NJCAT TECHNOLOGY VERIFICATION

Oldcastle PerkFilter™ System with ZPC Media

Oldcastle Infrastructure

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Table of Contents

Page

List of Figures

Page

List of Tables

1. Description of Technology

The PerkFilter™ is a stormwater quality treatment system typically consisting of an inlet chamber, a media-cartridge filter treatment chamber, and an outlet chamber (**Figure 1**). The system is typically housed in a precast concrete vault and can be designed in numerous configurations. Common configurations include single or multiple-cartridge catch basins, multiple sizes of precast concrete vaults and manholes. Custom designed modular structures are also available allowing maximum design flexibility. Typically, each vault is designed and constructed to withstand traffic loads.

The inlet chamber provides an opportunity for settling, allowing for the removal of heavier solids, and separation of floatables. Volumes or flows in excess of the treatment volume are bypassed prior to entering the cartridge chamber to minimize resuspension of accumulated pollutants.

The media-cartridge chamber is the portion of the vault that contains the cartridge stacks. A number of cartridge configurations are possible, depending on the site requirements. The width, length, and minimum height of the cartridge chamber are dependent on the number and height of cartridges required for treatment. The PerkFilter cartridge consists of an 18-inch diameter cylindrical outer screen that is manufactured in either a 12- or 18-inch height. Interior of the outer screen is the filtration media and slotted center tube. Each cartridge is designed to drain down between events. Cartridges can be provided in either the 12-inch or 18-inch heights, or can be stacked to provide 24-inch or 30-inch combinations.

The outlet chamber is located under the inlet and media-cartridge chamber and allows both the treated flow and bypass flow to combine and discharge to a common outlet.

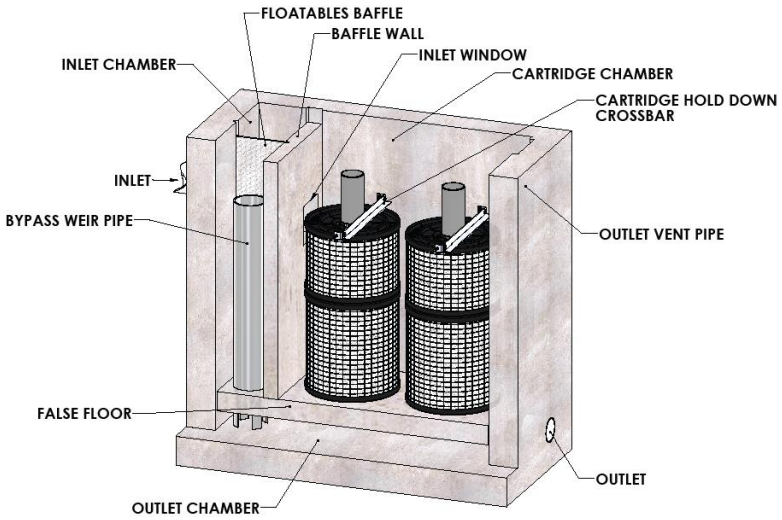

Figure 1 Schematic of the PerkFilter System

2. Laboratory Testing

The physical modeling (testing) program was conducted by the University of Florida's (UF) Stormwater Unit Operations Laboratory (SUOL), an independent unit operation and process laboratory located on the Gainesville, Florida campus of UF. Testing occurred during the summer and early autumn of 2016. The PerkFilter tested at SUOL is identical to commercially available manufactured units; with the exception that the PerkFilter tested did not have a concrete top that would be associated with a unit installed below grade. For physical model testing, there was no need for a concrete top as the concrete top inhibits access to the unit, observations, and measurements of the unit during testing. The testing of a PerkFilter without a concrete top had no impact on testing results.

Laboratory testing of the PerkFilter was carried out 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 Protocol for Filtration Manufactured Treatment Device). A quality assurance project plan (QAPP) was submitted to, and approved by the New Jersey Corporation for Advanced Technology (NJCAT) prior to testing the PerkFilter at SUOL.

2.1 Test Unit

The PerkFilter tested is a commercially available media filtration system, model SK-0840. The dimensions of the system tested are provided in **Figure 2**. The system tested has a total sedimentation area of 5.17 ft^2 (1.47 ft^2 for inlet chamber and 3.70 ft^2 for cartridge chamber) and two radial cartridge filter stacks, providing an effective filtration treatment area of 23.6 ft^2. The SK-0840 model can be scaled to other PerkFilter systems (**Table A-3**). Cartridges may be filled with a wide variety of media, but the standard mix, the one tested for this technology verification of performance report, is composed of zeolite, perlite and carbon (ZPC).

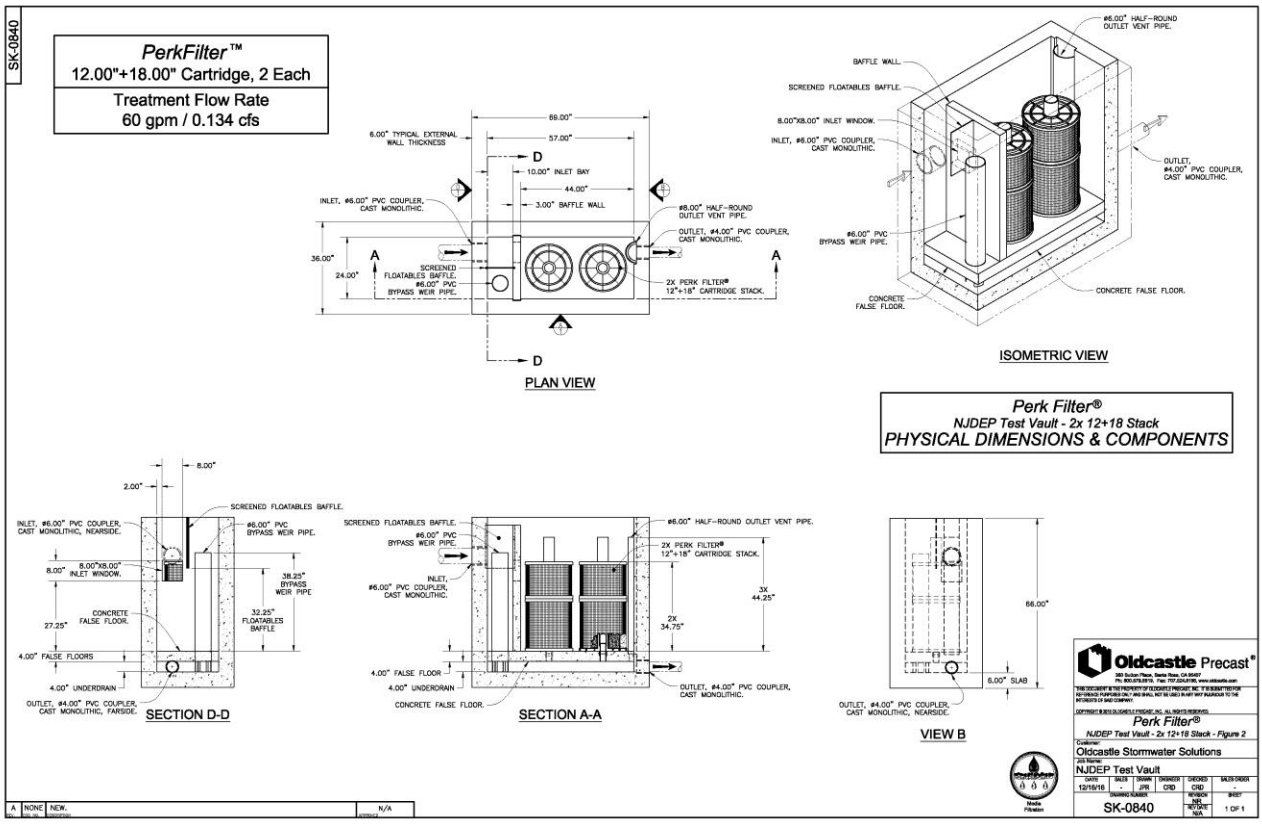

Figure 2 Oldcastle PerkFilter SK-0840

2.2 Test Setup

The SUOL configuration is a flow through testing system that utilized potable water as the carrier liquid for particulate matter (PM). The system is comprised of water reservoirs, pumps, standpipe, receiving tank and flow meters, in addition to the insertion of the Oldcastle PerkFilter for physical model testing. The total potable water capacity of the system's two water reservoirs is approximately 24,000 gallons. The flow through testing system with the PerkFilter in place is illustrated in **Figure 3**, **Figure 4**, and **Figure 5**.

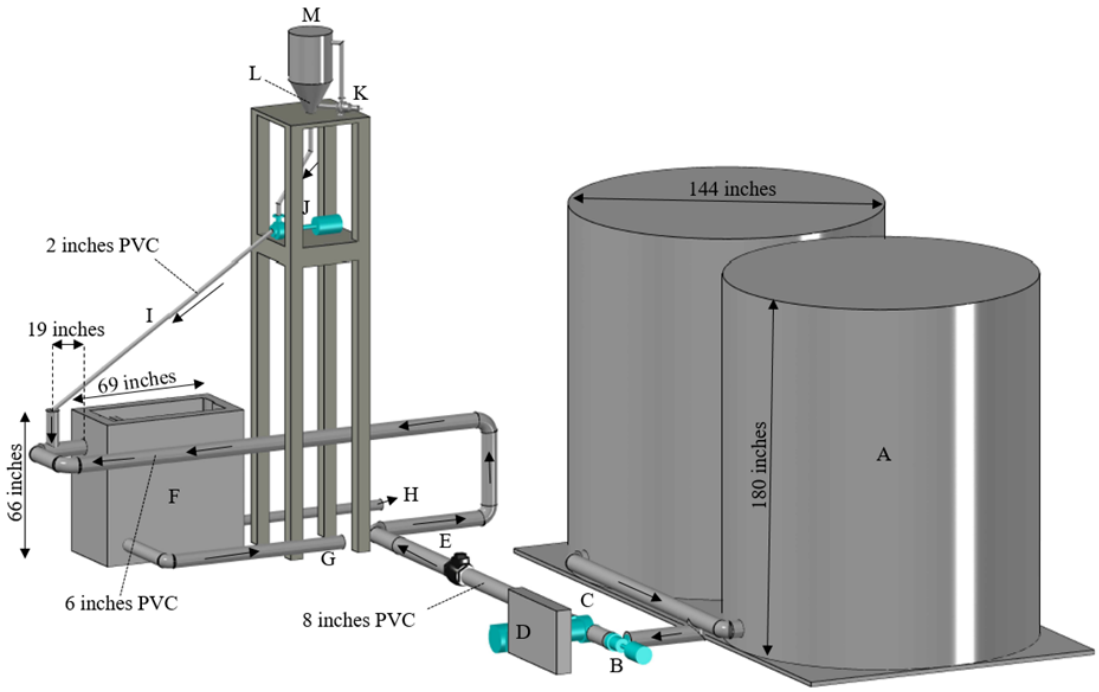

Figure 3 Three-Dimensional Schematic of SUOL Facility Testing System

(A: 12,000 gallon tanks; B: variable speed Berkley centrifugal pump, 300 gpm, 4" Suction, 3" Discharge, 3 HP; C: variable speed Berkley centrifugal pump, 1000 gpm, 8" Suction, 6" Discharge, 10 HP; D: Flow Booster Pumping Station with Programmable Logic Control System; E: MX Ultra Mag meter; F: Oldcastle PerkFilter; G: Bypass outlet; H: Outlet; I: 2 inch PVC pipe; J: Slurry pump; K: 3608 series centrifugal pump; L: ABS JC-11W submersible pump; M: 250 liter mixing slurry tank)

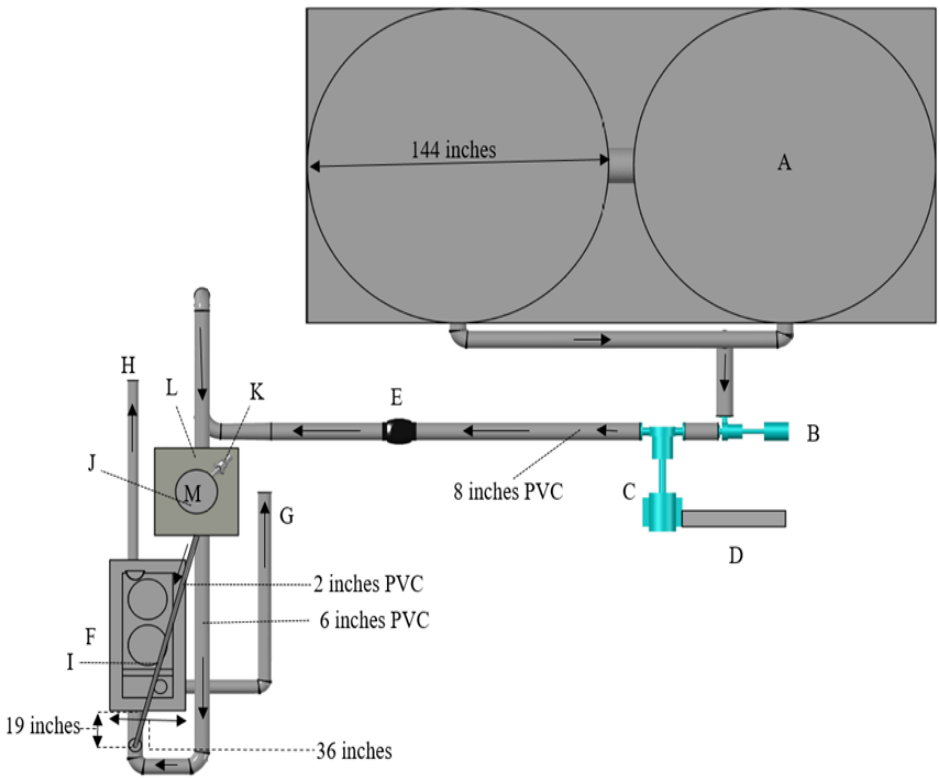

Figure 4 Plan View of SUOL Facility Testing System

(A: 12,000 gallon tanks; B: variable speed Berkley centrifugal pump, 300 gpm, 4" Suction, 3" Discharge, 3 HP; C: variable speed Berkley centrifugal pump, 1000 gpm, 8" Suction, 6" Discharge, 10 HP; D: Flow Booster Pumping Station with Programmable Logic Control System; E: MX Ultra Mag meter; F: Oldcastle PerkFilter; G: Bypass outlet; H: Outlet; I: 2 inch PVC pipe; J: Slurry pump; K: 3608 series centrifugal pump; L: ABS JC-11W submersible pump; M: 250 liter mixing slurry tank)

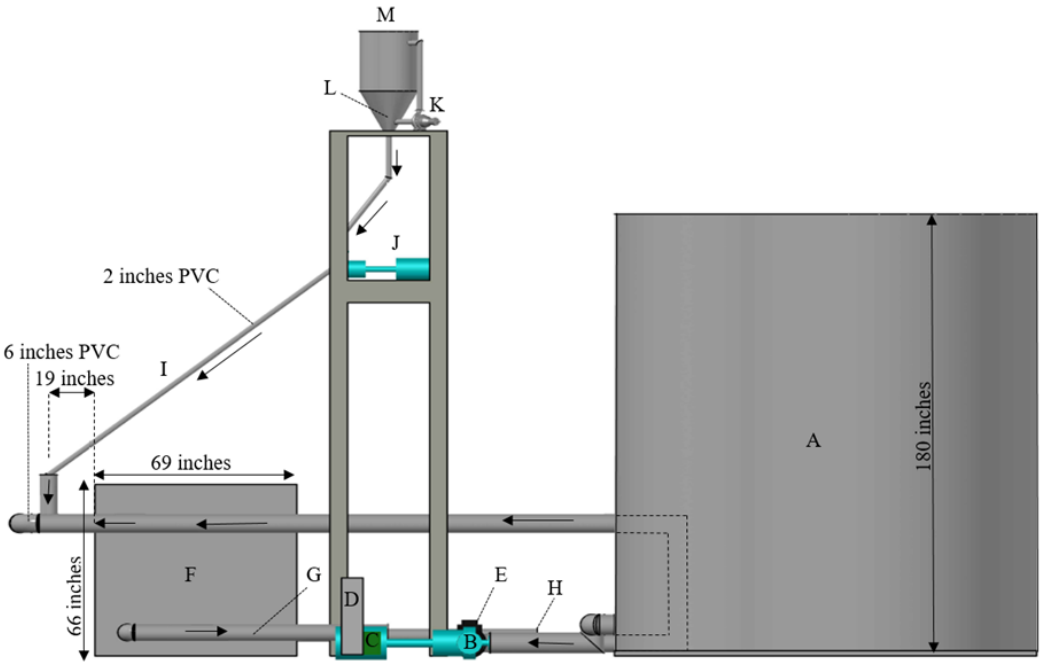

Figure 5 Elevation View of SUOL Facility Testing System

(A: 12,000 gallon tanks; B: variable speed Berkley centrifugal pump, 300 gpm, 4" Suction, 3" Discharge, 3 HP; C: variable speed Berkley centrifugal pump, 1000 gpm, 8" Suction, 6" Discharge, 10 HP; D: Flow Booster Pumping Station with Programmable Logic Control System; E: MX Ultra Mag meter; F: Oldcastle PerkFilter; G: Bypass outlet; H: Outlet; I: 2 inch PVC pipe; J: Slurry pump; K: 3608 series centrifugal pump; L: ABS JC-11W submersible pump; M: 250 liter mixing slurry tank)

Hydraulics and Measurement

Referring to **Figures 3, 4 and 5**, potable water stored in both 12,000 gallon tanks was pumped at 60 gallons per minute (gpm) ± 1.6 gpm for sediment removal efficiency testing and 120 gpm ± 3.3 gpm for sediment scour testing of the PerkFilter using the variable-speed Berkley centrifugal pump (300 gpm, 4" Suction, 3" Discharge, 3 HP and variable frequency drive, VFD). The hydraulics were controlled by the Flow Booster Pumping Station with a Programmable Logic Control (PLC) System. The flow rate was measured using an MX Ultra Mag meter and the flow rate manually checked with volume/time measurements at five minute intervals. The second pump, a variable-speed Berkley centrifugal pump (1000 gpm, 8" Suction, 6" Discharge, 10 HP) was not operated given that the 300 gpm pump provided the required hydraulic capacity for removal efficiency and scour testing. **Figure 5** illustrates that after water passes the MX Ultra Mag meter the potable water is piped through an 8 inch PVC line, incoming sediment is mixed with the potable water at the 6 inch PVC inlet stub with vertical standpipe fitting and this influent flow is discharged into the PerkFilter inlet chamber. The effluent flow from the PerkFilter is conveyed by hydraulic driving head across the PerkFilter to the 4-inch effluent pipe (identified as H in these figures). The effluent was always in an atmospheric free-discharge condition that allowed full cross sectional flow effluent sampling.

Water Sample Collection

Background potable water samples were obtained as manual grab samples taken from the potable water reservoirs supply piping. All samples were one liter taken in wide-mouth polypropylene bottles. The influent sediment samples are taken from the 6-inch diameter inflow pipe at the entrance to the unit. Effluent samples for the sediment removal efficiency, sediment mass loading capacity, and sediment scour testing were obtained as manual grab samples. All samples were taken in a one liter wide-mouth polypropylene bottle at the atmospheric free-discharge from the effluent pipe (identified as H in **Figures 3** and **4**).

Additional Instrumentation and Measurements

Beyond the instrumentation identified in **Figures 3**, **4** and **5**, water temperature was taken at the end of the effluent pipe. Water temperature was measured for the effluent of the PerkFilter with a Fisher Scientific Traceable Digital Thermometers to the nearest 0.1 °C.

The driving head, based on water level in the PerkFilter, was taken in the cartridge chamber at the midpoint against the unit sidewall using a staff gage with a resolution of 1/8" based on manual observation every 5 minutes. Driving head was measured from the top of the concrete false floor of the PerkFilter which represented the test datum and the horizontal base of the cartridge chamber. The water volume during draindown was determined through measured driving head after the end of inflow. All durations and sampling times were measured using synchronized Fisher Scientific Traceable stopwatches. Sediment was supplied through the 6-inch PVC inlet fitting vertical tee (3.19 pipe diameters) from the PerkFilter inlet with the configuration and specifications as shown in **Figure 3**, **4** and **5**.

2.3 Test Sediment

The sediment used in all testing of the PerkFilter was a batch mixture of commercially available silica sand/silt particle size distributions (PSD) such that the resulting mixture met the specification for the NJDEP Protocol for Filtration Manufactured Treatment Device. Four randomly sampled dry sediment sub-samples were tested for a mass-based PSD using the methodology of ASTM method D422-63. The dry sediment test results are summarized in **Table 1** (% finer by mass) and in **Figure 6** (cumulative frequency distribution (cfd) by mass). PSDs were analyzed as dry sediment after oven drying by the SUOL at the University of Florida. The test sediment met the NJDEP specification for PSD.

Table 1 Particle Size Distribution of Test Sediment

Particle diameter (µm)	NJCAT (% finer)	Sample A measured (% finer)	Sample B measured (% finer)	Sample C measured (% finer)	Sample D measured (% finer)	Mean measured (% finer)	Mean difference (%)	Mean measured increment:
1000	100	99.26	99.41	99.34	99.37	99.34	0.66	Coarser
500	95	95.15	94.85	94.96	94.84	94.95	0.05	Coarser
250	90	90.34	90.02	90.23	90.22	90.2	-0.2	Finer
150	75	76.57	76.11	76.19	76.17	76.26	-1.26	Finer
100	60	61.67	61.22	61.43	60.91	61.31	-1.31	Finer
75	50	50.3	49.96	50.28	50.39	50.23	-0.23	Finer
50	45	43.15	43.05	43.14	43.19	43.13	1.87	Coarser
20	35	33.39	34.3	33.25	34.45	33.85	1.15	Coarser
8	20	22.63	23.86	20.95	23.48	22.73	-2.73	Finer
5	10	16.5	17.6	16.34	18.33	17.19	-7.19	Finer
2	5	11.38	9.28	9.01	9.64	9.83	-4.83	Finer

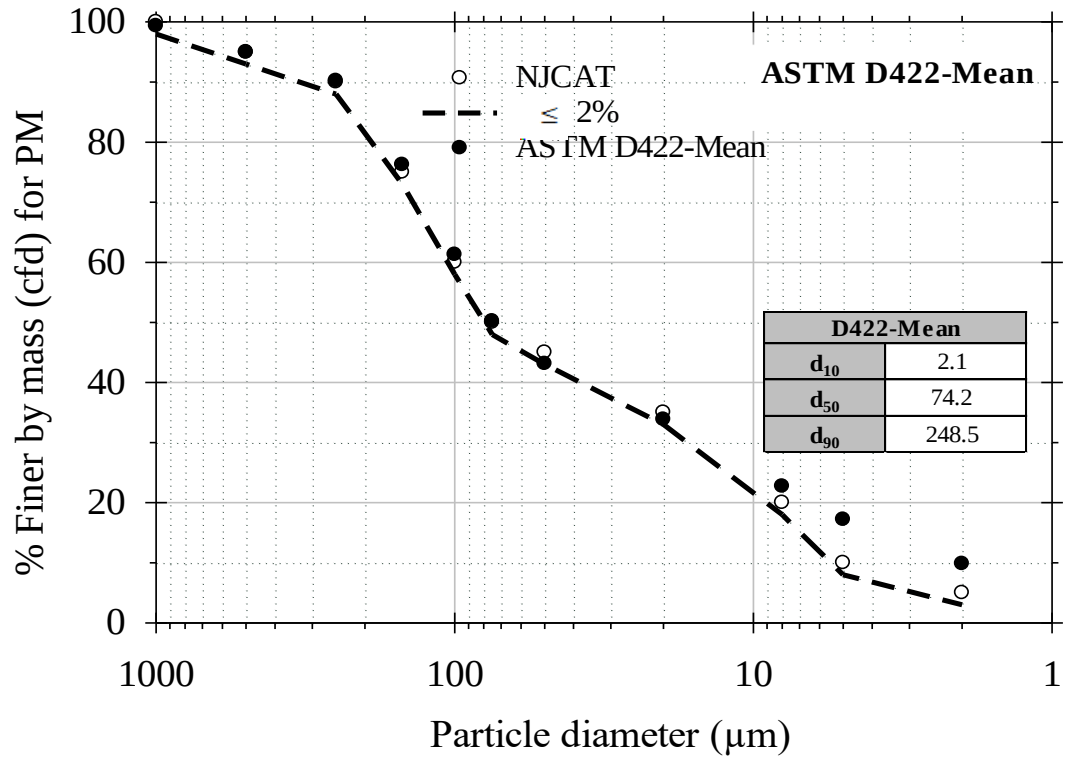

Figure 6 Comparison of Test Sediment PSD to NJDEP PSD Specification

2.4 Removal Efficiency Testing

Removal efficiency testing was conducted in accordance with Section 5 of the NJDEP Protocol for Filtration Manufactured Treatment Devices (MTDs). Testing was carried out at a steady target flow rate of 0.134 cfs (60 gpm) and a target influent sediment concentration of 200 mg/L.

Effluent grab sampling was spaced at intervals throughout the run and samples were taken 5 times per run. The loading duration for each run was 30 minutes followed by a drain down period. In addition to the effluent samples, eight background water samples were taken throughout the run. In all cases, effluent sampling did not start until the filtration MTD had been in operation for a minimum of three detention times (5.5 minutes at 60 gpm with a turnover volume of 109.6 gallons). Sampling frequency (times) for removal efficiency testing and sediment mass loading capacity are summarized in **Table 2A** and **Table 2B**. **Table 2A** represents the sampling frequency for the first 10 runs for removal efficiency testing, while **Table 2B** represents the sampling frequency for runs 11 through 24 for both removal efficiency and sediment mass loading capacity. After the sediment removal efficiency on a cumulative mass basis dropped below 80% the testing was terminated. All samples were collected in pre-washed one liter wide-mouth bottles and analyzed for sediment in accordance with ASTM D3977-97 (re-approval 2007) *"Standard Test Methods for Determining Sediment Concentrations in Water Samples"*.

The test sediment was sampled three times per run to confirm the sediment concentration (mg/L), one at the start of testing, one in the middle and one just prior to the end of the run. For each run, two drain down samples were collected after the end of the 30-minute run, after the cessation of influent loading. All samples were collected in pre-washed one liter wide-mouth bottles.

Table 2A Removal Efficiency Sampling Frequency: Runs 1 to 10

Sample/ Measurement	**Run Time (min.)**														
TAKEN	**1**	**4**	**6**	**8**	**12**	**15**	**18**	**20**	**24**	**25**	**29**	**30**		**33**	**36**
Influent	X					X					X				
Effluent			X		X		X		X			X	END of RUN		
Background	X	X		X	X	X		X		X	X				
Drain down														X	X

Table 2B Sediment Mass Loading Capacity Sampling Frequency: Runs 11 to 24

Sample/ Measurement	Run Time (min.)													
TAKEN	**1**	**4**	**5**	**8**	**10**	**12**	**15**	**20**	**25**	**29**	**30**		**33**	**36**
Influent	X						X			X				
Effluent			X		X		X	X	X		X	END of RUN		
Background	X	X		X		X	X	X	X	X				
Drain down													X	X

2.5 Sediment Mass Loading Capacity

Sediment mass loading capacity testing of the PerkFilter was an extension of the sediment removal efficiency testing. The test procedure remained the same until run 11. However, the influent sediment concentration for runs 11 through 24 was increased to 400 mg/L.

2.6 Scour Testing

A scour test is required to ensure that previously captured sediment will not be released or discharged when the PerkFilter is installed on-line. Therefore, in accordance to the protocol, the inlet and cartridge chambers were pre-loaded to 50% of the manufacturer's recommended maximum sediment storage volume. The pre-load PSD was consistent with the measured PSD summarized in **Table 1** and **Figure 6** and came from the same batch mixture of sediment.

Scour testing was conducted at 120 gpm. This flow rate represents 200% of the MTFR of 60 gpm. The inlet and cartridge sedimentation chamber were pre-loaded to 50% of the manufacturer's recommended maximum sediment storage volume; 3 inches on the inlet bay floor and 2 inches on the cartridge chamber floor. Following pre-loading of sediment and prior to

commencing the scour test, the test sediment layer was leveled. Commencement of the scour test was 48 hours after pre-loading the PerkFilter.

The PerkFilter was filled with potable clear water to the normal, dry weather operating depth. Clear water is defined as water with a background sediment concentration of less than 20 mg/L. Following pre-loading and the addition of potable water, the scour test commenced by conveying potable water through the PerkFilter at increasing flow rates up to the target maximum conveyance rate of 120 gpm. The flow rate was increased to the target flow rate within five minutes of commencement of the test. The flow rate remained constant at the target maximum flow rate for the remainder of the test duration. Effluent samples were collected at intervals of every one minute after achieving the maximum target flow rate over the 30-minute duration of the test. The flow rate was recorded and samples were taken from the effluent of the PerkFilter and did not include any externally bypassed flow. A minimum of eight background samples of the potable water were collected at evenly spaced intervals throughout the duration of the scour test (occurring at the target maximum flow rate). All samples (background and effluent) were analyzed for sediment in accordance with ASTM D3977-97 (re-approval 2007) *"Standard Test Methods for Determining Sediment Concentrations in Water Samples".* Effluent samples were taken as grab samples with one liter wide-mouth bottles.

All effluent sample results from the scour test were adjusted for background concentration [adjusted effluent concentration = recorded effluent concentration– background concentration (maximum allowable background TSS concentration is 20 mg/L)]. All background sample results were graphed with respect to time of collection so that the proper background TSS concentration at the time of effluent sample collection were used for determining the adjusted effluent concentration. All adjusted effluent concentrations from the scour test were included in the calculation of the mean (average) adjusted effluent TSS concentration.

3. Performance Claims

Per the NJDEP verification procedure, the following are the performance claims made by Oldcastle Infrastructure (formerly Oldcastle Precast Stormwater) and/or established via the laboratory testing conducted for the PerkFilter.

Total Suspended Solids Removal Rate
For the particle size distribution specified by the NJDEP Filtration MTD protocol, the PerkFilter Model SK-0840 at an MTFR of 2.54 gpm/ft^2 (0.00566 cfs/ft^2) of filter media surface area will demonstrate 80% TSS removal efficiency.

Maximum Treatment Flow Rate (MTFR) and Maximum Drain Down Cartridge Flow
The MTFR increases with the PerkFilter model size and the number of filter cartridges. For the tested unit, the PerkFilter Model SK-0840, the MTFR was 0.134 cfs (60 gpm). Each PerkFilter is designed so that each cartridge stack has a drain down function. Each cartridge stack's drain down flow is regulated by two drain down orifice openings (3/16-inch diameter each), sized so that an empty bed (clean) filter drains down in about 40 minutes.

Maximum Sediment Storage Depth and Volume
The maximum recommended sediment storage depth prior to maintenance is 6 inches in the inlet chamber and 4 inches in the cartridge chamber. The scour testing demonstrates that the PerkFilter qualifies for use as an on-line system based on a maximum flow of 200% of the MTFR when preloaded with sediment up to 50% of the maximum sediment storage depth.

Effective Sedimentation Area
The Effective Sedimentation area for the PerkFilter increases with increasing model size. For the PerkFilter Model SK-0840, the effective sedimentation area is the combined area of the inlet and cartridge chambers which is 5.17 ft^2.

Detention Time and Wet Volume
The PerkFilter detention time and wet volume will vary with model size. The PerkFilter Model SK-0840 tested had a wet volume of 14.65 ft^3 which corresponded to a detention time of 1.8 minutes at the test flow rate of 0.134 cfs.

Effective Filtration Treatment Area
The effective filtration treatment area varies with the number of cartridges installed in the PerkFilter unit. The PerkFilter Model SK-0840 has two filter stacks with a total effective filtration treatment area of 23.6 ft^2.

Sediment Mass Loading Capacity
The tested PerkFilter Model SK-0840 exhibited a sediment mass loading capacity of 85.8 lbs (3.64 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 PerkFilter SK-0840 of 85.8 lbs (3.64 lbs/ft^2 of filter surface area), the PerkFilter has a maximum allowable inflow drainage area of 0.072 acres per cartridge. See **Table A-1** for the maximum allowable drainage area of other SK Models.

4. Supporting Documentation

The NJDEP Procedure (NJDEP, 2013) 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.

4.1 Removal Efficiency and Mass Loading Capacity Testing

In accordance with the NJDEP Filtration MTD Protocol, sediment removal efficiency testing was conducted on the PerkFilter SK-0840 unit in order to establish the ability of the system to remove

the specified test sediment at the target MTFR with the goal to demonstrate at least 80% sediment removal as defined in the protocol. The MTFR established through this testing program is 2.54 gpm/ft^2 (0.00566 cfs/ft^2) of filter media surface area.

A total of 24 sediment removal efficiency and sediment mass loading capacity test runs were completed in accordance with the NJDEP filter protocol. The target flow rate and influent sediment concentration were 60 gpm and 200 mg/L or 400 mg/L. The results from all 24 runs were used to calculate the overall sediment removal efficiency of the PerkFilter SK-0840.

Flow Rate

The flow rate was measured and logged using the flow booster pumping station with a programmable logic control system and an MX Ultra Mag meter providing looped feedback to modulate the flow rate every 0.5 seconds and manually checked with volume/time measurements at five minute intervals. The effluent sampling of a treatment run did not start until the filtration MTD had been in operation for a minimum of three detention times (5.5 minutes at 60 gpm with a turnover volume of 109.6 gallons). For each run, the flow rate was within 10% of the target flow with a COV (coefficient of variation) of 0.03. The flow data has been summarized in **Table 3**, including the compliance to the QA/QC acceptance criteria. The mean flow for each run was 60.7 gpm.

Sediment

The target sediment concentration was 200 ± 20 mg/L for runs 1 to 10 (Removal Efficiency Testing) and 400 ± 40 mg/L for runs 11 to 24 (Mass Loading Capacity Testing), both with a COV within 0.10. The sediment concentration for each run was analyzed three times during each run. The PM concentrations and compliance with QA/QC criteria are summarized in **Table 4**.

Filter Drain Down

The PerkFilter is designed with a drain down feature that allows the filters and filter cartridge chamber to drain after a storm event. The sediment discharged from the PerkFilter during drain down was quantified and results are shown in **Table 5**.

Table 3 Flow Rate Statistics for Removal Efficiency and Sediment Mass Loading Capacity Testing

Run #	Flow Rate (gpm)			COV	QA/QC Compliance (COV < 0.03)	Maximum Water Temperature (°F)
	Min (gpm)	Max (gpm)	Mean (gpm)			
1	59.5	61.3	60.3	0.012	Yes	71.8
2	60.3	61.3	60.8	0.006	Yes	71.8
3	59.9	61.5	60.6	0.010	Yes	71.8
4	59.8	62.8	61.1	0.018	Yes	71.8
5	60.7	63.6	61.8	0.016	Yes	71.8
6	60.0	61.0	60.5	0.006	Yes	71.8
7	59.2	61.9	60.2	0.019	Yes	71.8
8	60.3	61.7	60.9	0.008	Yes	71.8
9	60.7	62.8	61.8	0.015	Yes	71.8
10	61.7	63.7	62.5	0.011	Yes	71.8
11	58.2	63.1	61.3	0.029	Yes	75.6
12	62.2	64.7	63.0	0.015	Yes	75.6
13	60.7	65.4	62.2	0.028	Yes	75.6
14	58.7	62.6	61.0	0.024	Yes	75.6
15	60.9	63.7	62.1	0.019	Yes	75.6
16	59.0	61.6	60.0	0.014	Yes	70.7
17	57.0	60.5	59.4	0.024	Yes	70.7
18	58.8	60.5	59.6	0.010	Yes	70.7
19	56.4	60.2	58.6	0.021	Yes	70.7
20	56.9	61.5	59.9	0.027	Yes	70.7
21	59.3	62.1	60.4	0.016	Yes	70.7
22	58.9	60.1	59.5	0.008	Yes	70.7
23	57.0	59.4	58.1	0.017	Yes	70.7
24	59.0	62.0	60.8	0.020	Yes	68.2
Overall Mean Flow 60.7 gpm						

Table 4 Summary of Influent Sediment Concentrations and Mass Loading Rates: Test Runs 1-24

Run #	Run Time (min)	Influent Sediment Concentration (mg/L)	Mass Loading Rate (g/min)	QA/QC Compliance (COV<0.1)
1	1	198.1	45.2	YES
	15	187.7	42.9	
	29	190.8	43.6	
	Mean	**192.2**	**43.9**	
	COV		**0.03**	
2	1	197.2	45.4	YES
	15	191.2	44.0	
	29	207.1	47.7	
	Mean	**198.5**	**45.7**	
	COV		**0.04**	
3	1	189.3	43.4	YES
	15	200.7	46.1	
	29	192.3	44.1	
	Mean	**194.1**	**44.5**	
	COV		**0.03**	
4	1	191.9	44.4	YES
	15	194.1	44.9	
	29	199.0	46.1	
	Mean	**195.0**	**45.1**	
	COV		**0.02**	
5	1	197.2	46.2	YES
	15	192.2	45.0	
	29	199.2	46.6	
	Mean	**196.2**	**45.9**	
	COV		**0.02**	
6	1	189.7	43.4	YES
	15	215.4	49.3	
	29	195.6	44.8	
	Mean	**200.2**	**45.8**	
	COV		**0.07**	

Run #	Run Time (min)	Influent Sediment Concentration (mg/L)	Mass Loading Rate (g/min)	QA/QC Compliance (COV<0.1)
7	1	193.4	44.0	YES
	15	185.2	42.2	
	29	191.1	43.5	
	Mean	**189.9**	**43.3**	
	COV		**0.02**	
8	1	189.0	43.6	YES
	15	196.9	45.4	
	29	198.1	45.7	
	Mean	**194.7**	**44.9**	
	COV		**0.03**	
9	1	199.4	46.6	YES
	15	191.8	44.8	
	29	195.4	45.7	
	Mean	**195.5**	**45.7**	
	COV		**0.02**	
10	1	192.6	45.6	YES
	15	186.9	44.2	
	29	200.3	47.4	
	Mean	**193.3**	**45.8**	
	COV		**0.03**	
11	1	379.0	87.9	YES
	15	387.6	89.9	
	29	396.6	92.0	
	Mean	**387.7**	**90.0**	
	COV		**0.02**	
12	1	378.2	90.1	YES
	15	390.8	93.1	
	29	380.8	90.8	
	Mean	**383.3**	**91.3**	
	COV		**0.02**	

Run #	Run Time (min)	Influent Sediment Concentration (mg/L)	Mass Loading Rate (g/min)	QA/QC Compliance (COV<0.1)
13	1	392.6	92.4	YES
	15	389.3	91.6	
	29	392.3	92.3	
	Mean	**391.4**	**92.1**	
	COV		**0.01**	
14	1	385.8	89.1	YES
	15	443.0	102.3	
	29	404.3	93.4	
	Mean	**411.1**	**94.9**	
	COV		**0.07**	
15	1	394.1	92.6	YES
	15	382.5	89.9	
	29	387.1	91.0	
	Mean	**387.9**	**91.2**	
	COV		**0.02**	
16	1	376.5	85.6	YES
	15	399.8	90.9	
	29	393.3	89.4	
	Mean	**389.9**	**88.6**	
	COV		**0.03**	
17	1	393.1	88.3	YES
	15	393.5	88.4	
	29	388.5	87.3	
	Mean	**391.7**	**88.0**	
	COV		**0.01**	
18	1	389.3	87.8	YES
	15	386.5	87.1	
	29	384.3	86.6	
	Mean	**386.7**	**87.2**	
	COV		**0.01**	

Run #	Run Time (min)	Influent Sediment Concentration (mg/L)	Mass Loading Rate (g/min)	QA/QC Compliance (COV<0.1)
19	1	409.3	90.8	YES
	15	387.8	86.1	
	29	391.4	86.9	
	Mean	**396.2**	**87.9**	
	COV		**0.03**	
20	1	380.8	86.3	YES
	15	388.8	88.1	
	29	397.1	90.0	
	Mean	**388.9**	**88.2**	
	COV		**0.02**	
21	1	385.8	88.2	YES
	15	410.8	93.9	
	29	385.7	88.2	
	Mean	**394.1**	**90.1**	
	COV		**0.04**	
22	1	387.7	87.3	YES
	15	383.0	86.3	
	29	395.7	89.1	
	Mean	**388.8**	**87.6**	
	COV		**0.02**	
23	1	395.2	87.0	YES
	15	384.7	84.7	
	29	391.2	86.1	
	Mean	**390.3**	**85.9**	
	COV		**0.01**	
24	1	400.7	92.2	YES
	15	404.1	92.9	
	29	401.8	92.4	
	Mean	**402.2**	**92.5**	
	COV		**0.00**	

Table 5 Sediment Drain Down Losses

Run #	Water Level at the End of Run (inches)	Draindown Volume (gal)	Sample Time from end of Run (min)	Draindown Sediment Concentration (mg/L)	Mean Draindown Sediment Concentration (mg/L)	Draindown Sediment Losses (g)
1	34	82.1	3	8.8	7.4	2.3
			6	6.0		
2	34	82.1	3	5.8	5.4	1.7
			6	4.9		
3	34	82.1	3	4.8	5.0	1.5
			6	5.2		
4	34.125	82.4	3	6.2	5.2	1.6
			6	4.2		
5	34.25	82.7	3	4.4	4.3	1.3
			6	4.2		
6	34	82.1	3	5.7	8.3	2.6
			6	10.9		
7	34.125	82.4	3	3.9	5.3	1.7
			6	6.7		
8	34	82.1	3	6.8	6.0	1.8
			6	5.1		
9	34.25	82.7	3	2.6	3.5	1.1
			6	4.3		
10	34.25	82.7	3	8.1	7.5	2.3
			6	6.9		
11	34.125	82.4	3	17.4	13.0	4.1
			6	8.7		
12	34.25	82.7	3	17.0	15.5	4.9
			6	14.0		
13	34.125	82.4	3	18.0	16.0	5.0
			6	14.0		
14	34.25	82.7	3	19.6	16.6	5.2
			6	13.6		
15	34.25	82.7	3	19.9	16.6	5.2
			6	13.2		

16	34.125	82.4	3	23.5	22.8	7.1
			6	22.1		
17	34.125	82.4	3	18.3	19.3	6.0
			6	20.3		
18	34.125	82.4	3	19.8	18.6	5.8
			6	17.4		
19	34.125	82.4	3	20.1	20.1	6.3
			6	20.0		
20	34.125	82.4	3	19.7	19.0	5.9
			6	18.3		
21	34.125	82.4	3	17.4	18.4	5.7
			6	19.4		
22	34.125	82.4	3	19.9	19.8	6.2
			6	19.7		
23	34.125	82.7	3	19.1	18.2	5.7
			6	17.2		
24	34	82.1	3	18.3	18.7	5.8
			6	19.1		

The volume of water in the cartridge chamber was determined by multiplying the chamber area by the water level in the chamber at the end of the run. The water volume was corrected for the displacement volume of the filters. Effluent samples were taken during drain down to estimate effluent sediment concentration discharged during the drain down period. The sediment concentration with the volume of drain down water resulted in an estimation of the sediment mass discharged during drain down. A clean PerkFilter has a drain down of 40 minutes. Flow rate samples were taken at three and six minutes. These samples provided the highest sediment concentrations that can be expected during a drain down period of declining flow rates.

Removal Efficiency Calculations

Samples for sediment concentration in the background, influent and effluent flows were analyzed by the SUOL at the University of Florida. The results are summarized in **Table 6A** and **Table 6B**. The potable water (background) sediment concentration was < 20 mg/L. Since the background sediment concentration from the potable water supply is contained in the influent and effluent aqueous samples, the effluent sediment concentration and background sediment concentrations are reported in **Table 6A** and **Table 6B**. However, the background sediment concentration is not subtracted from the effluent sediment concentration. **Table 7A** summarizes the results from the 10 sediment removal efficiency tests and **Table 7B** summarizes the results of the 14 mass loading capacity tests.

Table 6A Sediment Concentrations for Runs 1 to 10

Run #	Sample (mg/L)	Run Time (min.)													QA/QC Compliance (Background < 20 mg/L)
		1	4	6	8	12	15	18	20	24	25	29	30	Mean	
1	Effluent			23.5		24.5		25.0		24.6			24.6	24.4	N/A
	Background	0.9	1.4		1.6	1.4	1.1		1.2		1.0	0.8		1.2	YES
2	Effluent			26.7		29.5		27.3		26.2			34.9	28.9	N/A
	Background	0.9	0.2		0.8	0.7	1.0		0.2		0.3	0.5		0.6	YES
3	Effluent			31.7		28.1		33.2		32.2			27.3	30.5	N/A
	Background	0.7	2.4		0.9	3.9	1.1		0.7		0.1	0.6		1.3	YES
4	Effluent			30.1		27.5		29.6		26.4			19.7	26.6	N/A
	Background	1.8	0.9		0.9	0.9	0.3		0.7		0.3	0.6		0.8	YES
5	Effluent			26.2		30.6		31.3		26.4			32.7	29.4	N/A
	Background	1.8	1.1		3.8	0.9	1.3		1.8		0.5	0.2		1.4	YES
6	Effluent			29.9		28.7		27.8		27.2			24.4	27.6	N/A
	Background	0.1	1.1		0.9	0.8	0.7		0.1		0.5	0.7		0.6	YES
7	Effluent			27.3		28.8		31.7		21.9			26.5	27.2	N/A
	Background	0.2	0.4		0.9	0.9	0.6		1.0		0.3	1.3		0.7	YES
8	Effluent			35.6		28.3		26.1		26.5			32.4	29.8	N/A
	Background	0.8	0.8		0.5	0.8	0.8		0.8		0.6	0.5		0.7	YES
9	Effluent			26.0		30.6		25.6		24.7			34.1	28.2	N/A
	Background	1.1	1.6		0.9	0.7	1.3		0.4		0.2	0.5		0.8	YES
10	Effluent			32.2		27.4		30.0		36.5			36.8	32.6	N/A
	Background	0.2	0.6		0.2	0.4	0.4		0.3		0.4	0.1		0.3	YES

Table 6B Sediment Concentrations for Runs 11 to 24

Run #	Sample (mg/L)	Run Time (min.)												QA/QC Compliance (Back-ground < 20 mg/L)
		1	4	5	8	10	12	15	20	25	29	30	Mean	
11	Effluent			46.4		57.5		57.5	58.7	58.6		55.5	55.7	N/A
	Background	1.7	1.7		3.0		0.9	4.5	0.5	0.2	0.6		1.6	YES
12	Effluent			57.9		54.3		57.3	54.4	63.5		56.2	57.2	N/A
	Background	1.7	1.5		2.3		2.7	2.1	0.1	0.5	0.2		1.4	YES
13	Effluent			73.1		63.7		73.4	63.2	67.5		64.8	67.6	N/A
	Background	1.9	0.3		0.2		0.5	0.7	0.7	0.4	0.6		0.7	YES
14	Effluent			68.8		53.9		59.5	76.5	67.7		74.6	66.8	N/A
	Background	0.3	1.1		0.6		0.2	3.6	0.5	0.6	0.8		1.0	YES
15	Effluent			64.2		78.2		73.3	69.2	74.9		70.3	71.7	N/A
	Background	0.9	1.1		1.9		0.9	3.8	0.6	0.6	0.0		1.2	YES
16	Effluent			70.7		80.5		65.9	114.7	75.8		75.5	80.5	N/A
	Background	1.6	1.3		0.4		0.7	0.2	0.2	0.4	0.5		0.7	YES
17	Effluent			59.6		92.2		82.4	64.8	72.7		101.4	78.9	N/A
	Background	0.4	0.5		0.4		0.5	0.4	0.3	0.5	0.3		0.4	YES
18	Effluent			75.3		74.6		119.5	92.3	182.0		100.0	107.3	N/A
	Background	0.2	0.8		0.3		0.8	1.4	0.5	0.1	0.6		0.6	YES
19	Effluent			84.6		91.5		94.0	144.8	81.8		105.5	100.4	N/A
	Background	0.8	0.7		0.3		0.5	0.7	0.4	0.4	0.6		0.6	YES
20	Effluent			70.4		129.3		85.8	111.1	93.5		114.0	100.7	N/A
	Background	0.6	0.7		0.2		0.2	0.2	0.9	0.7	0.7		0.5	YES
21	Effluent			134.7		99.8		76.1	141.5	185.8		143.5	130.2	N/A
	Background	1.1	0.6		0.8		1.1	0.7	0.3	0.1	0.7		0.7	YES
22	Effluent			132.0		134.4		112.2	96.7	86.7		121.1	113.8	N/A
	Background	0.4	0.6		0.9		0.6	0.1	0.5	0.3	0.7		0.5	YES
23	Effluent			163.4		132.5		97.2	84.0	96.1		157.1	121.7	N/A
	Background	1.1	0.2		0.6		0.8	0.6	0.5	0.8	0.7		0.7	YES
24	Effluent			108.2		107.0		127.9	101.8	138.7		107.3	115.2	N/A
	Background	1.2	0.4		0.2		0.4	0.6	0.1	0.2	0.3		0.4	YES

Table 7A Sediment Removal Efficiency Results

Run #	Average Influent TSS (mg/L)	Average Effluent TSS (mg/L)	Average Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Mass Loading (kg)	Mass Captured (kg)	Run Removal Efficiency by Mass (%)
1	192.2	24.4	7.4	6,850.8	6,540.0	310.8	1.316	1.154	87.7
2	198.5	28.9	5.4	6,908.0	6,597.2	310.8	1.371	1.178	85.9
3	194.1	30.5	5.0	6,883.7	6,572.9	310.8	1.336	1.134	84.9
4	195.0	26.6	5.2	6,943.6	6,631.7	311.9	1.353	1.175	86.8
5	196.2	29.4	4.3	7,021.5	6,708.4	313.1	1.377	1.178	85.5
6	200.2	27.6	8.3	6,865.2	6,554.4	310.8	1.374	1.190	86.6
7	189.9	27.2	5.3	6,833.4	6,521.5	311.9	1.297	1.118	86.2
8	194.7	29.8	6.0	6,914.8	6,604.0	310.8	1.346	1.147	85.2
9	195.5	28.2	3.5	7,013.2	6,700.1	313.1	1.370	1.180	86.1
10	193.3	32.6	7.5	7,102.2	6,789.1	313.1	1.372	1.149	83.7
Total Mass Runs 1-10							13.512	11.603	--
Average Removal Efficiency by Mass									**85.9**

Table 7B Sediment Mass Loading Capacity Results

Run #	Average Influent TSS (mg/L)	Average Effluent TSS (mg/L)	Average Drawdown TSS (mg/L)	Influent Volume (L)	Effluent Volume (L)	Drawdown Volume (L)	Run Mass Loading (kg)	Run Mass Captured (kg)	Total Mass Loading (Kg)	Total Mass Captured (kg)	Cumulative Removal Efficiency by Mass (%)
11	387.7	55.7	13.0	6961.0	6649.1	311.9	2.698	2.323	16.210	13.928	85.92
12	383.3	57.2	15.5	7149.9	6836.8	313.1	2.739	2.343	18.949	16.271	85.87
13	391.4	67.6	16.0	7058.6	6746.7	311.9	2.762	2.301	21.711	18.572	85.54
14	411.1	66.8	16.6	6927.3	6614.2	313.1	2.847	2.400	24.557	20.971	85.40
15	387.9	71.7	16.6	7050.7	6737.6	313.1	2.734	2.246	27.291	23.217	85.07
16	389.9	80.5	22.8	6819.0	6507.1	311.9	2.658	2.127	29.949	25.343	84.62
17	391.7	78.9	19.3	6740.7	6428.8	311.9	2.639	2.126	32.588	27.469	84.29
18	386.7	107.3	18.6	6764.1	6452.2	311.9	2.615	1.916	35.202	29.386	83.48

19	396.2	100.4	20.1	6658.9	6347.0	311.9	2.637	1.994	37.839	31.379	82.93
20	388.9	100.7	19.0	6800.5	6488.6	311.9	2.644	1.984	40.483	33.363	82.41
21	394.1	130.2	18.4	6857.6	6545.7	311.9	2.701	1.843	43.184	35.207	81.53
22	388.8	113.8	19.8	6756.6	6444.7	311.9	2.626	1.886	45.810	37.093	80.97
23	390.3	121.7	18.2	6602.9	6289.8	313.1	2.576	1.805	48.386	38.898	80.39
24	402.2	115.2	18.7	6900.4	6589.6	310.8	2.774	2.009	51.160	40.907	79.96
								Total Runs 1-23	**48.386**	**38.898**	**80.4**

The cumulative mass from the three 1-liter influent samples taken during each run was subtracted from the total mass entering the system during each run.

The cumulative removal efficiency by mass dropped to 79.96% at the 24th run. Therefore, the mass loading capacity for the SK-0840 was 38.9 kg (85.8 lb.) achieved in runs 1-23.

4.2 Filter Driving Head

The filter driving head was measured with respect to the top of manufactured concrete false floor in the filter chamber. **Figure 7** illustrates that the driving head increase, with respect to 34.00 inches, was negligible during the 24 runs.

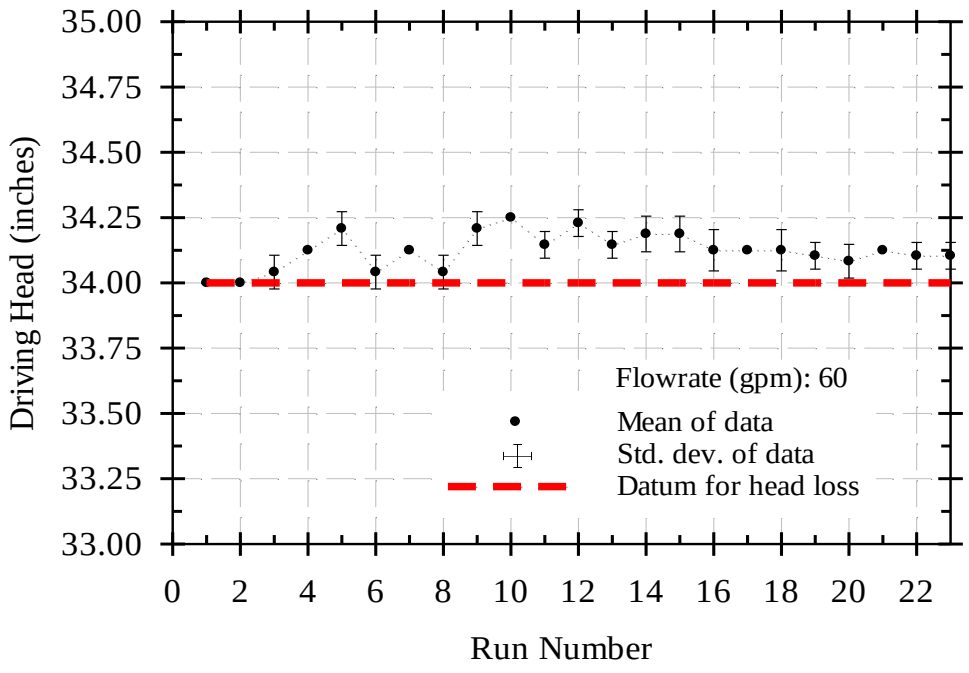

Figure 7 Driving Head for the PerkFilter across the 24 Sediment Test Runs

4.3 Scour Testing

Scour testing was conducted based on Section 4 of the NJDEP Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (NJDEP, 2013). Testing was conducted at a target flow rate of 200% of the maximum treatment flow rate (MTFR). The cartridge filters were removed from the PerkFilter after completion of the sediment mass loading capacity testing. The PerkFilter was completely cleaned and all sediment recovered and quantified gravimetrically. Based on the sediment quantified (influent mass, effluent mass, drawdown mass, settled mass and filtered mass) the overall mass balance on sediment was 95.6%. With respect to the separated fractions, 64.4% was due to sedimentation and 35.6% was due to filtration. The filter cartridges were replaced and dry sediment was pluviated into the clean PerkFilter to the manufacturer's specified depth for eventual scour testing. Pre-load sediment quantities for scour are given in **Table 8**. The scour test sampling frequencies are given in **Table 9**. The scour test flow rate summary is given in **Table 10**. **Table 11** summarizes the background sediment associated with the potable water influent feed water while **Table 12** tabulates the adjusted effluent sediment concentrations. **Figure 8** plots the results of **Table 11** and **12**.

Table 8 PerkFilter Chamber Sediment Pre-Load Amounts

Chamber	Sediment Volume (ft^3)	Sediment Depth (inches)	Sediment Mass (lbs)	Sediment (% of Total)
Inlet	0.39	3.0	36.2	27.2
Cartridge	0.70	2.0	97.0	72.8

Table 9 Scour Test Sampling Frequency

Sample/ Measurement	Run Time (min.)														
TAKEN	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Effluent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Background			X			X			X			X			X
Sample/ Measurement	**Run Time (min.)**														
TAKEN	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Effluent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Background			X			X			X			X			X

Table 10 Scour Test Flow Rate Summary

Scour Test Flow Rate (gpm)		**QA/QC Compliance (COV < 0.03 and avg. ± 10% of target)**
Minimum	113.5	YES
Maximum	126.9	
Mean	120.7	
COV	0.028	

Table 11 Scour Test Background Sediment Concentrations

Run Time (mins)	Sample ID	Sediment Concentration (mg/L)	QA/QC Compliance (Background < 20 mg/L)
3	Background-1	1.2	YES
6	Background-2	1.1	YES
9	Background-3	0.7	YES
12	Background-4	0.8	YES
15	Background-5	0.5	YES
18	Background-6	0.6	YES
21	Background-7	0.8	YES
24	Background-8	1.5	YES
27	Background-9	1.3	YES
30	Background-10	0.8	YES

Table 12 Scour Test Effluent Sediment Results

Run Time (mins)	Sample ID	Effluent Concentration (mg/L)	
		Initial	Adjusted
6	Effluent-6	36.8	35.8
7	Effluent-7	31.3	30.3
8	Effluent-8	28.3	27.3
9	Effluent-9	31.5	30.5
10	Effluent-10	27.7	26.7
11	Effluent-11	21.9	20.9
12	Effluent-12	22.7	21.7
13	Effluent-13	19.9	18.9
14	Effluent-14	12.5	11.5
15	Effluent-15	17.0	16.0
16	Effluent-16	17.2	16.2
17	Effluent-17	17.4	16.4
18	Effluent-18	16.7	15.7
19	Effluent-19	14.4	13.4

20	Effluent-20	11.9	10.9
21	Effluent-21	12.3	11.3
22	Effluent-22	9.8	8.8
23	Effluent-23	13.5	12.5
24	Effluent-24	8.8	7.8
25	Effluent-25	11.2	10.2
26	Effluent-26	10.1	9.1
27	Effluent-27	12.6	11.6
28	Effluent-28	8.5	7.5
29	Effluent-29	11.2	10.2
30	Effluent-30	12.6	11.6
Mean Adjusted Effluent Concentration (mg/L)			**16.5**

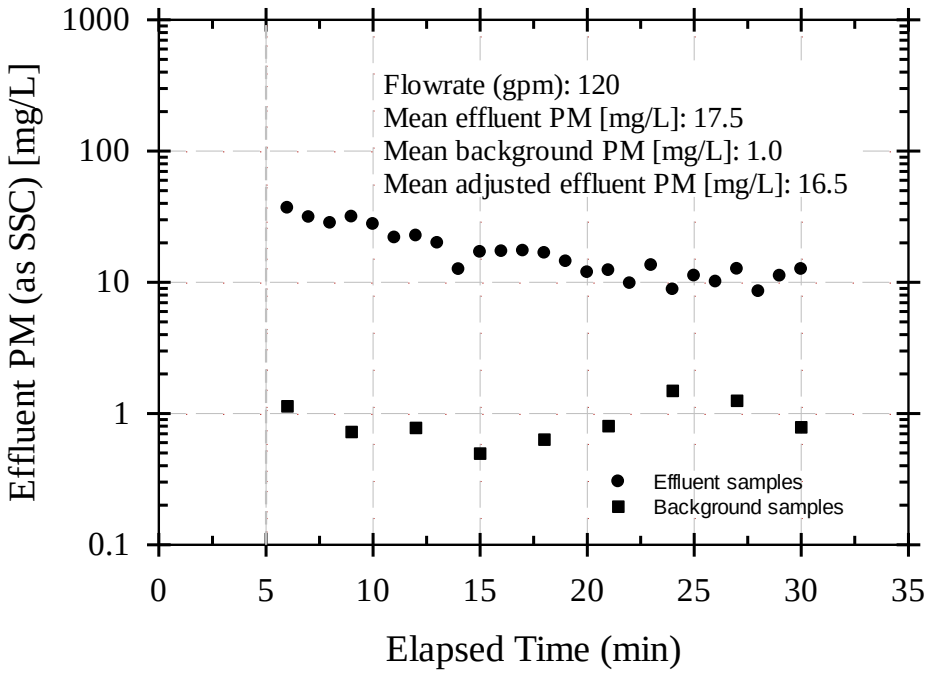

Figure 8 Scour Test Effluent and Background Sediment (PM) Concentrations

5. Design Limitations

Required Soil Characteristics
The PerkFilter is suitable for installation in all soil types.

Slope
The PerkFilter is typically recommended for installation with no slope to ensure proper, consistent operation of the cartridges. Often, the top piece can be installed to meet finished grade.

Maximum Flow Rate
The maximum flow rate for the PerkFilter is a function of the number and height of cartridges installed. The PerkFilter is rated for a cartridge loading rate of up to 2.54 gpm/ft^2 of cartridge surface area.

Allowable Head Loss
There is an operational head loss associated with each PerkFilter device. The head loss is dependent on the structure design and the cartridge stack configuration. Site specific treatment flow rates, peak flow rates, pipe diameters and pipe slopes are evaluated to ensure there is appropriate head for the system to function properly.

Maintenance Requirements
For all successful stormwater quality control systems, effective performance requires regular and proper maintenance. Maintenance frequency and requirements are dependent on the conditions and pollutant loading of each site. In general, it is recommended that inspections and/or maintenance be conducted on a regularly occurring basis to ensure continued functionality of the system. Maintenance activities could also be required in the case of an extreme rainfall event, chemical spill or heavier than anticipated pollutant loading.

Installation Limitations
The PerkFilter has few installation limitations. The PerkFilter is typically delivered to the site with all internal components, including the cartridges, installed. The contractor is then responsible for installation of the system following any requirements that would apply for any precast concrete structure. This typically includes: preparing the appropriate excavation and base layer; providing and using the appropriate lifting equipment to unload and set the PerkFilter vault components; providing and connecting the inlet and outlet piping; and following the construction plans for selection of backfill material and placement. The contractor is also responsible for protecting the PerkFilter from construction runoff until site construction is complete. Oldcastle Precast provides full-service technical design support throughout the life of a project.

Configurations
The PerkFilter is available in multiple configurations, including single- or multiple-cartridge catch basins, multiple sizes of precast concrete vaults and manholes, and custom-designed modular concrete structures, allowing maximum design flexibility.

Structural Load Limitations
The PerkFilter is typically designed for an H-20 traffic load rating and thus is applicable to all types of applications. Oldcastle Precast provides full-service technical design support throughout the life of a project and can help ensure the system is designed for the appropriate structural load requirements.

Pretreatment Requirements
The PerkFilter does not require additional pretreatment.

Limitations in Tailwater
Tailwater conditions may impact the amount of driving head available to the PerkFilter and thus may impact the operation and/or lifecycle of the system. Specific project conditions should be assessed as part of the design process.

Depth to Seasonal High Water Table
The operation of the PerkFilter is typically not impacted by the seasonal high water table. However, the high-water table may impact the buoyancy of the concrete vault. Specific project conditions should be assessed as part of the design process.

6. Maintenance Plans

Maintenance Overview
State and local regulations require all stormwater management systems to be inspected on a regular basis and maintained as necessary to ensure performance and protect downstream receiving waters. Maintenance prevents excessive pollutant buildup that can limit system performance by reducing the operating capacity and increasing the potential for scouring of pollutants during periods of high flow.

Inspection and Maintenance Frequency
The PerkFilter should be inspected on a regular basis, typically twice per year, and maintained as required. Initially, inspections of a new system should be conducted more frequently to help establish an appropriate site-specific inspection frequency. The maintenance frequency will be driven by the amount of runoff and pollutant loading encountered by a given system. In most cases, the optimum maintenance interval will be one to three years. Inspection and maintenance activities should be performed only during dry weather periods.

Inspection Equipment
The following equipment is helpful when conducting PerkFilter inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)

Inspection Procedures
PerkFilter inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded on the PerkFilter Inspection and Maintenance Log located in the PerkFilter Inspection and Maintenance Guide (link provided in the Specification Appendix) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Precast at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet pipe is blocked or obstructed. The outlet pipe is covered by a removable outlet hood and cannot be observed without entering the unit.
- Observe, quantify, and record the accumulation of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of floating oils or settled sediment is not yet warranted.
- Observe, quantify, and record the accumulation of oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe, quantify, and record the average accumulation of sediment in the inlet chamber and treatment chamber. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment in each chamber. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the PerkFilter to the top of the accumulated sediment and the measurement from the rim of the PerkFilter to the bottom of the PerkFilter structure. Finding the top of the accumulated sediment below standing water takes some practice and a light touch, but

increased resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.

- Finally, observe, quantify, and record the amount of standing water in the treatment chamber around the cartridges. If standing water is present, do not include the depth of sediment that may have settled out below the standing water in the measurement.

Maintenance Triggers

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the inlet chamber is significant.
- There is more than 6" of accumulated sediment in the inlet chamber.
- There is more than 4" of accumulated sediment in the treatment chamber.
- There is more than 4" of standing water in the treatment chamber more than 24 hours after end of rain event.
- A hazardous material release (e.g. automotive fluids) is observed or reported.
- The system has not been maintained for 3 years (wet climates) to 5 years (dry climates).

Maintenance Equipment

The following equipment is helpful when conducting PerkFilter maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.) • Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- 9/16" socket and wrench to remove hold-down struts and filter cartridge tops
- Replacement filter cartridges
- Vacuum truck with water supply and water jet

Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain vault and manhole PerkFilter configurations. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Confined space entry is not required for catch basin PerkFilter configurations. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove floating trash, debris, and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be refilled with water after maintenance is complete. The system will fill with water when the next storm event occurs.
- Remove the hold-down strut from each row of filter cartridges and then remove the top of each cartridge (the top is held on by four 9/16" bolts) and use the vacuum truck to evacuate the spent media. When empty, the spent cartridges may be easily lifted off their slip couplers and removed from the vault. The couplers may be left inserted into couplings cast into the false floor to prevent sediment and debris from being washed into the outlet chamber during wash-down.
- Once all the spent cartridges have been removed from the structure, the vacuum truck may be used to evacuate all accumulated sediment from the treatment chamber. Some jetting may be required to fully remove sediment. Take care not to wash sediment and debris through the openings in the false floor and into the outlet chamber. All material removed from the PerkFilter during maintenance including the spent media must be disposed of in accordance with local, state, and/or federal regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sump catch basins or manholes.
- Place a fresh cartridge in each cartridge position using the existing slip couplers and urethane bottom caps. If the vault is equipped with stacked cartridges, the existing outer and inner interconnector couplers must be used between the stacked cartridges to provide hydraulic connection. Transfer the existing vent tubes from the spent cartridges to the fresh cartridges. Finally, refit the struts to hold the fresh cartridges in place.
- Securely replace access covers, as appropriate.
- Arrange to return the empty spent cartridges to Oldcastle Infrastructure.

7. Statements

The following pages are signed statements from the manufacture Oldcastle Infrastructure (formerly Oldcastle Precast Stormwater), University of Florida (independent testing laboratory) and NJCAT. These statements are required as part of the verification process.

Oldcastle Precast®

5331 SW Macadam Ave., #376
Portland, OR 97239

March 17, 2017

Dr. Richard Magee, Sc.D, P.E., BCEE
Executive 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: Verification of PerkFilter according to NJDEP Filtration Laboratory Testing Protocol

Dear Dr. Magee,

Performance of the PerkFilter stormwater quality system by Oldcastle Precast Stormwater was recently verified according to the NJDEP filtration laboratory testing protocol by the research staff at the University of Florida in Gainesville, Florida. Based on work with the University of Florida staff, observations during testing, and review of the University's test report and appendices, Oldcastle Precast Stormwater believes that all applicable testing protocol requirements were met or exceeded. Additionally, we believe that all the required documentation has been provided to support verification of the PerkFilter.

Please contact me if you have any questions or concerns. Thank you.

Jay Holtz, PE
Director of Engineering
Oldcastle Precast Stormwater
971-271-0796
jay.holtz@oldcatlestormwater.com

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Engineering School of Sustainable Infrastructure and Environment
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01 March 2017

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

Subject: Physical model testing of the Oldcastle PerkFilter System

The University of Florida was contracted by Oldcastle Precast to conduct full-scale physical model performance testing verification of the Oldcastle PerkFilter in accordance with New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January, 2013).

The University of Florida is an independent research and academic institution in Gainesville, Florida. I certify that we have evaluated the Oldcastle PerkFilter SK-0840 in the Spring and Summer of 2016 according to the aforementioned protocol. The results presented in the NJCAT Verification Report dated 16 January 2017 are accurate and all procedures and requirements stated in the test protocol were met or exceeded. The University of Florida has no vested interest in the test results or financial conflict of interest in providing independent research and associated testing to Oldcastle Precast.

Thank you,

Professor John Sansalone, PhD, PE
Email: jsansal@ufl.edu
Phone: +352.846.0176

Center for Environmental Systems

Stevens Institute of Technology

One Castle Point

Hoboken, NJ 07030-0000

March 20, 2017

James J. Murphy, Chief
NJDEP
Division of Water Quality
Bureau of Non-Point Pollution Control
401-02B
PO Box 420
Trenton, NJ 08625-0420

Dear Mr. Murphy,

Based on my review, evaluation and assessment of the testing conducted on the Oldcastle PerkFilter™ System at the University of Florida by Prof. John Sansalone, PhD, PE, the test protocol requirements contained in the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device" (NJDEP Filtration Protocol, January 2013) were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of the PerkFilter test sediments comply with the PSD criteria established by the NJDEP Filtration protocol. The PerkFilter removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be slightly finer than the sediment blend specified by the protocol (<75µm); the test sediment d_{50} was approximately 74 microns. The identical sediment was used for the scour testing, which was much finer than required by the NJDEP protocol.

Removal Efficiency Testing

Ten (10) removal efficiency testing runs were completed in accordance with the NJDEP test protocol. The target flow rate and influent sediment concentration were 60 gpm and 200 mg/L respectively. The PerkFilter demonstrated an average sediment removal efficiency on a mass basis of 85.9% over the course of the 10 test runs.

Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency testing. Mass loading test runs were conducted using identical testing procedures and targets as those used in the removal efficiency runs, the only change was to increase the target influent concentration to 400 mg/L after test run 10. Testing concluded after 24 test runs. The system did not occlude or reach maximum driving head during the test process, but the average mass removal efficiency dropped below 80% after run 23 so testing was suspended and deemed complete as per the QAPP and protocol.

The total influent mass loaded through run 23 was 106.7 lbs (48.39 kg) and the total mass captured by the PerkFilter was 85.8 lbs (38.9 kg). This is equivalent to a sediment mass loading capacity of 3.64 lbs/ft^2 of filtration area.

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

Scour Testing

Scour testing was conducted based on Section 4 of the NJDEP Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (NJDEP, 2013). Testing was conducted at a target flow rate of 120 gpm, 200% of the maximum treatment flow rate (MTFR). The cartridge filters were removed from the PerkFilter after completion of the sediment mass loading capacity testing. The PerkFilter was completely cleaned and all sediment recovered and quantified gravimetrically. The filter cartridges were replaced and dry sediment identical to the sediment used for removal efficiency testing was pre-loaded into the clean PerkFilter to the manufacturer's specified depth for eventual scour testing. The mean adjusted effluent concentration was 16.5 mg/L, qualifying the PerkFilter for on-line installation.

Sincerely,

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

8. References

1. 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*. January 25, 2013.

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

3. University of Florida, January 16, 2017, *NJCAT Technology Verification of the Oldcastle PerkFilter™ System by the University of Florida.*

VERIFICATION APPENDIX

Introduction

- Manufacturer: Oldcastle Infrastructure, 7000 Central Parkway, Suite 800, Atlanta, GA 30328. *Phone*: 800-579-8819. *Website:* www.oldcastleintrastructure.com

- MTD: Oldcastle PerkFilter™ System. Verified PerkFilter™ models are shown in **Table A-1.**

- TSS Removal Rate: 80%

- On-line installation for up to 200% of the MTFR.

Detailed Specification

- **Table A-1** includes PerkFilter models and New Jersey treatment capabilities. **Table A-2** lists the PerkFilter model standard dimensions including the sedimentation areas and the wet volumes. **Table A-3** includes PerkFilter model scaling ratios, while **Table A-4** lists PerkFilter cartridge heights and New Jersey cartridge treatment capabilities.

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

- Each cartridge stack's drain down flow is regulated by two drain down orifice openings (3/16-inch diameter each), sized so that an empty bed (clean) filter drains down in about 40 minutes.

- Driving head remained constant at 34 -34.125 inches throughout the 24 runs.

- The PerkFilter Inspection and Maintenance Guide is available at: https://oldcastleinfrastructure.com/wp-content/uploads/2018/10/OSS_PerkFilter_InspMaint_Feb-2019_v1.pdf

- According to N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow the PerkFilter™ system to be used in series with a settling chamber (such as a hydrodynamic separator) or a media filter (such as a sand filter) to achieve an enhanced TSS removal rate.

Table A-1 PerkFilter Models and New Jersey Treatment Capabilities

PerkFilter Configuration	Nominal Dimensions	Maximum Number of Cartridge Stacks	Sedimentation Area (ft^2)	Effective Filtration Treatment Area				MTFR				Maximum Drainage Area Per Configuration[1]			
				12" Cartridge (sf)	18" Cartridge (sf)	24" Cartridge (sf)	30" Cartridge (sf)	12" Cartridge (gpm)	18" Cartridge (gpm)	24" Cartridge (gpm)	30" Cartridge (gpm)	12" Cartridge (acre)	18" Cartridge (acre)	24" Cartridge (acre)	30" Cartridge (acre)
Steel Catchbasin	2' x 4'	1	5.66	4.7	7.1	9.4	11.8	12	18	24	30	0.029	0.043	0.057	0.072
	2' x 6'	2	7.40	9.4	14.1	18.8	23.6	24	36	48	60	0.057	0.086	0.114	0.143
	2' x 8'	3	9.13	14.1	21.2	28.3	35.3	36	54	72	90	0.086	0.129	0.172	0.215
	2' x 10'	4	10.86	18.8	28.3	37.7	47.1	48	72	96	120	0.114	0.172	0.229	0.286
Concrete Catchbasin	2' x 4'	1	6.14	4.7	7.1	9.4	11.8	12	18	24	30	0.029	0.043	0.057	0.072
	2' x 6'	2	8.38	9.4	14.1	18.8	23.6	24	36	48	60	0.057	0.086	0.114	0.143
	2' x 8'	3	10.61	14.1	21.2	28.3	35.3	36	54	72	90	0.086	0.129	0.172	0.215
	2' x 10'	4	12.84	18.8	28.3	37.7	47.1	48	72	96	120	0.114	0.172	0.229	0.286
Concrete Vault	2' x 4.75'	2	5.17	9.4	14.1	18.8	23.6	24	36	48	60	0.057	0.086	0.114	0.143
	4' x 6'	3	15.82	14.1	21.2	28.3	35.3	36	54	72	90	0.086	0.129	0.172	0.215
	4' x 8'	5	20.29	23.6	35.3	47.1	58.9	60	90	120	150	0.143	0.215	0.286	0.358
	6' x 8'	8	28.14	37.7	56.5	75.4	94.2	96	144	192	240	0.229	0.343	0.458	0.572
	6' x 12'	14	41.54	66.0	99.0	131.9	164.9	168	252	336	420	0.400	0.601	0.801	1.001
	8' x 16'	27	72.02	127.2	190.9	254.5	318.1	324	486	648	810	0.772	1.158	1.544	1.931
	8' x 18'	31	80.96	146.1	219.1	292.2	365.2	372	558	744	930	0.887	1.330	1.773	2.217
Concrete Manhole	48"	2	6.71	9.4	14.1	18.8	23.6	24	36	48	60	0.057	0.086	0.114	0.143
	60"	3	11.81	14.1	21.2	28.3	35.3	36	54	72	90	0.086	0.129	0.172	0.215
	72"	5	16.41	23.6	35.3	47.1	58.9	60	90	120	150	0.143	0.215	0.286	0.358
	84"	7	22.40	33.0	49.5	66.0	82.5	84	126	168	210	0.200	0.300	0.400	0.501
	96"	10	28.70	47.1	70.7	94.2	117.8	120	180	240	300	0.286	0.429	0.572	0.715

[1] Based on sediment mass loading capacity of 3.64 lb/ft^2 (filtration area)

Table A-2 PerkFilter Model Standard Dimensions

PerkFilter Configuration	Nominal Dimensions	Maximum Number of Cartridge Stacks	Inlet Chamber							Cartridge Chamber						
			Length (ft)	Width (ft)	Sediment Area[1] (sf)	Wet Volume				Length (ft)	Width (ft)	Sediment Area[2] (sf)	Wet Volume			
						12" Cartridge (cf)	18" Cartridge (cf)	24" Cartridge (cf)	30" Cartridge (cf)				12" Cartridge (cf)	18" Cartridge (cf)	24" Cartridge (cf)	30" Cartridge (cf)
Steel Catchbasin	2' x 4'	1	2.17	1.58	3.43	4.11	6.11	8.93	10.93	2.00	2.00	2.23	2.68	3.98	5.81	7.12
	2' x 6'	2	2.17	1.58	3.43	4.11	6.11	8.93	10.93	3.75	2.00	3.97	4.75	7.07	10.33	12.64
	2' x 8'	3	2.17	1.58	3.43	4.11	6.11	8.93	10.93	5.50	2.00	5.70	6.83	10.15	14.84	18.16
	2' x 10'	4	2.17	1.58	3.43	4.11	6.11	8.93	10.93	7.25	2.00	7.43	8.91	13.24	19.35	23.69
Concrete Catchbasin	2' x 4'	1	2.47	1.58	3.91	4.69	6.97	10.19	12.47	2.00	2.00	2.23	2.68	3.98	5.81	7.12
	2' x 6'	2	2.47	1.58	3.91	4.69	6.97	10.19	12.47	4.00	2.00	4.47	5.35	7.96	11.63	14.23
	2' x 8'	3	2.47	1.58	3.91	4.69	6.97	10.19	12.47	6.00	2.00	6.70	8.03	11.93	17.44	21.35
	2' x 10'	4	2.47	1.58	3.91	4.69	6.97	10.19	12.47	8.00	2.00	8.93	10.70	15.91	23.26	28.47
Concrete Vault	2' x 4.75'	2	0.83	2.00	1.47	1.76	2.62	3.83	4.17	3.67	2.00	3.70	4.43	6.59	9.64	10.49
	4' x 6'	3	2.00	4.00	7.21	8.65	12.85	18.79	23.00	3.75	4.00	8.61	10.31	15.34	22.42	27.44
	4' x 8'	5	2.25	4.00	8.21	9.84	14.64	21.39	26.18	5.50	4.00	12.07	14.47	21.51	31.44	38.48
	6' x 8'	8	2.25	6.00	11.73	14.06	20.90	30.55	37.40	5.50	6.00	16.41	19.66	29.23	42.73	52.30
	6' x 12'	14	2.75	6.00	14.73	17.65	26.25	38.37	46.96	9.00	6.00	26.81	32.12	47.76	69.81	85.44
	8' x 16'	27	3.17	8.00	22.19	26.59	39.54	57.79	70.74	12.50	8.00	49.83	59.72	88.79	129.77	158.84
	8' x 18'	31	3.42	8.00	24.19	28.99	43.10	63.00	77.11	14.25	8.00	56.76	68.02	101.13	147.82	180.94
Concrete Manhole	48"	2	*Portion of circle*		3.47	4.16	6.19	9.05	11.07	*Portion of circle*		3.24	3.88	5.76	8.43	10.31
	60"	3	*Portion of circle*		4.00	4.80	7.13	10.43	12.76	*Portion of circle*		7.81	9.36	13.91	20.33	24.89
	72"	5	*Portion of circle*		7.90	9.47	14.08	20.58	25.18	*Portion of circle*		8.50	10.19	15.15	22.15	27.11
	84"	7	*Portion of circle*		8.72	10.45	15.54	22.71	27.80	*Portion of circle*		13.68	16.39	24.37	35.62	43.60
	96"	10	*Portion of circle*		9.48	11.36	16.89	24.69	30.22	*Portion of circle*		19.22	23.03	34.24	50.05	61.26

[1] Does not include footprint of bypass weir pipe

[2] Does not include footprint of cartridge(s) or outlet vent pipe

Table A-3 PerkFilter Model Scaling Ratios

PerkFilter Configuration	Nominal Dimensions	Maximum Number of Cartridge Stacks	Effective Filtration Treatment Area				MTFR				Total Effective Sedimentation Area (sf)	Total Wet Volume				Ratio MTFR to EFTA				Ratio ESA to EFTA				Ratio WV to EFTA			
			12" Cartridge (sf)	18" Cartridge (sf)	24" Cartridge (sf)	30" Cartridge (sf)	12" Cartridge (gpm)	18" Cartridge (gpm)	24" Cartridge (gpm)	30" Cartridge (gpm)		12" Cartridge (cf)	18" Cartridge (cf)	24" Cartridge (cf)	30" Cartridge (cf)	12" Cartridge (sf)	18" Cartridge (sf)	24" Cartridge (sf)	30" Cartridge (sf)	12" Cartridge (sf)	18" Cartridge (sf)	24" Cartridge (sf)	30" Cartridge (sf)	12" Cartridge (sf)	18" Cartridge (sf)	24" Cartridge (sf)	30" Cartridge (sf)
Steel Catchbasin	2' x 4'	1	4.7	7.1	9.4	11.8	12	18	24	30	5.66	6.79	10.09	14.75	18.05	2.55	2.55	2.55	2.55	1.20	0.80	0.60	0.48	1.44	1.43	1.56	1.53
	2' x 6'	2	9.4	14.1	18.8	23.6	24	36	48	60	7.40	8.86	13.18	19.26	23.58	2.55	2.55	2.55	2.55	0.78	0.52	0.39	0.31	0.94	0.93	1.02	1.00
	2' x 8'	3	14.1	21.2	28.3	35.3	36	54	72	90	9.13	10.94	16.27	23.77	29.10	2.55	2.55	2.55	2.55	0.65	0.43	0.32	0.26	0.77	0.77	0.84	0.82
	2' x 10'	4	18.8	28.3	37.7	47.1	48	72	96	120	10.86	13.02	19.35	28.29	34.62	2.55	2.55	2.55	2.55	0.58	0.38	0.29	0.23	0.69	0.68	0.75	0.73
Concrete Catchbasin	2' x 4'	1	4.7	7.1	9.4	11.8	12	18	24	30	6.14	7.36	10.95	16.00	19.58	2.55	2.55	2.55	2.55	1.30	0.87	0.65	0.52	1.56	1.55	1.70	1.66
	2' x 6'	2	9.4	14.1	18.8	23.6	24	36	48	60	8.38	10.04	14.93	21.82	26.70	2.55	2.55	2.55	2.55	0.89	0.59	0.44	0.36	1.07	1.06	1.16	1.13
	2' x 8'	3	14.1	21.2	28.3	35.3	36	54	72	90	10.61	12.71	18.90	27.63	33.82	2.55	2.55	2.55	2.55	0.75	0.50	0.38	0.30	0.90	0.89	0.98	0.96
	2' x 10'	4	18.8	28.3	37.7	47.1	48	72	96	120	12.84	15.39	22.88	33.44	40.94	2.55	2.55	2.55	2.55	0.68	0.45	0.34	0.27	0.82	0.81	0.89	0.87
Concrete Vault	2' x 4.75'	2	9.4	14.1	18.8	23.6	24	36	48	60	5.17	6.20	9.21	13.47	14.65	2.55	2.55	2.55	2.55	0.55	0.37	0.27	0.22	0.66	0.65	0.71	0.62
	4' x 6'	3	14.1	21.2	28.3	35.3	36	54	72	90	15.82	18.96	28.19	41.20	50.43	2.55	2.55	2.55	2.55	1.12	0.75	0.56	0.45	1.34	1.33	1.46	1.43
	4' x 8'	5	23.6	35.3	47.1	58.9	60	90	120	150	20.29	24.31	36.15	52.83	64.67	2.55	2.55	2.55	2.55	0.86	0.57	0.43	0.34	1.03	1.02	1.12	1.10
	6' x 8'	8	37.7	56.5	75.4	94.2	96	144	192	240	28.14	33.72	50.14	73.28	89.70	2.55	2.55	2.55	2.55	0.75	0.50	0.37	0.30	0.89	0.89	0.97	0.95
	6' x 12'	14	66.0	99.0	131.9	164.9	168	252	336	420	41.54	49.78	74.01	108.17	132.40	2.55	2.55	2.55	2.55	0.63	0.42	0.31	0.25	0.75	0.75	0.82	0.80
	8' x 16'	27	127.2	190.9	254.5	318.1	324	486	648	810	72.02	86.31	128.32	187.56	229.58	2.55	2.55	2.55	2.55	0.57	0.38	0.28	0.23	0.68	0.67	0.74	0.72
	8' x 18'	31	146.1	219.1	292.2	365.2	372	558	744	930	80.96	97.01	144.24	210.82	258.05	2.55	2.55	2.55	2.55	0.55	0.37	0.28	0.22	0.66	0.66	0.72	0.71
Concrete Manhole	48"	2	9.4	14.1	18.8	23.6	24	36	48	60	6.71	8.04	11.95	17.47	21.39	2.55	2.55	2.55	2.55	0.71	0.47	0.36	0.28	0.85	0.85	0.93	0.91
	60"	3	14.1	21.2	28.3	35.3	36	54	72	90	11.81	14.15	21.05	30.76	37.65	2.55	2.55	2.55	2.55	0.84	0.56	0.42	0.33	1.00	0.99	1.09	1.07
	72"	5	23.6	35.3	47.1	58.9	60	90	120	150	16.41	19.66	29.23	42.72	52.29	2.55	2.55	2.55	2.55	0.70	0.46	0.35	0.28	0.83	0.83	0.91	0.89
	84"	7	33.0	49.5	66.0	82.5	84	126	168	210	22.40	26.84	39.91	58.34	71.40	2.55	2.55	2.55	2.55	0.68	0.45	0.34	0.27	0.81	0.81	0.88	0.87
	96"	10	47.1	70.7	94.2	117.8	120	180	240	300	28.70	34.39	51.13	74.74	91.48	2.55	2.55	2.55	2.55	0.61	0.41	0.30	0.24	0.73	0.72	0.79	0.78

A-4 PerkFilter Cartridge Heights and New Jersey Cartridge Treatment Capabilities

PerkFilter Cartridge Height	Filtration Treatment Area (ft^2)	MTFR (gpm)[1]	Mass Capture Capacity (lb)[2]	Max Allowable Inflow Area (acres)[3]
12"	4.7	12	17.2	0.029
18"	7.1	18	25.7	0.043
24"	9.4	24	34.3	0.057
30"	11.8	30	42.9	0.072

[1] Based on surface loading rate of 2.54 gpm/ft^2

[2] Based on sediment mass loading capacity of 3.64 lb/ft^2 filtration treatment area

[3] Based on calculation of 600 lbs of sediment per acre annually