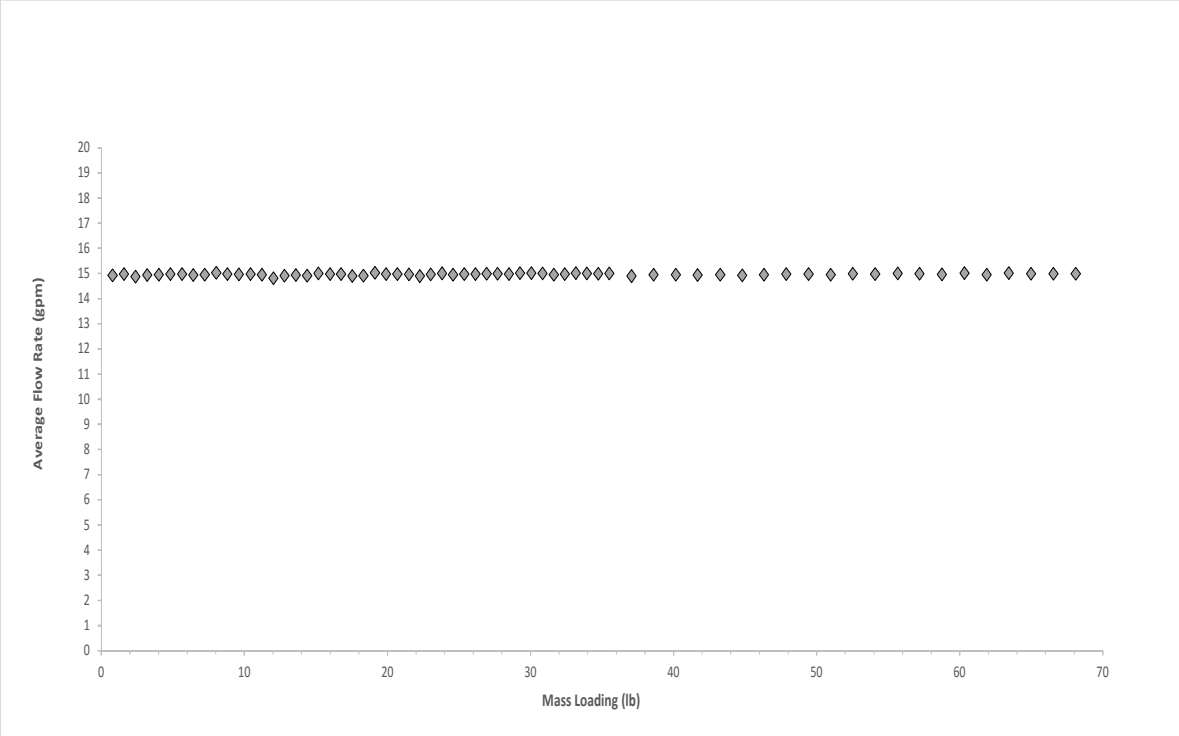

Figure 7 Average Flow Rate vs. Sediment Mass Loading

4.4 Excluded Results

The RE results of test runs 14, 27 and 61 were excluded to either sample collection or equipment errors. As required, all data collected during these trials are disclosed in **Table 4** through **Table 13**. During test run 14, the data logger battery failed, which compromised the flow rate data for that trial. Test run 27 showed correct sediment feed rates, but an equipment setup error prevented the sediment from being injected at a constant influent dosing of 200 mg/L over the entirety of the trial. It was verified that a portion of sediment intended for (but not injected during) run 27 entered the test box during the start of test run (28). The drawdown period of test run 61 was shorter than anticipated because the cartridge float valve did not fully close. As a result of the shorter duration, the second drawdown TSS sample could not be collected before the test run concluded.

The mass captured calculation (**Equation 9)** uses individual test run RE values and could not be performed for test runs 14, 27 and 61 with the stated data exclusions. Instead, the average removal efficiency from the trial immediately prior to and proceeding the impacted trials was substituted for the purpose of calculating the mass captured. This approach is consistent with the policy established by NJDEP and NJCAT.

5. Design Limitations

Required Soil Characteristics

The StormFilter is suitable for installation in all types of soils.

Slope

The StormFilter is recommended to be installed at 0% slope. Steep pipe slopes (>25 degrees) may present a fabrication or installation challenge and are likely to create inlet velocities that even at low flows may cause excess turbulence or resuspension of settled pollutants. However, due to the wide variety of configurations available for both the structure and the internal components, the StormFilter may be able to accommodate pipes with such aggressive slopes with minimal impact to the overall system performance. Inlet configurations such as the catch basin can be designed to accommodate sloping surface grades. Contech's engineering team should be consulted during the design process with questions relative to slope.

Maximum Flow Rate

The maximum treatment flow rate for the StormFilter is a function of model size and the number and size of the filter cartridges contained in the unit. The StormFilter is rated for a hydraulic loading rate of 2.12 gpm/ft^2 of filter media surface area.

Maintenance Requirements

As is true of all stormwater best management practices, maintenance requirements for each individual StormFilter installation will be influenced by site specific pollutant loading. Detailed maintenance information is provided in **Section 6**.

Driving Head

The amount of driving head required for normal operation of the StormFilter is typically fixed and dependent on the cartridge height. The minimum drop required across a StormFilter system is typically 1.8 ft, 2.3 ft and 3.05 ft for the low drop, 18 and 27-inch tall cartridges respectively. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up into the upstream piping during operation to ensure sufficient driving head is provided. The StormFilter can be designed to accommodate much higher drop/driving head where applicable.

Installation Limitations

The StormFilter is subject to few installation limitations. Contech's engineering team works with the site design engineer and support is provided to the contractor to ensure each unit is properly designed and installed given the unique conditions of each site.

Configurations

The StormFilter is typically comprised of a vault or manhole structure that house the rechargeable, media-filled filter cartridges. The StormFilter is also offered in plastic, steel, and concrete catch basins. Other configurations include panel vaults, CON/SPAN®, box culverts, and curb inlets. The filter cartridges operate consistently and act independently, regardless of

housing, which enables linear scaling.

Structural Load Limitations

Most StormFilter configurations are designed for H-20 traffic loading. Contech's engineering team ensures that the configuration is appropriate for the site specific loading conditions during the design process.

Pre-treatment Requirements

The StormFilter does not require additional pretreatment. If desirable, pretreatment may be provided upstream of the StormFilter to reduce the pollutant load reaching the filter media and extend the useful life of the cartridges. However, all sediment capacity and maintenance recommendations assume no additional pretreatment is provided.

Limitations in Tailwater

Tailwater has the potential to impact the operation of the StormFilter. Any applications where the StormFilter will be subject to tailwater conditions should be reviewed with Contech's engineering team to evaluate the potential impact on proper functionality and performance.

Depth to Seasonal High Water Table

The operation and performance of the StormFilter is not typically impacted by high ground water since the unit is fully contained in a vault, manhole or other closed structure. Contech's engineering team is available to consult on the need for water tightness and/or concerns related to buoyancy.

6. Maintenance

Maintenance Procedures

Although there are many effective maintenance options, Contech believes the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended and can also be found at: http://www.conteches.com/DesktopModules/Bring2mind/DMX/Download.aspx?EntryId=2813&PortalId=0&DownloadMethod=attachment.

1. Inspection - vault interior to determine the need for maintenance.
2. Maintenance - cartridge replacement and sediment removal

Inspection and Maintenance

At least one scheduled inspection should take place per year, followed by maintenance if necessary. First, an inspection should be performed before the winter season. During the inspection, the need for maintenance should be determined. If disposal during maintenance will be required, samples of the accumulated sediments and filtration media should be collected.

Second, if necessary, maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather. In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/ maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading. A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine, as-needed basis in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that consistently develop problems should be inspected more frequently than areas that experience fewer problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs.

Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then large amounts of sediments will typically be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

> **Warning:** In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit.

To conduct an inspection:

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system to vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as regulatory requirements, may need to be considered).

1. Sediment loading on the vault floor.
    - If >4” of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
    - If >1/4” of accumulation, maintenance is required. (Note that this indicator is not always applicable to volume StormFilter designs)
3. Submerged cartridges.
    - If >4” of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.

- If pore space between media granules is absent, maintenance is required.

5. Bypass condition.
    - If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.

6. Hazardous material release.
    - If hazardous material release (automotive fluids or other) is reported, maintenance is required.

7. Pronounced scum line.
    - If pronounced scum line (≥ 1/4" thick) is present above top cap, maintenance is required.

Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

Warning: In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.

2. Visually inspect the external condition of the unit and take notes concerning defects and/or problems.

3. Open the doors (access portals) to the vault and allow the system to vent.

4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.

5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.

6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.

7. Remove used cartridges from the vault using one of the following methods:

Method 1

1. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

   Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

2. Remove the used cartridges (up to 250 lbs. each) from the vault.

   Important: Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

3. Set the used cartridge aside or load onto the hauling truck.

4. Continue steps 1 through 3 until all cartridges have been removed.

Method 2

1. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

2. Unscrew the cartridge cap.

3. Remove the cartridge hood and float.

4. At location under structure access, tip the cartridge on its side.

5. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.

6. Set the empty, used cartridge aside or load onto the hauling truck.

7. Continue steps 1 through 5 until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.

9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.

10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.

11. Close and fasten the door.

12. Remove safety equipment.

13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used empty cartridges to Contech Engineered Solutions.

Related Maintenance Activities - Performed on an As-needed Basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system. In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities. In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste

disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

7. Statements

The following signed statements from the manufacturer (Contech Engineered Solutions, LLC), third-party observer (Scott A. Wells and Associates) and NJCAT are required to complete the NJCAT verification process.

In addition, it should be noted that this report has been subjected to public review (e.g. stormwater industry) and all comments and concerns have been satisfactorily addressed.

Contech Engineered Solutions LLC
71 US Route 1, Suite F
Scarborough, Maine 04074
Phone: (207) 885-9830
Fax: (207) 885-9825
www.ContechES.com

8/25/2016

Dr. Richard Magee
Technical Director
New Jersey Corporation for Advanced Technology
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

RE: 2016 Verification of the Stormwater Management StormFilter® (StormFilter)

Dr. Magee,
This correspondence is being sent to you in accordance with the "*Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology*" (Process Document) dated January 25, 2013. Specifically, the process document requires that manufacturers submit a signed statement confirming that all of the procedures and requirements identified in the aforementioned process document and the accompanying NJDEP Filter Laboratory Testing Protocol have been met. We believe that the testing executed at Contech's laboratory in Portland, Oregon on the StormFilter during the summer of 2016 under the direct supervision of Dr. Scott Wells, Ph.D. and Associates was conducted in full compliance with all applicable protocol and process criteria. Additionally, we believe that all of the required documentation of the testing and resulting performance calculations has been provided within the submittal accompanying this correspondence.

Please do not hesitate to contact me with any additional questions related to this matter.

RE:

Respectfully,

Derek M. Berg
Director – Stormwater Regulatory Management – East
CONTECH Engineered Solutions LLC
71 US Route 1, Suite F | Scarborough, ME 04074
T: 207.885.6174 F: 207.885.9825
DBerg@conteches.com
www.ContechES.com

Scott A. Wells and Associates

Environmental Engineering and Modeling
2382 SW Cedar Street
Portland, OR 97205 USA

September 7, 2016

Deborah Beck
Contech Engineered Solutions LLC
11815 NE Glenn Widing Dr.
Portland, OR 97220

Re: NJCAT Technology Verification of Stormwater Management Stormfilter

Dear Deborah:

NJCAT technology verification testing of the Contech Stormwater Management Stormfilter were overseen by Scott A. Wells and Associates during June-July, 2016 at the Contech Portland, Oregon laboratory. Except for the effluent, background, and drawdown sample TSS analysis which was conducted by an outside laboratory, all phases of the test were observed. This included sediment particle size distribution sampling, calibration of the flow meter, weighing of the sediment feed rate samples, and in-house calculations. The frequency of water surface elevation measurements, temperature measurements, sediment feed rate sampling, background sampling, effluent sampling, and drawdown sampling reported for the test were also observed and are reported accurately. The test used applicable NJCAT protocol and that their report accurately reflects the testing observed by Scott A. Wells and Associates.

Truly,

Scott A. Wells, P.E., Ph.D. Christopher J. Berger, P. E., Ph.D.

503-935-6379

drswells@outlook.com

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

November 15, 2016

Titus Magnanao
NJDEP
Division of Water Quality
Bureau of Non-Point Pollution Control
401-02B
PO Box 420
Trenton, NJ 08625-0420

Dear Mr. Magnanao,

Based on my review, evaluation and assessment of the testing conducted on the Contech Stormwater Management StormFilter® (StormFilter) under the direct supervision of Scott A. Wells, Ph.D. and Associates, the test protocol requirements contained in the "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device" (NJDEP Filter Protocol, January 2013) were met or exceeded. Specifically:

Test Sediment Feed

Sediment used for solids removal efficiency testing was high-purity silica (SiO_2 99.8%) material with a PSD consisting of approximately 55% sand, 40% silt, and 5% clay. Three composite PSD samples were sent to Apex Labs, Tigard, OR, an independent analytical testing laboratory. The sediment was found to meet the NJDEP particle size specification and was acceptable for use.

Removal Efficiency Testing

Sixty-seven (67) removal efficiency testing runs were completed in accordance with the NJDEP test protocol. Fifty-seven (57) of the 67 test runs were conducted during mass loading and 10 during RE testing. The target flow rate and influent sediment concentration were 15 gpm and 200 mg/L (increased to 400 mg/L after run 45) respectively. The system did not occlude or reach

maximum driving head during the test process, but the average removal efficiency (on a mass basis) dropped below 80% after run 66 so testing was suspended and deemed complete as per the QAPP and protocol. The StormFilter demonstrated an average sediment removal efficiency on a mass basis of 80% over the course of the 66 test runs.

Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency (RE) testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the RE runs, the only change was to increase the target influent concentration to 400 mg/L after test run 45. Testing concluded after 67 test runs.

The total influent mass loaded through run 66 was 68.1 lbs and the total mass captured by the StormFilter was 54.5 lbs. This is equivalent to a sediment mass loading capacity of 7.71 lbs/ft^2 of filter surface area.

No maintenance was performed on the test system during the entire testing program.

Scour Testing

The StormFilter is designed for off-line installation. Consequently, scour testing is not required.

Sincerely,

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

8. References

ASTM D422-63. *Standard Test Method for Particle-Size Analysis of Soils.*

ASTM D3977-97. *Standard Test Methods for Determining Concentrations in Water Samples*.

Contech Engineered Solutions, LLC 2016. *Quality Assurance Project Plan for Verification of the Stormwater Management StormFilter®*. Prepared by Contech Engineered Solutions. May, 2016.

Contech Engineered Solutions, LLC 2016. *NJCAT Technology Verification: StormFilter.* Prepared by Contech Engineered Solutions. August 2016.

NJDEP 2013a. *New Jersey Department of Environmental Protection Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology.* Trenton, NJ. January 25, 2013.

NJDEP 2013b. *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device.* Trenton, NJ. January 25, 2013.

VERIFICATION APPENDIX

Introduction

- Manufacturer – Contech Engineered Solutions LLC, 9025 Centre Pointe Drive, West Chester, OH 45069. *General Phone*: 800-338-1122. *Website*: http://www.conteches.com/

- MTD - The Stormwater Management StormFilter® (StormFilter) available cartridge heights and their verified capacities as well as standard models are shown in **Table A-1 and A-2.** Additional models are available when designed per the applicable capacities and conditions of this verification.

- TSS Removal Rate – 80%

- Media - Perlite

- Off-line installation

Detailed Specification

- NJDEP sizing tables and physical dimensions of StormFilter verified models are attached (**Table A-1)**. These Sizing Tables are valid for NJ following NJDEP Water Quality Design Storm Event of 1.25" in 2 hours (NJAC 7:8-5.5(a)).
- Maximum inflow drainage area
    - For flow through designs, the maximum inflow drainage area is typically governed by the maximum treatment flow rate of each model as presented in **Table A-1 and Table A-2**.
    - When installed downstream of a detention system that reduces the release rate for the water quality storm the maximum inflow drainage area is often governed by the mass capture capacity. These capacities are expressed as the maximum treatable area in **Table A-1 and Table A-2**
- The flow rate is individually controlled for each cartridge by a restrictor disc located at the connection point between the cartridge and the underdrain manifold. Driving head is managed by positioning of the inlet, outlet, and overflow elevations. The StormFilter is typically designed so that the restrictor disc passes the design treatment rate once the water surface reaches the shoulder of the cartridge which is equivalent to the cartridge height. Since the StormFilter uses a restrictor disc to restrict treatment flows below the hydraulic capacity of the media the system typically operates under consistent driving head for the useful life of the media. Site specific head constraints are also addressed by three different cartridge heights (low drop (effective height of 12 inches), 18, and 27 inches) which operate on the same principal and surface area specific loading rates. The StormFilter requires a minimum of 1.8 ft, 2.3 ft and 3.05 ft of drop between inlet invert and outlet invert to accommodate the low drop, 18 and 27 inch cartridges, respectively, without backing up flow into the upstream piping during operation. When site conditions limit the amount of drop available across the StormFilter then flow is typically backed up

into the upstream piping during operation to ensure sufficient driving head is provided. If desirable the StormFilter can be designed to operate under additional driving head.

- The drain down flow is regulated by a drain down orifice, sized so that a clean filter drains down in approximately 25 minutes.
- StormFilter Inspection and Maintenance Procedures can be found at: http://www.conteches.com/DesktopModules/Bring2mind/DMX/Download.aspx?EntryId=2813&PortalId=0&DownloadMethod=attachment.
- This certification does not extend to the enhanced removal rates under NJAC 7:8-5.5 through the addition of settling chambers (such as hydrodynamic separators) or media filtration practices (such as a sand filter).

Table A-1 Common StormFilter Model Sizes and New Jersey Treatment Capacities

Common StormFilter Model Sizes and New Jersey Treatment Capacities											
Configuration	Model Size	Max. # Cartridges (Low Drop & 18")	Sedimentation Area (ft^2)	Min. Sedimentation Area Per Cartridge[1] (ft^2)	MTFR Low Drop (12") Cartridge (gpm)	MTFR 18" Cartridge (gpm)	Max. # of 27" Cartridges	MTFR 27" Cartridge[2] (gpm)	Max. Treatable Area Low Drop (12") Cartridge (acre)	Max. Treatable Area 18" Cartridge (acre)	Max. Treatable Area 27" Cartridge (acre)
CATCHBASIN STEEL	SFCB1	1	4.00	4.00	10.0	15.0	0	N/A	0.061	0.090	N/A
	SFCB2	2	8.00	4.00	20.0	30.0	1	22.5	0.122	0.180	0.136
	SFCB3	3	11.33	3.78	30.0	45.0	2	45.0	0.183	0.270	0.272
	SFCB4	4	14.67	3.67	40.0	60.0	3	67.5	0.244	0.360	0.408
MANHOLE	SFMH48	3	12.56	4.19	30.0	45.0	2	45.0	0.183	0.270	0.272
	SFMH60	4	19.63	4.91	40.0	60.0	4	90.0	0.244	0.360	0.544
	SFMH72	7	28.27	4.04	70.0	105.0	6	135.0	0.427	0.630	0.816
	SFMH96	14	50.26	3.59	140.0	210.0	11	247.5	0.854	1.260	1.496
VAULT	SF0806	11	48.00	4.36	110.0	165.0	10	225.0	0.671	0.990	1.360
	SF0811	26	88.00	3.38	260.0	390.0	19	427.5	1.586	2.340	2.584
	SF0814	34	112.00	3.29	340.0	510.0	24	540.0	2.074	3.060	3.264
	SF0816	39	128.00	3.28	390.0	585.0	28	630.0	2.379	3.510	3.808
	SF0818	44	144.00	3.27	440.0	660.0	32	720.0	2.684	3.960	4.352
	SF0820	51	160.00	3.14	510.0	765.0	35	787.5	3.111	4.590	4.760
	SF0822	56	176.00	3.14	560.0	840.0	39	877.5	3.416	5.040	5.304
	SF0824	61	192.00	3.15	610.0	915.0	42	945.0	3.721	5.490	5.712
LINEAR GRATE	SFLG0408	4	23.33	5.83	40.0	60.0	4	90.0	0.244	0.360	0.544
	SFLG0608	9	38.67	4.30	90.0	135.0	8	180.0	0.549	0.810	1.088
	SFLG0610	11	49.67	4.52	110.0	165.0	10	225.0	0.671	0.990	1.360
	SFLG0612	15	60.67	4.04	150.0	225.0	13	292.5	0.915	1.350	1.768
	SFLG0614	18	71.67	3.98	180.0	270.0	15	337.5	1.098	1.620	2.040
	SFLG0616	21	82.67	3.94	210.0	315.0	18	405.0	1.281	1.890	2.448
	SFLG0618	24	90.67	3.78	240.0	360.0	20	450.0	1.464	2.160	2.720
	SFLG0816	25	110.67	4.43	250.0	375.0	24	540.0	1.525	2.250	3.264
	SFLG0818	29	121.29	4.18	290.0	435.0	26	585.0	1.769	2.610	3.536
PEAK DIVERSION	SFPD0806	8	34.28	4.28	80.0	120.0	7	157.5	0.488	0.720	0.952
	SFPD0612	11	55.58	5.05	110.0	165.0	11	247.5	0.671	0.990	1.496
	SFPD0811	18	68.83	3.82	180.0	270.0	15	337.5	1.098	1.620	2.040
	SFPD0814	25	92.83	3.71	250.0	375.0	20	450.0	1.525	2.250	2.720
	SFPD0816	33	108.83	3.30	330.0	495.0	24	540.0	2.013	2.970	3.264
	SFPD0818	38	124.83	3.29	380.0	570.0	27	607.5	2.318	3.420	3.672
	SFPD0820	43	140.83	3.28	430.0	645.0	31	697.5	2.623	3.870	4.216
	SFPD0822	48	156.83	3.27	480.0	720.0	34	765.0	2.928	4.320	4.624
	SFPD0824	55	172.83	3.14	550.0	825.0	38	855.0	3.355	4.950	5.168

1 - Sedimentation Area shown references maximum # cartridges column.

2 - MTFR 27" Cartridges uses reduced maximum cartridge count associated with maintaining 4.50 sqft/cartridge sedimentation area lower limit.

NOTE: ADDITIONAL SIZES AND CONFIGURATIONS AVAILABLE, CONSULT CONTECH FOR ASSISTANCE

Table A-2 StormFilter Cartridge Heights and New Jersey Treatment Capacities

StormFilter Cartridge Heights and New Jersey Treatment Capacities				
StormFilter Cartridge Height	**Filtration Surface Area (ft^2)**	**MTFR* (GPM)**	**Mass Capture Capacity (lbs)**	**Maximum Allowable Inflow Area (acres)**
Low Drop (12")	4.71	10	36.3	0.061
18"	7.07	15	54.5	0.09
27"	10.61	22.5	81.8	0.136
*2.12 gpm/ft^2 of filter surface				