

NJCAT TECHNOLOGY VERIFICATION

Arcadia™ Hydrodynamic Separator

Advanced Drainage Systems, Inc.

May 2025

**(Addendum for Alternative Configurations begins on
page 42)**

Table of Contents

List of Figures	ii
List of Tables	iii
1. Description of Technology	1
2. Laboratory Testing	3
2.1 Test Setup	3
2.2 Test Sediment	5
2.3 Sediment Removal Efficiency Testing	7
2.4 Scour Testing	8
2.5 Hydraulic Testing	9
2.6 Laboratory Proficiency	9
3. Performance Claims	9
4. Supporting Documentation	10
4.1 Removal Efficiency Results	11
4.1.1 10% of Target MTFR	12
4.1.2 25% of Target MTFR	14
4.1.3 50% of Target MTFR	16
4.1.4 75% of Target MTFR	18
4.1.5 100% of Target MTFR	20
4.1.6 125% of Target MTFR	22
4.1.7 150% of Target MTFR	24
4.2 Scour Testing	25
4.3 Hydraulic Testing	27
5. Design Limitations	28
6. Maintenance	29
7. Statements	31
8. References	37
VERIFICATION APPENDIX	38

List of Figures

Figure 1 Profile View of the Arcadia Test Unit, Including False Floor Positions.....	1
Figure 2 Plan View of Arcadia	2
Figure 3 Diagram of Arcadia Indicating Flow Path	2
Figure 4 Diagram of Arcadia Noting Sediment Drain	3
Figure 5 Arcadia ARC4 Test Unit Effluent Sampling Area, Sediment Dosing Port, and Background Sampling Area.....	4
Figure 6 Schematic of the Arcadia Test Configuration	4
Figure 7 Average PSD of Removal Efficiency Sediment vs NJDEP Protocol Specification	6
Figure 8 Average PSD of Scour Sediment vs NJDEP Protocol Specification	7
Figure 9 Removal Efficiency vs Flow Rate	12

List of Tables

Table 1 Particle Size Distribution Results of Removal Efficiency Test Sediment Samples	5
Table 2 Particle Size Distribution Results of Scour Sediment Samples	6
Table 3 Laboratory Proficiency SSC Results	9
Table 4 Summarized Removal Efficiency from Captured Sediment	11
Table 5 Calculated Removal Efficiency Results Summary	12
Table 6 Sample Schedule: 10% MTFR	12
Table 7 Flow: 10% MTFR.....	13
Table 8 Temperature: 10% MTFR	13
Table 9 Background SSC: 10% MTFR	13
Table 10 Sediment Feed: 10% MTFR	13
Table 11 Sediment Injected: 10% MTFR	14
Table 12 Sample Schedule: 25% MTFR	14
Table 13 Flow: 25% MTFR.....	14
Table 14 Temperature: 25% MTFR	14
Table 15 Background SSC: 25% MTFR	15
Table 16 Sediment Feed: 25% MTFR	15
Table 17 Sediment Injected: 25% MTFR	15
Table 18 Sample Schedule: 50% MTFR	16
Table 19 Flow: 50% MTFR.....	16
Table 20 Temperature: 50% MTFR	16
Table 21 Background SSC: 50% MTFR	16
Table 22 Sediment Feed: 50% MTFR	17
Table 23 Sediment Injected: 50% MTFR	17
Table 24 Sample Schedule: 75% MTFR	18
Table 25 Flow: 75% MTFR.....	18
Table 26 Temperature: 75% MTFR	18
Table 27 Background SSC: 75% MTFR	18
Table 28 Sediment Feed: 75% MTFR.....	19
Table 29 Sediment Injected: 75% MTFR	19
Table 30 Sample Schedule: 100% MTFR	20
Table 31 Flow: 100% MTFR.....	20
Table 32 Temperature: 100% MTFR	20
Table 33 Background SSC: 100% MTFR	20
Table 34 Sediment Feed: 100% MTFR	21
Table 35 Sediment Injected: 100% MTFR.....	21
Table 36 Sample Schedule: 125% MTFR	22
Table 37 Flow: 125% MTFR	22
Table 38 Temperature: 125% MTFR.....	22
Table 39 Background SSC: 125% MTFR	22
Table 40 Sediment Feed: 125% MTFR	23
Table 41 Sediment Injected: 125% MTFR	23
Table 42 Sample Schedule: 150% MTFR	24
Table 43 Flow: 150% MTFR.....	24
Table 44 Temperature: 150% MTFR	24

List of Tables, Continued

Table 45 Background SSC: 150% MTFR	24
Table 46 Sediment Feed: 150% MTFR	25
Table 47 Sediment Injected:150% MTFR	25
Table 48 Sample Schedule: Scour	26
Table 49 Flow: Scour	26
Table 50 Temperature: Scour	26
Table 51 SSC: Scour	27
Table 52 Head and Head Loss	27
Table A-1 MTFRs and Sediment Removal Intervals for Arcadia Model	40
Table A-2 Standard Dimensions for Arcadia Models.....	41

1. Description of Technology

Advanced Drainage Systems' (ADS) Arcadia™ hydrodynamic separator (Arcadia) is a stormwater treatment device that removes suspended solids from stormwater. The internal components, molded from either polyethylene or polypropylene, can be typically installed in either a precast concrete manhole or a polypropylene manhole. In Arcadia, stormwater is directed to an inlet chamber inside the unit, which then directs the flow into the vertical cylinder. A weir separates the inlet chamber from the outlet chamber. Once water has flowed through the inlet chamber and down through the vertical cylinder to the sump, the water rises through a series of angled baffles up to the outlet pipe. The angled baffles have concentric openings, alternating in location between the outer wall and the vertical cylinder, causing the water to flow upward in a circuitous path, which enhances settling and reduces resuspension. The inlet chamber is equipped with a sediment drain opening that directs sediment into the sump during operation. The dimensions, components, and flow path of the ADS Arcadia are shown in **Figures 1 – 4**.

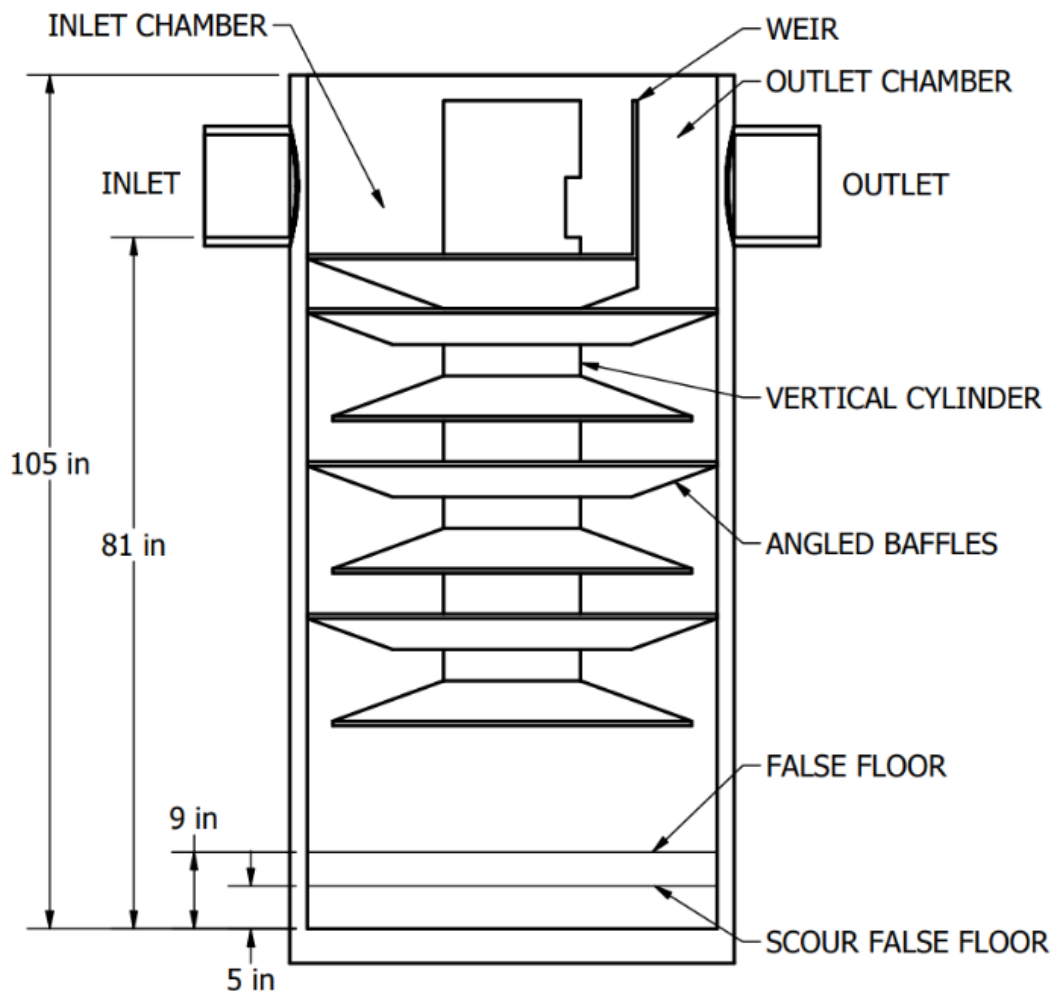


Figure 1 Profile View of the Arcadia Test Unit, Including False Floor Positions

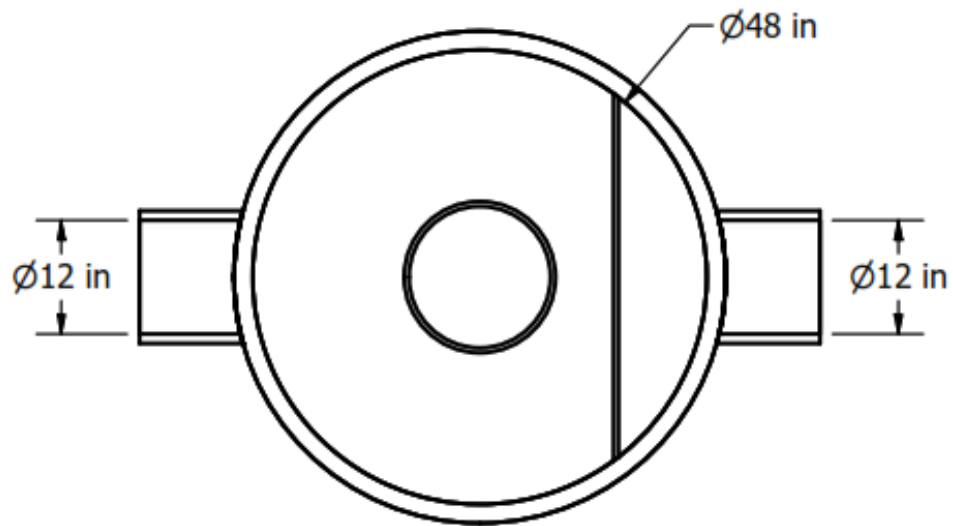


Figure 2 Plan View of Arcadia

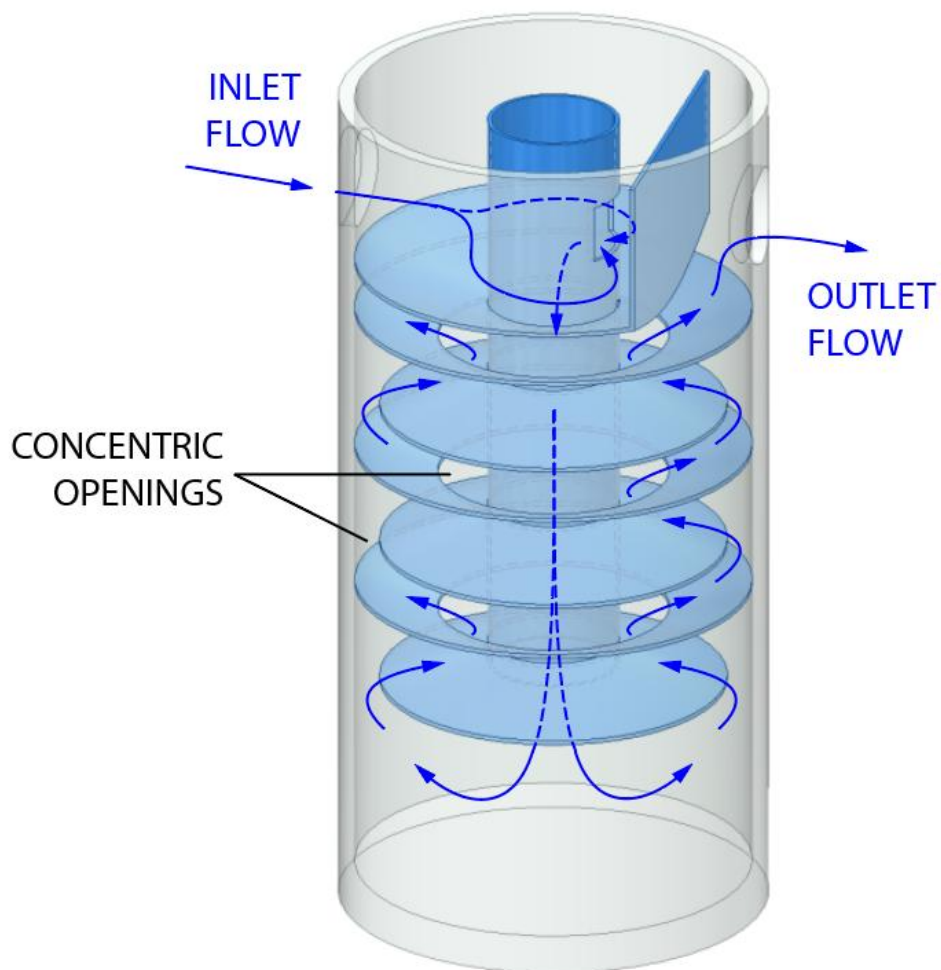


Figure 3 Diagram of Arcadia Indicating Flow Path

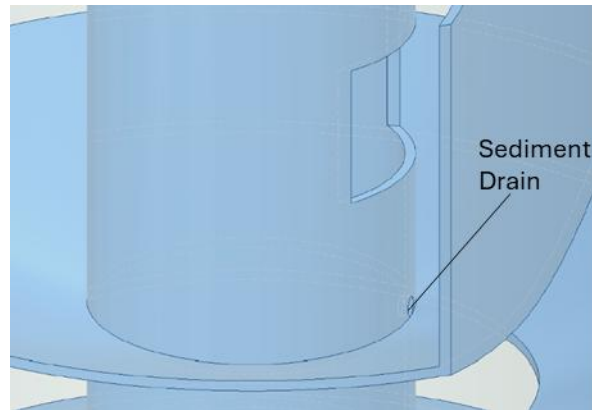


Figure 4 Diagram of Arcadia Noting Sediment Drain

2. Laboratory Testing

All testing disclosed in this report was performed in accordance with the New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device (NJDEP Protocol) dated January 1, 2021, last updated April 25, 2023. The NJDEP approval process requires submittal of a Quality Assurance Project Plan (QAPP) to the New Jersey Corporation for Advanced Technology (NJCAT) for review and approval prior to testing to ensure that all laboratory procedures will be conducted in strict accordance with the NJDEP Protocol. The QAPP was submitted and approved by NJCAT in November of 2024, prior to commencement of testing.

All removal efficiency and scour testing for this project was carried out at ADS's Engineering and Technology Center Hydraulics Laboratory, located in Hilliard, OH, in December of 2024 and January of 2025. Independent third-party observation was provided by Sustainable Stormwater Solutions Engineering (SSSE), in accordance with the NJDEP Protocol. All water quality samples collected during the test program were analyzed by Fredericktowne Labs, which is a NELAP-accredited independent environmental testing laboratory located in Myersville, MD. All sediment PSD samples were analyzed by GeoTesting Express, which is an independent geotechnical and environmental testing facility located in Acton, MA.

2.1 Test Setup

The test unit is a full-scale commercially available Arcadia ARC4 unit (4 ft diameter), shown in **Figures 1 and 2**. Influent and effluent piping to the Arcadia unit were 12-inches in diameter and at the same inlet/outlet elevations. The inlet pipe slope was approximately 3%. For removal efficiency testing, the false floor was set to allow for simulation of the 50% maximum sediment storage volume. For scour testing, the false floor was set to allow for four inches of sediment to be pre-loaded to the 50% maximum sediment storage volume. The test unit dimensions shown in **Figures 1 and 2** were confirmed by SSSE prior to testing.

A schematic of the closed-loop recirculating test configuration is shown in **Figure 5**. Flow rate was controlled using a Bell & Gossett e-1510 5EB pump and an Emerson Keystone 22L0250 control valve. The VFD control system automatically adjusted the pump speed and control valve

position to achieve the desired flow rate from the source tank. The flow rates were measured upstream of the test unit using either a 4-inch Emerson Magnetic 8750 flow meter or 10-inch Emerson Magnetic 8750 flow meter. The water temperature in the source tank was measured using a Rosemount 214A Temperature Sensor. All flow rate and temperature data were recorded in one-minute intervals. Test sediment was dry fed by a Coperion K-tron gravimetric screw doser through an 8-inch port at the crown of the 12-inch diameter influent pipe at a distance of 34 inches upstream of the test unit. The water flowed through the inlet chamber and lower internal structure of the test unit, and the effluent was discharged into the outfall. The effluent flowed to an underground settling tank, through a pressurized filter bag system, and was returned to the source tank.

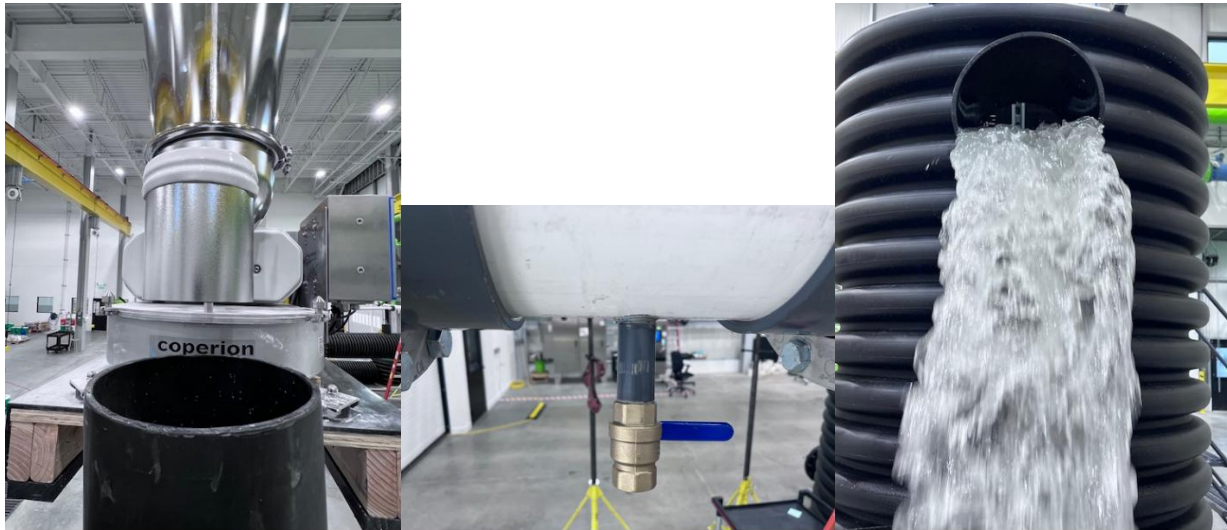


Figure 5 Arcadia ARC4 Test Unit Effluent Sampling Area, Sediment Dosing Port, and Background Sampling Area

Sediment calibration sample collection occurred at the sediment dosing port. Background TSS (SSC) sample collection occurred approximately 22 feet upstream of the sediment dosing port. Background samples were a minimum of 500 mL.

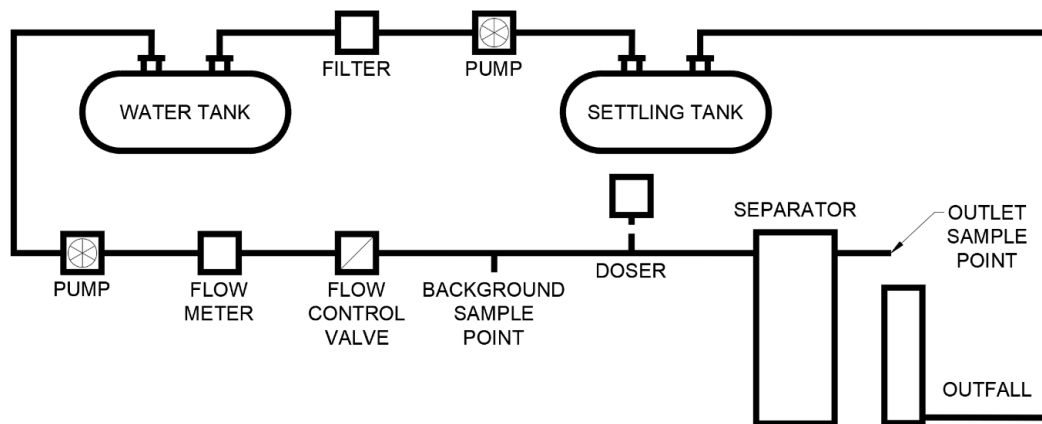


Figure 6 Schematic of the Arcadia Test Configuration

2.2 Test Sediment

The test sediment for removal efficiency testing was a blend of commercially available silica sand grades supplied by AGSCO Corporation and US Silica Company. The particle size distribution was independently verified by GeoTesting Express (A2LA, AASHTO, and USACE accredited and certified for ASTM D6913 and D7928 by the State of Massachusetts) to show that the test sediment blend meets the specification as described in Section 4A of the Protocol.

The sediment blend was mixed by ADS and stored in sealed containers. SSSE observed the collection of three representative samples composited from each of the containers prior to the start of testing. Results of particle size gradation testing are shown in **Table 1** and **Figure 6** below. The D50 of this blend was 74 microns.

The moisture content of the test sediment was determined in accordance with ASTM D2216 “Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.” The moisture content was found to be 0.1%.

Table 1 Particle Size Distribution Results of Removal Efficiency Test Sediment Samples

Particle Size (um)	% Finer				Test Sediment Average	NJDEP Specification (minimum % passing)
	NJDEP Protocol	Sample 1	Sample 2	Sample 3		
1000	100	100	100	100	100	98
500	95	95	95	95	95	93
250	90	90	89	90	90	88
150	75	75	77	77	76	73
100	60	56	59	59	58	58
75	50	50	50	51	50	50
50	45	47	46	48	47	43
20	35	35	33	35	34	33
8	20	18	18	18	18	18
5	10	12	11	13	12	8
2	5	4	4	5	4	3

Note: Data for specific particle sizes (500um, 100um, 50 um and smaller) were found via linear interpolation of GeoTesting Express’ data.

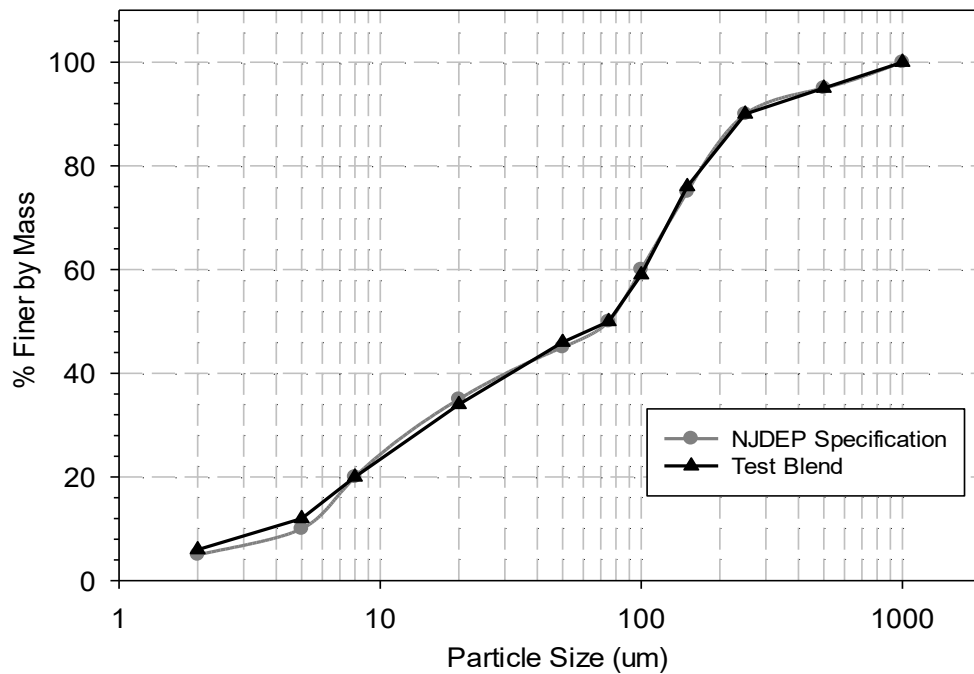


Figure 7 Average PSD of Removal Efficiency Sediment vs NJDEP Protocol Specification

The scour sediment was a blend of commercially available silica sand grades supplied by AGSCO Corporation. The particle size distribution was independently confirmed by GeoTesting Express to show that the test sediment blend meets the specification as described in Section 4A of the Protocol. The sediment blend was mixed by ADS and stored in sealed containers. SSSE observed the collection of three representative samples composited from each of the containers prior to the start of scour testing. A Chain of Custody (COC) form was used for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory. Results of particle size gradation testing are shown in **Table 2** and **Figure 7** below.

Table 2 Particle Size Distribution Results of Scour Sediment Samples

Particle Size (um)	% Finer				Test Sediment Average	NJDEP Specification (minimum % passing)
	NJDEP Protocol	Sample 1	Sample 2	Sample 3		
1000	100	100	100	100	100	98
500	90	96	96	96	96	88
250	55	64	63	62	63	53
150	40	51	48	49	49	38
100	25	34	28	33	32	23
75	10	16	15	16	16	8
5	0	9	9	9	9	0

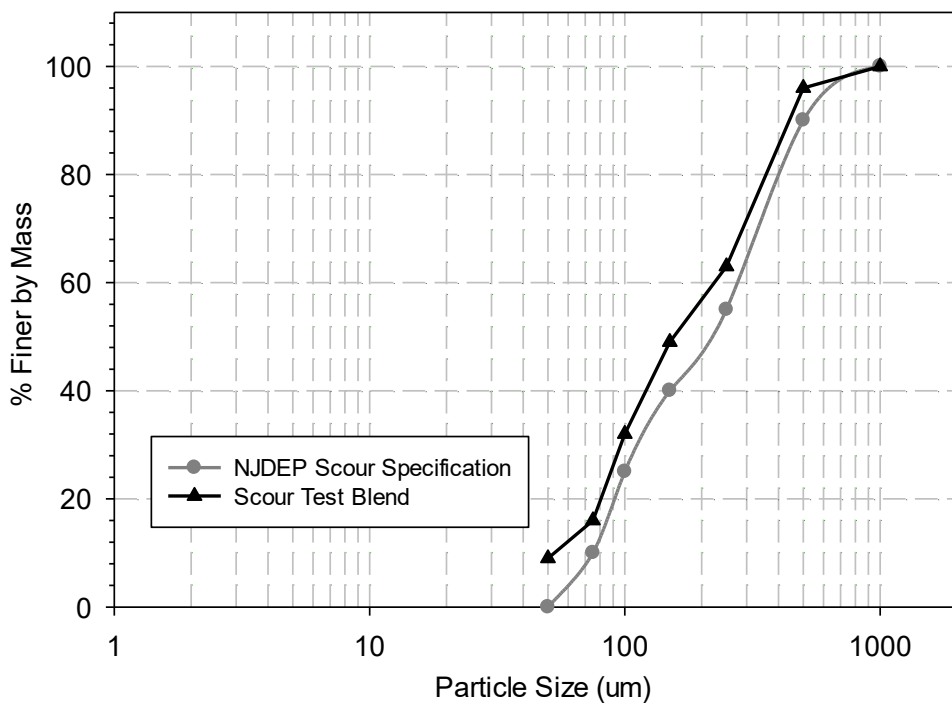


Figure 8 Average PSD of Scour Sediment vs NJDEP Protocol Specification

2.3 Sediment Removal Efficiency Testing

Removal efficiency testing was conducted using the Mass Capture Test Method in accordance with Sections 4B and 4C of the Protocol for HDS MTD's. A total of seven flow rates were tested: 10%, 25%, 50%, 75%, 100%, 125%, and 150% of the target Maximum Treatment Flow Rate (MTFR). The target MTFR was 1.5 cfs (673 gpm). The flow rate was logged once every minute. All flow rates were within 10% of the targeted value, and the coefficient of variance (COV) did not exceed 0.03. Flow continued for one detention time after sediment feed was stopped to allow for sediment that would not normally be captured to pass through the MTD. The water temperature was recorded at one-minute intervals and did not exceed 80 °F.

Background samples were collected at the background sample port upstream of the doser port. Eight background samples were taken at evenly spaced intervals during each run. Each sample was a minimum of 500 ml. A Chain of Custody (COC) form was used for each test run to record sampling date and time for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory. The background TSS concentrations did not exceed 20.0 mg/L. All background samples were analyzed by Fredericktowne Labs in accordance with ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentrations in Water Samples."

The test sediment feed rate and total mass of test sediment introduced during each test run were each a known quantity and were introduced at a rate within $\pm 10\%$ of the targeted value of 200 mg/L influent concentration. A minimum of 25 lbs of sediment was fed into the unit for every test. The total sediment introduced to the system was determined from the weights on the Coperion K-

torn D5 XPC3 scale at the beginning and end of each test. The times of sediment calibration samples, sediment feed start, sediment feed stop, and flow start/stop were recorded for every run.

Six sediment feed calibration samples were taken from the injection point at evenly spaced intervals during each test. Calibration samples were collected over timed intervals not exceeding one minute but resulting in a minimum size of 20.0 g. Each sample was weighed under the observation of SSSE. The coefficient of variance (COV) of the sediment rate calibration samples did not exceed 0.10.

After each test, the test unit was decanted by means of a sump pump. Recovered test sediment was placed into pre-weighed non-ferrous trays and dried in a vented oven until a constant weight was obtained when cooled to room temperature, as determined by two successive measurements taken no less than two hours apart which showed no more than a 0.1% difference in measured mass weighed to a precision of 10 grams. The sediment mass captured in the MTD and the inlet pipe were quantified and reported separately.

Removal efficiency was calculated for each MTFR using the following equation:

$$\text{Removal Efficiency (\%)} = \left(\frac{\text{Total Mass Collected in MTD}}{\text{Total Mass Input During Run}} \right) \times 100$$

2.4 Scour Testing

The false floor was placed 4 inches below the 50% maximum sediment storage volume and covered with 4 inches of scour test sediment. The sediment was leveled and the test unit was filled with clear water to its normal dry weather operating depth. Scour testing began within 96 hours of pre-loading the unit.

Scour testing began by conveying clear water to the unit and ramping up the flow rate until it reached 200% of the MTFR within three minutes of commencing flow. The flow rate remained constant at the target 200% MTFR rate for the remainder of the test duration. The flow rate was recorded once per minute.

A total of 15 effluent samples were taken over the duration of the test at 1, 3, and 5 minutes after commencement of conveying clear water through the MTD, and then every two minutes thereafter for an additional 12 samples (i.e., 7, 9, 11...29 minutes). The effluent samples were collected using the grab sampling method with a minimum sample volume of 500 ml.

Eight background samples were collected at evenly spaced intervals throughout the duration of the test. The background samples were drawn from the background sample port located upstream of the test unit. All background samples were a minimum volume of 500 ml. A Chain of Custody (COC) form was used for the test run to record sampling date and time for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory.

All samples were analyzed by Fredericktowne Labs in accordance with ASTM D3977-97. All background samples were less than 20.0 mg/L. All 15 adjusted effluent sample concentrations were included in the calculation of the average effluent concentration.

2.5 Hydraulic Testing

Hydraulic testing was conducted in accordance with Sections 4B of the Protocol for HDS MTD overseen by SSSE. Nine flow rates, ranging from 0.15 to 3.41 cfs, were tested, including the point of bypass. Flow rates and corresponding water levels at the inlet, outlet, and upstream of the bypass weir were measured and recorded to determine the head loss across the Arcadia unit. Testing was conducted on a clean unit, free of sediment. Flow rates were logged every minute, and water levels were recorded to an accuracy of 0.125 inches with a yardstick.

2.6 Laboratory Proficiency

Prior to the start of testing, to demonstrate laboratory proficiency in executing ASTM D3977, in accordance with Section 3B of the Protocol, under the observation of SSSE, ADS prepared six spiked SSC samples at two known concentrations -- three at 20 (± 5) mg/L, and three at 50 (± 5) mg/L -- using the same test sediment as for the removal efficiency testing. Fredericktowne Labs analyzed these samples in accordance with ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentrations in Water Samples." Results are shown in **Table 3**.

Table 3 Laboratory Proficiency SSC Results

Sample	Prepared Concentration (mg/L)	FTL Reported Concentration (mg/L)	Recovery (%)	QA/QC
A1	24.7	23.2	93.9	
A2	22.3	24.3	109.0	
A3	23.3	23.0	98.7	
		Average	100.5	PASS
B1	52.4	53.3	101.7	
B2	52.4	52.9	101.0	
B3	51.0	53.2	104.3	
		Average	102.3	PASS

The SSC recovery for both concentrations were within the required $\pm 15\%$ required by the Protocol.

3. Performance Claims

Per the NJDEP verification procedure and based on the laboratory testing conducted for the Arcadia, the following are the performance claims made by Advanced Drainage Systems, Inc.

Total Suspended Solids (TSS) Removal Efficiency

For the particle size distribution and weighted calculation method required by the NJDEP HDS Protocol, the Arcadia achieved a weighted TSS removal efficiency of 50.1% for an MTFR of 1.68 cfs.

Maximum Treatment Flow Rate (MTFR)

The MTFR for the 4-ft Arcadia was demonstrated to be 1.68 cfs (754 gpm), with a total sedimentation area of 12.57 ft², which corresponds to a surface loading rate of 60.0 gpm/ft².

Maximum Sediment Storage Depth and Volume

The maximum sediment storage depth is 18-inches, which corresponds to 18.85 ft³ of sediment storage volume for the Arcadia 4-ft model. A sediment storage depth of 9 inches corresponds to the 50% maximum sediment storage volume (9.42 ft³).

Effective Treatment and Sedimentation Area

The effective treatment and sedimentation area of the Arcadia varies with model size, as it is dependent upon the surface area of the model, which varies with diameter. The effective treatment sedimentation area of the 4-ft model of the Arcadia is 12.57 ft².

Detention Time and Volume

The Arcadia detention time depends on flow rate and model size. The Arcadia model tested had a detention time of approximately 45 seconds for a flow rate of 1.68 cfs (754 gpm). Detention time is calculated by dividing the treatment chamber wet volume by the flow rate. The wet volume is defined as the volume between the pipe invert and the false floor. However, since the operating water volume in the Arcadia increases as flow increases during testing, the 3X detention time was calculated up to the operating head for all test runs.

Online Installation

Per the results of the Scour Test shown in Section 4.2 of this report, the Arcadia qualifies for online installation.

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. This information was provided to NJCAT and is available upon request.

4.1 Removal Efficiency Results

Removal efficiency test runs were completed on the Arcadia 4-ft model at flow rates of 10%, 25%, 50%, 75%, 100%, 125% and 150% of the target MTFR (1.5 cfs), at a target average influent concentration of 200 mg/L, in accordance with the NJDEP HDS protocol. Average flow rate was determined from the data collected from the flow data logger in one-minute intervals. No background concentration exceeded the 20.0 mg/L concentration specified by the NJDEP HDS Protocol. At no point did the water temperature exceed 80 °F.

A mass balance on the system was used to calculate the sediment removal efficiencies at each flow rate. These results are summarized in **Table 4**.

The sediment removal efficiencies of the seven test runs were plotted versus flow rate to generate a removal efficiency curve (**Figure 8**), from which an MTFR was selected for which an annualized weighted removal efficiency was calculated to be at least 50.0%. The fitted curve yielded an R² value of 0.988, exceeding the Protocol requirement of 0.97.

The annualized weighted TSS removal efficiency of the 4-ft Arcadia was calculated using the fitted curve and the weighting factors provided in the NJDEP HDS protocol. The Arcadia achieved an annualized weighted removal efficiency of 50.08% at an MTFR of 1.68 cfs. The removal efficiency results are summarized in **Table 5**.

Individual test results for each flow rate tested are provided below, detailing the sample schedule, flow, temperature, and sediment measurements. All tests met the NJDEP Protocol requirements and QA/QC parameters.

Table 4 Summarized Removal Efficiency from Captured Sediment

%MTFR	10	25	50	75	100	125	150
Total Mass Injected (lb)	27.158	28.276	31.148	32.052	34.295	32.179	34.584
Total Sediment Feed Calibration samples (lb)	0.678	1.649	1.684	2.569	3.407	4.167	5.094
Sediment Retained in Inlet pipe (lb)	0.036	0.006	0.000	0.003	0.000	0.003	0.001
Sediment Feed into MTD (lb)	26.444	26.621	29.464	29.480	30.888	28.009	29.489
Sediment Captured in MTD (lb)	18.243	17.094	16.398	14.967	11.855	10.126	8.069
Removal Efficiency (%)	69.0	64.2	55.7	50.8	38.4	36.2	27.4

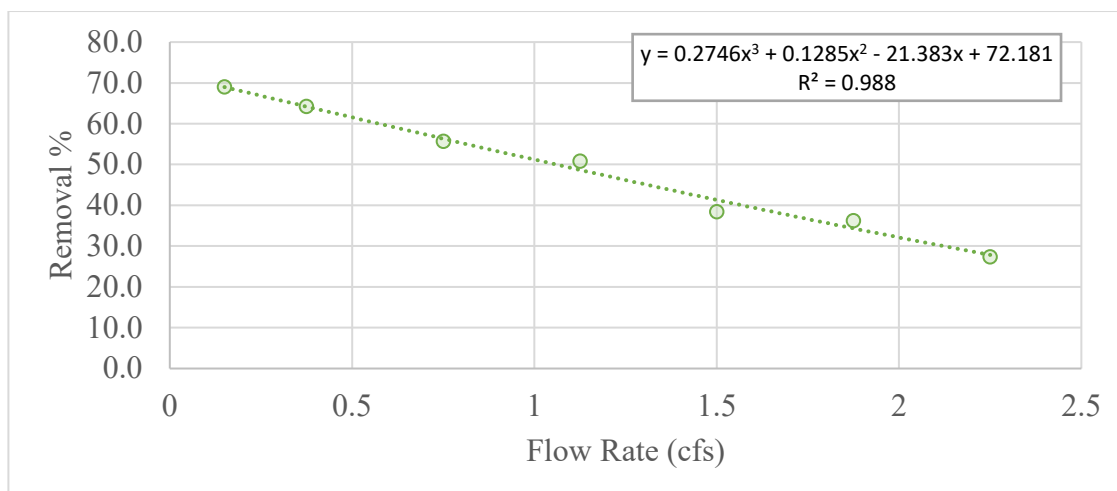


Figure 9 Removal Efficiency vs Flow Rate

Table 5 Calculated Removal Efficiency Results Summary

%MTFR	Flow Rate (cfs)	Removal Efficiency (%)	Weighting Factor	Weighted Removal (%)
25	0.42	63.24	0.25	15.81
50	0.84	54.47	0.3	16.34
75	1.26	45.99	0.2	9.20
100	1.68	37.92	0.15	5.69
125	2.10	30.39	0.1	3.04
Annualized Weighted Removal Efficiency (%)				50.08

4.1.1 10% of Target MTFR (0.15 cfs)

Table 6 Sample Schedule: 10% MTFR

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
34.5		2
48	2	
68		3
96	3	
101.5		4
135		5
144	4	
168.5		6
192	5	
202		7
235.5		8
240	6	
MTD Detention Time = 9.76 minutes		

Table 7 Flow: 10% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	0.15	0.15	PASS	0.005	PASS
gpm	67	67.0			

Table 8 Temperature: 10% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
72.9	PASS

Table 9 Background SSC: 10% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	2.6	PASS
2	1.3	PASS
3	1.7	PASS
4	1.7	PASS
5	2.2	PASS
6	2.3	PASS
7	2.6	PASS
8	3.1	PASS

Table 10 Sediment Feed: 10% MFTR

Sample #	Sediment Feed Rate (g/min)
1	51.97
2	51.45
3	50.96
4	52.54
5	49.54
6	51.04
Average	51.3
COV	0.020
QA/QC COV ≤0.10	PASS

Table 11 Sediment Injected: 10% MTFR

Sediment Mass Used (lb)	27.158
Sediment Mass Used Adjusted for Feed Samples (lb)	26.480
Water Volume During Sediment Addition (gal)	15,744
Average Sediment Concentration (mg/L)	201.5
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.2 25% of Target MTFR (0.375 cfs)**Table 12 Sampling Schedule: 25% MTFR**

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
15		2
20	2	
29		3
40	3	
43		4
57		5
60	4	
71		6
80	5	
85		7
99		8
100	6	
MTD Detention Time = 4.01 minutes		

Table 13 Flow: 25% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			$\pm 10\%$	COV	$\text{COV} \leq 0.03$
cfs	0.38	0.37	PASS	0.005	PASS
gpm	168	167.0			

Table 14 Temperature: 25% MTFR

Maximum Temperature (°F)	QA/QC
$\leq 80^{\circ}\text{F}$	
72.2	PASS

Table 15 Background SSC: 25% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	3.5	PASS
2	3.4	PASS
3	3.8	PASS
4	3.8	PASS
5	4.4	PASS
6	5.9	PASS
7	5.5	PASS
8	6.5	PASS

Table 16 Sediment Feed: 25% MFTR

Sample #	Sediment Feed Rate (g/min)
1	126.56
2	126.72
3	126.45
4	124.22
5	128.16
6	116.17
Average	124.7
COV	0.035
QA/QC COV ≤0.10	PASS

Table 17 Sediment Injected: 25% MTFR

Sediment Mass Used (lb)	28.276
Sediment Mass Used Adjusted for Feed Samples (lb)	26.627
Water Volume During Sediment Addition (gal)	15,864
Average Sediment Concentration (mg/L)	201.1
QA/QC	
Total Mass Added ≥ 25 lbs	PASS
Average Concentration within ±10% of 200 mg/L	PASS

4.1.3 50% of Target MTFR (0.75 cfs)

Table 18 Sample Schedule: 50% MTFR

Elapsed Time (minutes)	Sediment Feed Sample	Background sample
0	1	
1		1
8.5		2
11	2	
16		3
22	3	
23.5		4
31		5
33	4	
38.5		6
44	5	
46		7
53.5		8
55	6	
MTD Detention Time = 2.08 minutes		

Table 19 Flow: 50% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	0.75	0.75	PASS	0.007	PASS
gpm	337	338.1			

Table 20 Temperature: 50% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
71.3	PASS

Table 21 Background SSC: 50% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	3.2	PASS
2	3.6	PASS
3	3.6	PASS
4	3.4	PASS
5	4.8	PASS
6	4.9	PASS
7	2.7	PASS
8	2.7	PASS

Table 22 Sediment Feed: 50% MFTR

Sample #	Sediment Feed Rate (g/min)
1	248.50
2	257.51
3	252.54
4	257.80
5	256.31
6	255.68
Average	254.7
COV	0.014
QA/QC COV ≤ 0.10	PASS

Table 23 Sediment Injected: 50% MTR

Sediment Mass Used (lb)	31.148
Sediment Mass Used Adjusted for Feed Samples (lb)	29.464
Water Volume During Sediment Addition (gal)	17,748
Average Sediment Concentration (mg/L)	198.9
QA/QC	
Total Mass Added ≥ 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.4 75% of Target MTFR (1.125 cfs)

Table 24 Sampling Schedule: 75% MTFR

Elapsed Time (minutes)	Sediment Feed Sample	Background sample
0	1	
1		1
6		2
7.5	2	
11		3
15	3	
16		4
21		5
22.5	4	
26		6
30	5	
31		7
36		8
37.5	6	
MTD Detention Time = 1.46 minutes		

Table 25 Flow: 75% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	1.13	1.13	PASS	0.001	PASS
gpm	505	505.0			

Table 26 Temperature: 75% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
71.6	PASS

Table 27 Background SSC: 75% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	2.2	PASS
2	7.4	PASS
3	6.7	PASS
4	8.0	PASS
5	7.8	PASS
6	6.8	PASS
7	7.8	PASS
8	10.0	PASS

Table 28 Sediment Feed: 75% MFTR

Sample #	Sediment Feed Rate (g/min)
1	391.83
2	383.39
3	385.04
4	383.11
5	388.90
6	397.98
Average	388.4
COV	0.015
QA/QC COV ≤ 0.10	PASS

Table 29 Sediment Injected: 75% MTFR

Sediment Mass Used (lb)	32.052
Sediment Mass Used Adjusted for Feed Samples (lb)	29.483
Water Volume During Sediment Addition (gal)	17,765
Average Sediment Concentration (mg/L)	198.9
QA/QC	
Total Mass Added ≥ 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.5 100% of Target MTR (1.5 cfs)

Table 30 Sampling Schedule: 100% MTR

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
5		2
6	2	
9		3
12	3	
13		4
17		5
18	4	
21		6
24	5	
25		7
29		8
30	6	
MTD Detention Time = 1.13 minutes		

Table 31 Flow: 100% MTR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	1.50	1.50	PASS	0.004	PASS
gpm	673	673.0			

Table 32 Temperature: 100% MTR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
70.4	PASS

Table 33 Background SSC: 100% MTR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	5.8	PASS
2	5.6	PASS
3	5.7	PASS
4	5.7	PASS
5	6.0	PASS
6	7.2	PASS
7	7.2	PASS
8	7.8	PASS

Table 34 Sediment Feed: 100% MFTR

Sample #	Sediment Feed Rate (g/min)
1	536.76
2	508.15
3	507.42
4	504.40
5	517.95
6	511.55
Average	514.4
COV	0.023
QA/QC COV ≤ 0.10	PASS

Table 35 Sediment Injected: 100% MTFR

Sediment Mass Used (lb)	34.295
Sediment Mass Used Adjusted for Feed Samples (lb)	30.888
Water Volume During Sediment Addition (G)	18,509
Average Sediment Concentration (mg/L)	200.0
QA/QC	
Total Mass Added ≥ 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.6 125% of Target MTR (1.875 cfs)

Table 36 Sampling Schedule: 125% MTR

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
4		2
4.5	2	
7		3
9	3	
10		4
13		5
13.5	4	
16		6
18	5	
19		7
22		8
22.5	6	
MTD Detention Time = 0.91 minutes		

Table 37 Flow: 125% MTR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	1.88	1.87	PASS	0.002	PASS
gpm	842	841.0			

Table 38 Temperature: 125% MTR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
74.3	PASS

Table 39 Background SSC: 125% MTR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	7.7	PASS
2	9.0	PASS
3	8.2	PASS
4	8.8	PASS
5	8.6	PASS
6	9.4	PASS
7	9.1	PASS
8	10.0	PASS

Table 40 Sediment Feed: 125% MFTR

Sample #	Sediment Feed Rate (g/min)
1	582.55
2	641.33
3	641.69
4	642.29
5	642.50
6	637.49
Average	631.3
COV	0.038
QA/QC COV ≤ 0.10	PASS

Table 41 Sediment Injected: 125% MTFR

Sediment Mass Used (lb)	32.179
Sediment Mass Used Adjusted for Feed Samples (lb)	28.012
Water Volume During Sediment Addition (gal)	16,820
Average Sediment Concentration (mg/L)	199.6
QA/QC	
Total Mass Added ≥ 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.7 150% of Target MTFR (2.25 cfs)

Table 42 Sampling Schedule: 150% MTFR

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
3.5		2
4	2	
6		3
8	3	
8.5		4
11		5
12	4	
13.5		6
16	5	
16		7
18.5		8
20	6	
MTD Detention Time = 0.76 minutes		

Table 43 Flow: 150% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	2.25	2.25	PASS	0.001	PASS
gpm	1010	1010.2			

Table 44 Temperature: 150% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
73.8	PASS

Table 45 Background SSC: 150% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	6.8	PASS
2	6.5	PASS
3	6.9	PASS
4	7.1	PASS
5	7.1	PASS
6	7.8	PASS
7	8.0	PASS
8	7.7	PASS

Table 46 Sediment Feed: 150% MFTR

Sample #	Sediment Feed Rate (g/min)
1	804.14
2	762.84
3	767.41
4	764.64
5	753.50
6	764.94
Average	769.6
COV	0.023
QA/QC COV ≤ 0.10	PASS

Table 47 Sediment Injected: 150% MTFR

Sediment Mass Used (lb)	34.584
Sediment Mass Used Adjusted for Feed Samples (lb)	29.490
Water Volume During Sediment Addition (gal)	17,679
Average Sediment Concentration (mg/L)	199.9
QA/QC	
Total Mass Added ≥ 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.2 Scour Testing

Scour testing was performed according to Section 5 of the Protocol at 200% MTFR to verify the Arcadia's suitability for online use. The sample schedule is provided in **Table 48**. QA/QC checks are provided in **Table 49** and **Table 50**. Effluent, background, and adjusted effluent SSC concentrations are provided in **Table 51**. The adjusted effluent concentration was calculated by subtracting the paired background concentration from the raw measured effluent concentration. For effluent samples that were not paired with a background sample, the average of the surrounding background samples was used to calculate the adjusted SSC concentration. All background samples were below 20.0 mg/L. For sample concentrations below the detection limit of 1.0 mg/L, a value of 0.5 mg/L was used. The average adjusted effluent concentration was below 20.0 mg/L, thus qualifying the Arcadia for online installation.

Table 48 Sampling Schedule: Scour

Elapsed Time (minutes)	Effluent Sample	Background Sample
0		
1	1	1
3	2	
5	3	2
7	4	
9	5	3
11	6	
13	7	4
15	8	
17	9	5
19	10	
21	11	6
23	12	
25	13	7
27	14	
29	15	8

Table 49 Flow: Scour

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	3.36	3.37	PASS	0.001	PASS
gpm	1508	1510.7			

Table 50 Temperature: Scour

Maximum Temperature (°F)	QA/QC
	≤ 80°F
60.7	PASS

Table 51 SSC: Scour

Sample ID	Effluent Concentration (mg/L)	Background Concentration (mg/L)	BG QA/QC	Adjusted Effluent Concentration (mg/L)
			≤ 20.0 mg/L	
1	0.5	4.7	PASS	0.0
2	7.4		PASS	2.5
3	8.1	5.1	PASS	3.0
4	10.0		PASS	4.7
5	14.0	5.5	PASS	8.5
6	6.1		PASS	0.9
7	6.3	5.0	PASS	1.3
8	21.0		PASS	15.5
9	11.0	6.1	PASS	4.9
10	14.0		PASS	8.0
11	19.0	5.9	PASS	13.1
12	6.8		PASS	0.7
13	10.0	6.2	PASS	3.8
14	10.0		PASS	4.0
15	11.0	5.9	PASS	5.1
AVERAGE			PASS	5.1

4.3 Hydraulic Testing

Hydraulic testing was conducted on a clean Arcadia ARC4 unit that was free of sediment. The testing covered the span of 0.15 cfs to 3.41 cfs, which meets the requirement of the Protocol to cover 10% to 200% of the MTFR (0.168 – 3.36 cfs). Head was measured using piezometer taps located approximately one pipe diameter from the unit in the inlet and effluent pipes, and an engineer's scale. **Table 52** details the measured flow rates and head loss across the unit. The bypass flow rate was 605 gpm.

Table 52 Head and Head Loss

Flow Rate		Head (inches)		Head Loss (inches)
gpm	cfs	Inlet	Outlet	
67	0.15	1.31	1.24	0.07
168	0.38	3.15	2.13	1.02
337	0.75	6.83	3.37	3.47
505	1.13	12.27	4.63	7.63
605 (Bypass)	1.35	14.70	5.30	9.40
673	1.50	15.26	6.00	9.26
842	1.88	16.11	6.63	9.48
1010	2.25	16.68	7.44	9.23
1346	3.00	18.14	8.41	9.73
1528	3.41	18.73	8.84	9.89
1700	3.79	19.23	8.17	11.07

5. Design Limitations

The Advanced Drainage Systems (ADS) Water Quality Team provides engineering support to all clients. Each system is designed and sized according to anticipated flow rate, load rating, and system depth at the installation site. All site and design constraints are discussed during the design and manufacturing process.

Required Soil Characteristics

The Arcadia is delivered to the job site to be housed in a pre-cast concrete structure or an ADS polypropylene manhole. During the pre-casting design process, soil characteristics, including corrosiveness, top and lateral loading, and ground water must be addressed. The Arcadia can be installed and will function in all soil types. A copy of the geotechnical report along with surface loading requirements, and groundwater situation must be reviewed and verified during the design process (see below for buoyancy situations).

Slope

The Arcadia is typically installed on a 0% slope or flat installation grade across the unit (invert in to invert out). In general, it is recommended that the pipe slope into the system not exceed 10%. Slopes in excess of 10% could cause increased velocities which could affect the turbulence into the system. The ADS Water Quality Engineering Team will evaluate the design prior to specification for application on sites with steep slopes.

Maximum Flow Rate

The maximum treatment flow rate (MTFR) of the Arcadia is dependent upon model size and performance specifications. The hydraulic loading rate is 60.0 gpm/ft² for all models. ADS Water Quality Engineering staff can assist site design engineers to ensure an appropriate model.

Maintenance Requirements

The lifespan and maintenance needs of the Arcadia depend on the sediment load and individual site conditions. The system must be inspected at regular intervals and maintained when necessary to ensure the optimal performance. Detailed requirements can be found in **Section 6**.

Driving Head

Driving head will vary depending on the site-specific configuration. Design support is given by the ADS Water Quality Team for each project, and site-specific drawings (cut sheets) will be provided that show pipe inverts, finish surface elevation, and peak treatment and maximum flow rates through the Arcadia to ensure no adverse impact on the hydraulic grade-line.

Installation Limitations

The ADS Water Quality Team provides contractors with instructions prior to delivery, and onsite assistance is available from the installation technician during delivery and installations. Pick weights and lifting details are also provided prior to delivery to ensure that the contractor is able to prepare the appropriate equipment on site.

Configurations

The Arcadia is available in various sizes and can be installed on- or off-line, although this verification pertains to on-line installations. An internal bypass weir removes the need for any external high-flow diversion structure in the on-line system. When bypass occurs, flow is routed directly from the treatment chamber to the outlet chamber, thus preventing any scour or loss of captured pollutants.

Structural Load Limitations

Arcadias are typically designed for HS-20 loading. If a depth greater than 15 feet is required from final grade, the manhole structural design must be reviewed by the manufacturer. Contact the ADS Water Quality Team if increasing load is expected.

Pre-treatment Requirements

The Arcadia has no pre-treatment requirements.

Limitations in Tailwater

Site-specific tailwater conditions will be assessed on each individual project. Tailwater conditions increase the amount of driving head required for optimal system operation. The manufacturer's internal protocols require that these conditions are discussed with the engineer of record and that a solution be implemented to adjust for any design variations caused by tailwater conditions at both treatment and bypass flow rates.

Depth to Seasonal High Water Table

Groundwater conditions do not affect Arcadia function and treatment performance. High groundwater may cause buoyancy, and an anti-floatation ballast can be added to the structure to counteract this. If high groundwater is anticipated, the ADS Water Quality Engineering Team will evaluate the need for anti-buoyance measures and provide the guidance to address the concerns.

6. Maintenance

The Arcadia requires periodic maintenance to continue operating at design efficiency. The maintenance process is comprised of the cleaning of the manhole with a vacuum truck. The system needs to be cleaned, when necessary, to ensure optimum performance, typically every 12-18 months. The rate at which the system collects pollutants will depend more upon site activities than

the size of the unit. Since storm water solids loads can be variable, it is possible that the maintenance cycle could be more or less than the projected duration for a given O&M cycle.

An Arcadia Maintenance Guide is at:

<https://assets.adspipe.com/m/2b13451739fb2bfe/original/Arcadia-Separator-Maintenance-Guide.pdf>

Inspection

Inspection is the key to effective maintenance, and it is easily performed. The ADS Water Quality Team recommends the Arcadia be inspected every six (6) months for the first year, and then on an annual basis. Sediment accumulation may be especially variable during the first year after installation as construction disturbances and landscaping stabilizes. Inspections may need to be performed more often in the winter months in climates where sanding operations may lead to rapid accumulations or in other areas with heavy sediment loading. It is particularly useful to keep a record of each inspection. NJDEP requires that sediment be removed when the sediment depth reaches 50% of the MTD's maximum sediment storage capacity. The Arcadia should be cleaned when inspection reveals that 9 inches or more of sediment is accumulated at the bottom of manhole or when visual inspection shows a large accumulation of debris or oil. This determination of sediment depth can be made by lowering a stadia rod into the manhole until it hits the sediment and measuring the distance from the bottom of the pole to the water line mark on the stadia rod. Note: To avoid underestimating the volume of sediment in the manholes, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile may offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Maintenance frequency can be determined by adhering to the initial sizing frequency given by the initial sizing of the system. Once actual sediment loading on-site is determined, a modified maintenance frequency can be proposed to the site owner. Please contact the ADS Water Quality Engineering Team for maintenance cycle estimations or assistance at 1.800.821.6710.

Maintenance Procedures

1. Remove the manhole cover to provide access to the pollutant storage. Pollutants are stored in the sump, below the internal assembly visible from the surface. Access to this area is through the opening at the bottom of the vertical cylinder.
2. Use a vacuum truck or other similar equipment to remove all water, debris, oils, and sediment from both the top inlet treatment area and the bottom sump compartment area of the Arcadia unit.
3. Use a high-pressure hose to clean the manhole of all remaining sediment and debris (recommended but optional). Then, use the vacuum truck to remove this water.
4. Fill the cleaned Arcadia unit with water to the invert of the outlet pipe.
5. Replace the manhole cover/close the hatch (if applicable).
6. Dispose of polluted water, oils, sediment, and trash at an approved facility.
7. Local regulations prohibit the discharge of solid material into the sanitary system. Check with the local sewer authority for authority to discharge the liquid.
8. Many places treat the pollutants as leachate. Check with local regulators about disposal requirements. Important: Additional local regulations may apply to the maintenance procedure.

7. Statements

The following signed statements from the manufacturer (Advanced Drainage Systems, Inc.), third-party observer (Sustainable Stormwater Solutions Engineering, LLC), 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.



January 22, 2025

Dr. Richard S. Magee, Sc.D., P.E., BCEE
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 the Arcadia

Dr. Richard Magee,

Advanced Drainage Systems has completed verification testing for the ADS Arcadia in accordance with the *"New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device"* (April 25, 2023). ADS is pleased to provide this letter as our statement that all procedures and requirements identified in the protocol were met and exceeded. The testing was performed at the Hydraulic Laboratory in the ADS Engineering & Technology Center, located in Hilliard, Ohio under the direct supervision of independent consultant Dr. Ryan Winston in compliance with all applicable protocol and process criteria. All data pertaining to the Arcadia HDS NJDEP Protocol test is included in the Verification Report.

If you have any questions or comments regarding the verification, please do not hesitate to contact us.

Regards,

Bo Liu, P.E. Ph.D.
Advanced Drainage Systems
Senior Engineer
Phone (301)252-0418
e-mail: bo.liu@adspipe.com

cc Joe Chylik, ADS





Sustainable Stormwater Solutions Engineering

January 27, 2025

To: Gordon Baugh, Advanced Drainage Systems, Inc. (ADS)
From: Ryan Winston, PhD, P.E., Sustainable Stormwater Solutions Engineering, LLC
Subject: Third Party Verification of Arcadia™ Hydrodynamic Separator
CC: Bo Liu, Advanced Drainage Systems, Inc. (ADS)

Subject: **Witness Statement**
Third Party Observer

Sustainable Stormwater Solutions Engineering (SSSE) served as the third-party observer for tests performed on the Arcadia™ Hydrodynamic Separator model ARC4 in the Hydraulics Laboratory of ADS, Inc., located in their Engineering and Technology Center at 4671 Raindrop Way, Hilliard, Ohio. Hydraulics, removal efficiency, and scour tests were performed in December 2024 and January 2025 following QAPP approval in November 2024. Tests were conducted to achieve certification through the New Jersey Department of Environmental Protection (NJDEP) according to the *Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (NJDEP protocol). This document was dated January 1, 2021, and subsequently updated on April 25, 2023. I was on site during all tests documented in the attached report and verified the compliance with the test protocol above. I was present to observe all testing procedures including sampling intervals, sample volumes, flow rates, water temperature measurements, head loss calculations, sediment feed rate, sediment recovery and sediment mass captured in the inlet pipes and test unit. I was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory.

I have reviewed the data, calculations, and conclusions associated with the hydraulic, removal efficiency, and scour testing in the Arcadia™ Hydrodynamic Separator report by ADS, Inc. dated January 2025. I state that the results presented therein conform to what I observed during my supervision as a third-party observer.

Thank you,



Ryan J. Winston, PhD, P.E.
Sustainable Stormwater Solutions Engineering



Sustainable Stormwater Solutions Engineering

January 27, 2025

To: Gordon Baugh, Advanced Drainage Systems, Inc. (ADS)
From: Ryan Winston, PhD, P.E., Sustainable Stormwater Solutions Engineering, LLC
Subject: Third Party Verification of Arcadia™ Hydrodynamic Separator
CC: Bo Liu, Advanced Drainage Systems, Inc. (ADS)

Subject: **Conflict of Interest Statement**

Sustainable Stormwater Solutions Engineering, LLC (SSSE) served as the third-party observer for hydraulic, removal efficiency, and scour tests performed on the Arcadia™ ARC4 Hydrodynamic Separator in December 2024 and January 2025. Tests were conducted to achieve certification through the New Jersey Department of Environmental Protection (NJDEP) according to the *Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (NJDEP protocol). SSSE has no financial conflict of interest regarding the test results of this stormwater treatment device. SSSE and ADS have no relationships beyond this testing agreement that would constitute a conflict of interest. For instance, SSSE does not own stock in ADS, have partial ownership of the company, and have licensing agreements with the company. We have not received funds from ADS beyond those associated for third party observation of testing for the Arcadia™.

Thank you,



Ryan J. Winston, PhD, P.E.
Sustainable Stormwater Solutions Engineering



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

January 30, 2025

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

Dear Mr. Mahon,

Based on my review, evaluation and assessment of the testing conducted on the ADS Arcadia™ Hydrodynamic Separator, the test protocol requirements contained in the “*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*” (NJDEP HDS Protocol, January 1, 2021- Updated April 25, 2023) were met or exceeded consistent with the NJDEP Approval Process. Specifically:

Test Sediment Feed

The mean PSD of the test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The 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 ($<75\ \mu\text{m}$); the test sediment D_{50} was 74 microns. The scour test sediment PSD analysis was plotted against the NJDEP scour test PSD specification and shown to meet the protocol specifications.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on an Arcadia ARC4 test unit comprised of full-scale, commercially available internal components to establish the ability of the Arcadia ARC4 to remove the NJDEP protocol specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR. The Arcadia demonstrated an annualized weighted solids removal as defined in the NJDEP HDS Protocol of 50.1%. The flow rates, feed rates, and influent concentration all met the NJDEP HDS test protocol's coefficient of variance requirements. Background concentrations never exceeded 20 mg/L.

Scour Testing

The scour testing was conducted at 3.37 cfs which is equal to 201% of the MTFR. The scour test was conducted with the unit preloaded with 4.0" of levelled sediment to the 50% capacity level, prior to conducting the test. A total of 15 effluent samples were collected throughout the test. The calculated concentrations, adjusted for background, ranged from 0.0 to 15.5 mg/L, with an average of 5.1 mg/L, qualifying the Arcadia for online installation.

Maintenance Frequency

The predicted maintenance frequency for all Arcadia models is 40 months.

Sincerely,



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

8. References

Advanced Drainage Systems, Inc. 2024. *Quality Assurance Project Plan for ADS New Separator*. Prepared by Advanced Drainage Systems, Inc. November 2024.

ASTM (2017). *Standard Test Methods for Particle-Size Distribution (Gradation of Soils Using Sieve Analysis)*, Annual Book of ASTM Standards, D6913/D6913M-17, Vol. 4.09.

ASTM (2019). *Standard Test Methods for Determining Concentrations in Water Samples*, Annual Book of ASTM Standards, D3977-97, Vol. 11.02.

NJDEP (2021). *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. August 4, 2021.

NJDEP (2021). *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*. Trenton, NJ. January 1, 2021 (updated April 25, 2023).

VERIFICATION APPENDIX

Introduction

- Manufacturer –Advanced Drainage Systems, Inc., 4640 Trueman Blvd., Hilliard, OH 43206. Website: adspipe.com Phone: 800-733-7473.
- Arcadia verified models are shown in **Table A-1** and **Table A-2**.
- TSS Removal Rate – 50%
- On-line installation

Detailed Specification

- NJDEP sizing tables and physical dimensions of the Arcadia verified models are attached (**Table A-1** and **Table A-2**).
- New Jersey requires that the peak flow rate of the NJWQ Design Storm event of 1.25 inch in 2 hours shall be used to determine the appropriate size for the MTD. The Arcadia 4-ft model has a maximum treatment flow rate (MTFR) of 1.68 cfs (754 gpm), which corresponds to a surface loading rate of 60.0 gpm/ft².
- Pick weights and installation procedures vary slightly with model size. Design support is given by the ADS Water Quality Team for each project and pick weights and installation procedures will be provided prior to delivery.
- NJ maximum recommended sediment depth prior to cleanout is 9-inches for all model sizes.
- An Arcadia Maintenance Guide is at:
<https://assets.adspipe.com/m/2b13451739fb2bfe/original/Arcadia-Separator-Maintenance-Guide.pdf>
- Under N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow a hydrodynamic separator such as the Arcadia to be used in series with another hydrodynamic separator to achieve an enhanced TSS removal rate

Table A-1 MTFRs and Sediment Removal Intervals for Arcadia Models

Model¹	Manhole Diameter (ft)	NJDEP 50% TSS Maximum Treatment Flow Rate (cfs)	Treatment Area (ft²)	Hydraulic Loading rate (gpm/ft²)	50% Maximum Sediment Storage² (ft³)	Sediment Removal Interval¹ (months)
Arcadia ARC3	3	0.95	7.07	60.0	5.30	40
Arcadia ARC4	4	1.68	12.57	60.0	9.43	40
Arcadia ARC5	5	2.63	19.63	60.0	14.72	40
Arcadia ARC6	6	3.78	28.27	60.0	21.20	40
Arcadia ARC8	8	6.72	50.27	60.0	37.70	40
Arcadia ARC10	10	10.50	78.54	60.0	58.91	40
<p>Notes:</p> <ol style="list-style-type: none"> 1. Sediment Removal Interval (months) = (50% HDS MTD Max Sediment Storage Volume * 3.57) / (MTFR * TSS Removal Efficiency) calculated using equation in Appendix B, Part B of the NJDEP HDS Protocol. 2. 50% Sediment Storage Capacity is equal to manhole diameter x 9 inches of sediment depth. Each Arcadia unit has an 18-inch deep sediment sump. 						

Table A-2 Standard Dimensions for Arcadia Models

Model	Manhole Diameter (ft)	NJDEP 50% TSS MTR (cfs)	Total Chamber Depth (ft)	Treatment Chamber Depth¹ (ft)	Treatment Chamber Wet Volume⁴ (ft³)	Aspect Ratio² (Depth/Dia.)	Sediment Sump Depth (in)
Arcadia ARC3	3	0.95	4.58	3.83	27.0	1.275	18.0
Arcadia ARC4	4	1.68	6.75	6	75.4	1.50	18.0
Arcadia ARC5	5	2.63	6.75	6	117.8	N/A	18.0
Arcadia ARC6	6	3.78	6.75	6	169.6	N/A	18.0
Arcadia ARC8	8	6.72	11.00	10.25	512.8	1.281	18.0
Arcadia ARC10	10	10.50	13.50	12.75	1001.4	1.275	18.0

Notes:

1. Treatment chamber depth is defined as the total chamber depth minus ½ the sediment storage depth.
2. The aspect ratio is the unit's treatment chamber depth/diameter. The aspect ratio for the tested unit is 1.50. Larger models (>250% MTR of the tested unit, > 4.20 cfs) must be geometrically proportionate to the tested unit. A variance of 15% is allowable (1.275 to 1.725).
3. For units < 250% MTR (5 and 6 ft models), the depth must be equal or greater than the depth of the unit tested.
4. Referred to as Treatment Chamber Capacity in the ADS Arcadia Maintenance Guide

ADDENDUM

Arcadia™ Hydrodynamic Separator Alternate Configurations

Advanced Drainage Systems, Inc.

September 2025

Table of Contents

List of Figures	43
List of Tables	43
1. Introduction	45
2. Laboratory Testing	45
2.1 Test Setup	45
2.2 Test Sediment	49
2.3 Sediment Removal Efficiency Testing	51
2.4 Scour Testing	52
2.5 Laboratory Proficiency	53
3. Performance Claims	54
4. Supporting Documentation	54
4.1 Removal Efficiency Results	55
4.1.1 Angled Inlet, 25% of Target MTFR	56
4.1.2 Angled Inlet, 75% of Target MTFR	58
4.1.3 Grate Inlet, 25% of Target MTFR	60
4.1.4 Grate Inlet, 75% of Target MTFR	62
4.1.5 Horseshoe Configuration, 25% of Target MTFR	64
4.1.6 Horseshoe Configuration, 75% of Target MTFR	66
4.2 Scour Testing	68
5. Statements	72
6. References	78
VERIFICATION APPENDIX	79

List of Figures

Figure 1 Plan View of the Arcadia in Angled Inlet Configuration	46
Figure 2a Profile View of the Arcadia in Grate Inlet Configuration	47
Figure 2a Plan View of the Arcadia in Grate Inlet Configuration	47
Figure 3 Plan View of the Arcadia in Horseshoe Configuration	48
Figure 4 Schematic of the Arcadia Test Configuration	49
Figure 5 Average PSD of Removal Efficiency Sediment vs NJDEP Protocol Specification	50
Figure 6 Average PSD of Scour Sediment vs NJDEP Protocol Specification	51

List of Tables

Table 1 Particle Size Distribution Results of Removal Efficiency Test Sediment Samples	49
Table 2 Particle Size Distribution Results of Scour Sediment Samples	51
Table 3 Laboratory Proficiency SSC Results	53
Table 4a Summarized Removal Efficiency from Captured Sediment for Angled Inlet	55
Table 4b Summarized Removal Efficiency from Captured Sediment for Grate Inlet	55
Table 4c Summarized Removal Efficiency from Captured Sediment for Horseshoe	56
Table 5 Sampling Schedule: Angled, 25% MTFR	56
Table 6 Flow: Angled, 25% MTFR	56
Table 7 Temperature: Angled, 25% MTFR	57

Table 8 Background SSC: Angled, 25% MTFR.....	57
Table 9 Sediment Feed: Angled, 25% MTFR	57
Table 10 Sediment Injected: Angled, 25% MTFR	58
Table 11 Sampling Schedule: Angled, 75% MTFR	58
Table 12 Flow: Angled, 75% MTFR.....	58
Table 13 Temperature: Angled, 75% MTFR.....	59
Table 14 Background SSC: Angled, 75% MTFR.....	59
Table 15 Sediment Feed: Angled, 75% MTFR	59
Table 16 Sediment Injected: Angled, 75% MTFR	60
Table 17 Sampling Schedule: Grate, 25% MTFR	60
Table 18 Flow: Grate, 25% MTFR.....	60
Table 19 Temperature: Grate, 25% MTFR.....	61
Table 20 Background SSC: Grate, 25% MTFR.....	61
Table 21 Sediment Feed: Grate, 25% MTFR	61
Table 22 Sediment Injected: Grate, 25% MTFR	62
Table 23 Sampling Schedule: Grate, 75% MTFR	62
Table 24 Flow: Grate, 75% MTFR.....	62
Table 25 Temperature: Grate, 75% MTFR.....	63
Table 26 Background SSC: Grate, 75% MTFR.....	63
Table 27 Sediment Feed: Grate, 75% MTFR	63
Table 28 Sediment Injected: Grate, 75% MTFR	64
Table 29 Sampling Schedule: Horseshoe, 25% MTFR	64
Table 30 Flow: Horseshoe, 25% MTFR.....	64
Table 31 Temperature: Horseshoe, 25% MTFR.....	65
Table 32 Background SSC: Horseshoe, 25% MTFR.....	65
Table 33 Sediment Feed: Horseshoe, 25% MTFR	65
Table 34 Sediment Injected: Horseshoe, 25% MTFR	66
Table 35 Sampling Schedule: Horseshoe, 75% MTFR	66
Table 36 Flow: Horseshoe, 75% MTFR.....	66
Table 37 Temperature: Horseshoe, 75% MTFR.....	67
Table 38 Background SSC: Horseshoe, 75% MTFR.....	67
Table 39 Sediment Feed: Horseshoe, 75% MTFR	67
Table 40 Sediment Injected: Horseshoe, 75% MTFR	68
Table 41 Sampling Schedule: Scour	69
Table 42 Flow: Angled Inlet Scour	69
Table 43 Temperature: Angled Inlet Scour	69
Table 44 Flow: Grate Inlet Scour	69
Table 45 Temperature: Grate Inlet Scour	69
Table 46 Flow: Horseshoe Configuration Scour	70
Table 47 Temperature: Horseshoe Configuration Scour	70
Table 48 SSC Angled Inlet Scour	70
Table 49 SSC Grate Inlet Scour	71
Table 50 SSC Horseshoe Configuration Scour	71

1. Introduction

Advanced Drainage Systems' (ADS) Arcadia™ hydrodynamic separator (Arcadia) was tested to the New Jersey Department of Environmental Protection Laboratory (NJDEP) *Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (NJDEP Protocol), dated January 1, 2021 (updated April 25, 2023), and subsequently verified by the New Jersey Corporation for Advanced Technology (NJCAT) in April of 2025, and certified by NJDEP in May of 2025. That testing program was performed with the Arcadia inlet and outlet piping in the standard configuration (with flow passing straight through, inlet and outlet pipes set opposite of each other, offset at 180 degrees). Per Section 1 of the NJDEP HDS Protocol, alternate configurations of inlet and outlet piping can be assessed by testing at 25% and 75% of the manufacturer's target MTR, and the results must be within $\pm 5\%$ of the original configuration test results.

2. Laboratory Testing

All testing disclosed in this addendum was performed in accordance with the New Jersey Department of Environmental Protection (NJDEP) *Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (NJDEP Protocol) dated January 1, 2021, last updated April 25, 2023. The NJDEP approval process requires submittal of a Quality Assurance Project Plan (QAPP) to the New Jersey Corporation for Advanced Technology (NJCAT) for review and approval prior to testing. This ensures that all laboratory procedures will be conducted in strict accordance with the NJDEP Protocol. The QAPP was submitted and approved by NJCAT in July of 2025, prior to commencement of testing.

Three alternate configurations were tested: Angled Inlet, Grate Inlet, and Horseshoe. All removal efficiency and scour testing for this project was carried out at ADS's Engineering and Technology Center Hydraulics Laboratory, located in Hilliard, OH, in July and August of 2025. Independent third-party observation was provided by Sustainable Stormwater Solutions Engineering (SSSE), in accordance with the NJDEP Protocol. All water quality samples collected during the test program were analyzed by Fredericktowne Labs, which is a NELAP-accredited independent environmental testing laboratory located in Myersville, MD. All sediment PSD samples were analyzed by Bowser-Morner, Inc. (BMI), which is an ISO-certified lab located in Dayton, OH.

2.1 Test Setup

The test unit was the same full-scale commercially available Arcadia AR4 unit (4 ft diameter), used in the original testing. The three alternate configurations tested are shown in **Figures 1 through 3**. The unit is 105 inches in height (131.5 inches for Grate Inlet configuration) and 48 inches in diameter. For the Angled Inlet and Horseshoe configurations, influent and effluent piping to the Arcadia unit were 12-inches in diameter and at the same inlet/outlet elevations. The inlet pipe slope was greater than 1%. For the Angled Inlet and Horseshoe configurations, the edge of the weir was positioned centered between the inlet and outlet pipes, with the back side of the weir turned toward the outlet pipe. For removal efficiency testing, the false floor was set to allow for simulation of the 50% maximum sediment storage volume. For scour testing, the false floor was set

to allow for four inches of sediment to be pre-loaded to the 50% maximum sediment storage volume. The test unit dimensions were confirmed by SSSE prior to testing.

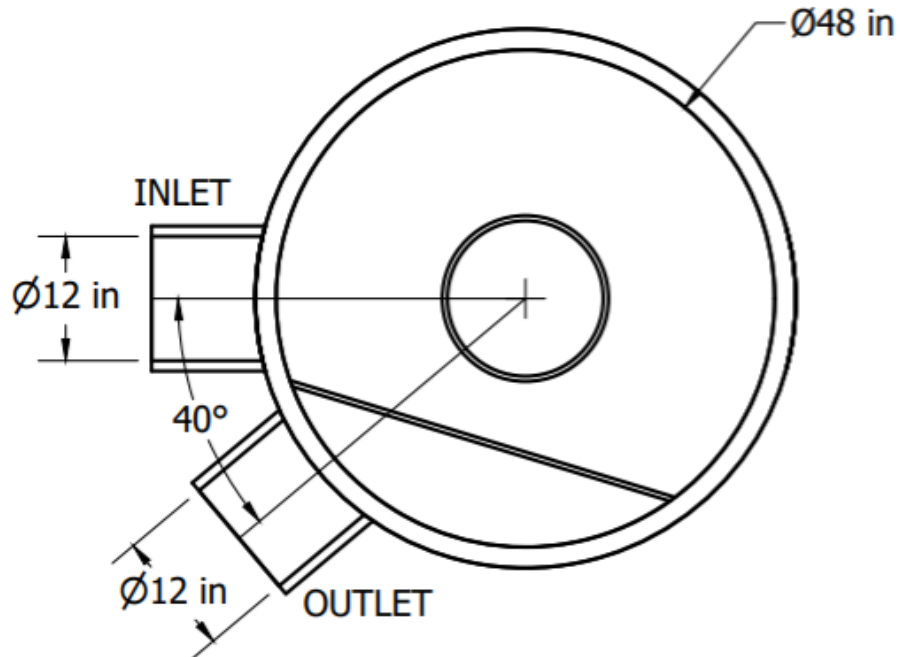


Figure 1 Plan View of the Arcadia in Angled Inlet Configuration

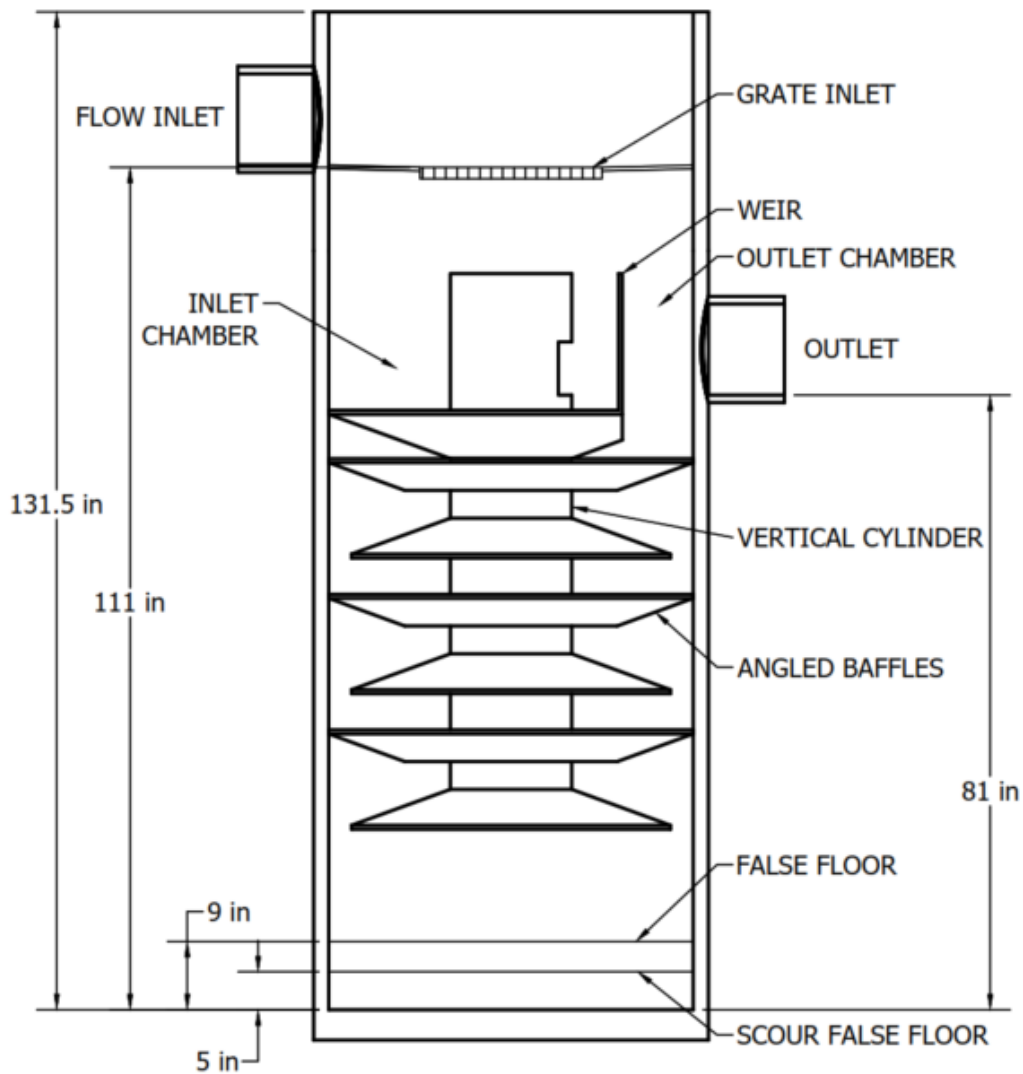


Figure 2a Profile View of the Arcadia in Grate Inlet Configuration

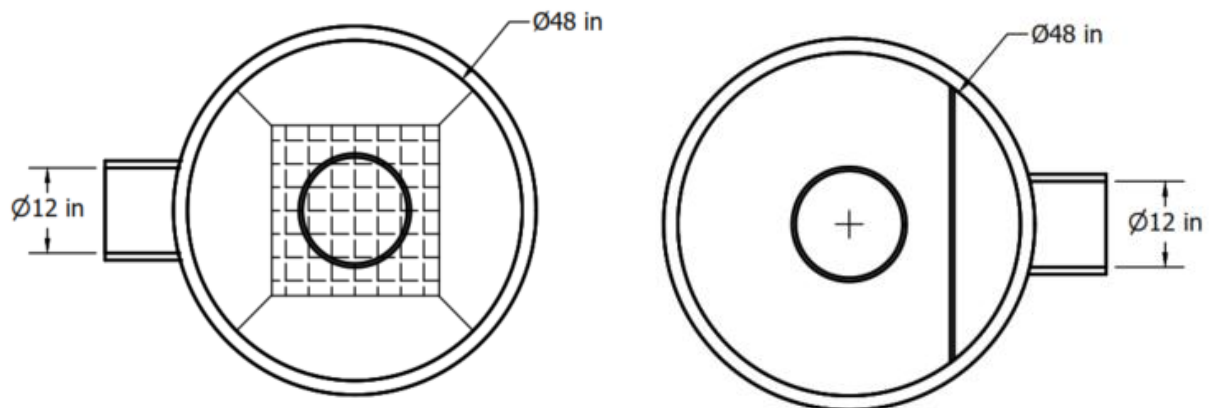


Figure 2b Plan View of the Arcadia in Grate Inlet Configuration

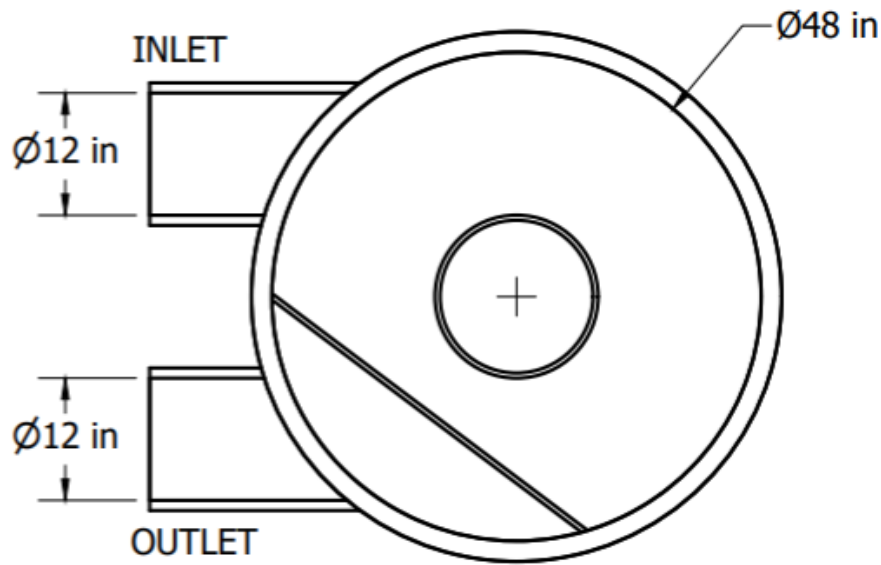


Figure 3 Plan View of the Arcadia in Horseshoe Configuration

The closed-loop recirculated test configuration, shown in **Figure 4**, was identical to that used in the original testing. Flow rate was controlled using a Bell & Gossett e-1510 5EB pump and an Emerson Keystone 22L0250 control valve. The VFD control system automatically adjusted the pump speed and control valve position to achieve the desired flow rate from the source tank. The flow rates were measured upstream of the test unit using either a 4-inch Emerson Magnetic 8750 flow meter or 10-inch Emerson Magnetic 8750 flow meter. The water temperature in the source tank was measured using a Rosemount 214A Temperature Sensor. All flow rate and temperature data were recorded in one-minute intervals. Test sediment was dry fed by a Coperion K-tron gravimetric screw doser through an 8-inch port at the crown of the 12-inch diameter influent pipe located 34 inches upstream of the test unit. The water flowed through the inlet chamber and lower internal structure of the test unit, and the effluent was discharged into the outfall. The effluent flowed to an underground settling tank, through a pressurized filter bag system, and was returned to the source tank.

Sediment calibration sample collection occurred at the sediment dosing port. Background TSS (SSC) sample collection occurred approximately 22 feet upstream of the sediment dosing port. Background samples were a minimum of 500 mL.

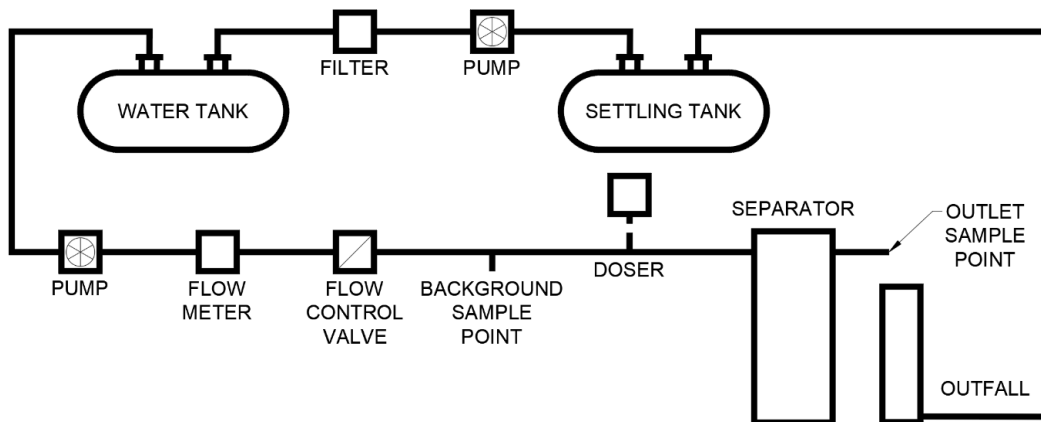


Figure 4 Schematic of the Arcadia Test Configuration

2.2 Test Sediment

The test sediment for removal efficiency testing was a blend of commercially available silica sand grades supplied by AGSCO Corporation and US Silica Company. The particle size distribution was independently verified by Bowser-Morner, Inc. (ISO-certified) to show that the test sediment blend met the specification as described in Section 4A of the NJDEP Protocol.

The sediment blend was mixed by ADS and stored in sealed containers. SSSE observed the collection of three representative samples composited from each of the containers prior to the start of testing. A Chain of Custody (COC) form was used for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory. Results of particle size gradation testing are shown in **Table 1** and **Figure 5** below. The D50 of this blend was 53.7 microns.

Table 1 Particle Size Distribution Results of Removal Efficiency Test Sediment Samples

Particle Size (μm)	% Finer				Test Sediment Average	NJDEP Specification (minimum % passing)
	NJDEP Protocol	Sample 1	Sample 2	Sample 3		
1000	100	100.0	100.0	100.0	100.0	98
500	95	95.7	95.2	94.9	95.3	93
250	90	91.7	90.9	90.3	91.0	88
150	75	80.9	81.1	79.2	80.4	73
100	60	62.6	62.9	62.3	62.6	58
75	50	53.5	53.8	53.8	53.7	50
50	45	50.3	51.3	51.8	51.1	43
20	35	38.2	39.3	41.5	39.7	33
8	20	21.2	21.1	21.5	21.3	18
5	10	14.9	13.9	14.5	14.4	8
2	5	6.2	4.9	5.2	5.4	3

Note: Data for specific particle sizes (500 μm , 100 μm , 50 μm and smaller) were found via linear interpolation of BMI's data.

The moisture content of the test sediment was determined in accordance with ASTM D2216 “Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.” The average moisture content was found to be 0.2%.

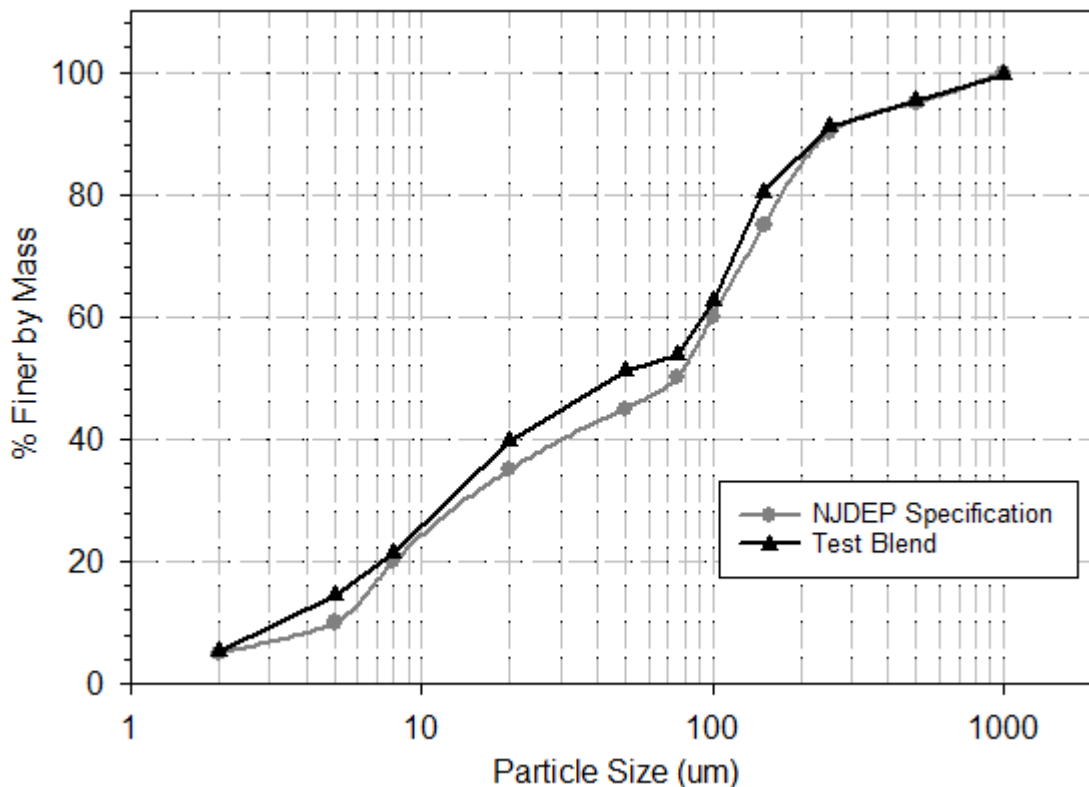


Figure 5 Average PSD of Removal Efficiency Sediment vs NJDEP Protocol Specification

The scour sediment was a blend of commercially available silica sand grades supplied by AGSCO Corporation. The particle size distribution was independently confirmed by BMI to show that the test sediment blend met the specification as described in Section 4A of the NJDEP Protocol. The sediment blend was mixed by ADS and stored in sealed containers. SSSE observed the collection of three representative samples composited from each of the containers prior to the start of scour testing. A Chain of Custody (COC) form was used for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory. Results of particle size gradation testing are shown in **Table 2** and **Figure 6** below. The average moisture content was found to be 0.1%.

Table 2 Particle Size Distribution Results of Scour Sediment Samples

Particle Size (μm)	% Finer				Test Sediment Average	NJDEP Specification (minimum % passing)
	NJDEP Protocol	Sample 1	Sample 2	Sample 3		
1000	100	100.0	100.0	100.0	100.0	98
500	90	93.4	89.3	99.5	95.1	88
250	55	59.7	55.4	68.0	61.0	53
150	40	48.7	45.9	55.3	50.0	38
100	25	30.5	29.6	34.0	31.4	23
75	10	17.5	16.4	18.3	17.4	8
50	0	8.6	8.1	9.6	8.8	0

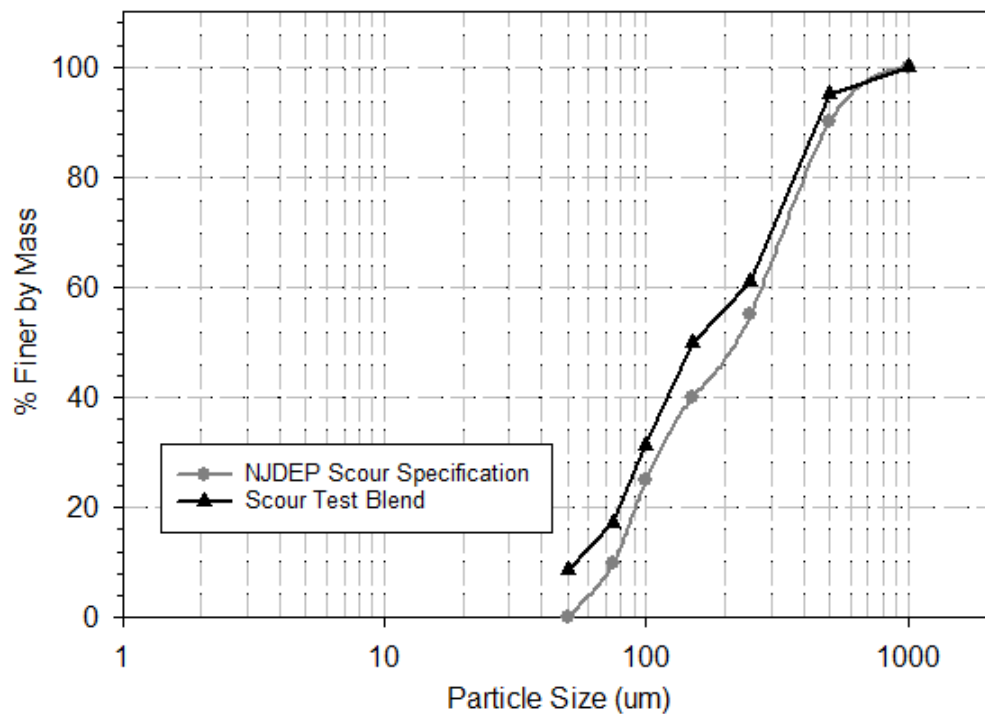


Figure 6 Average PSD of Scour Sediment vs NJDEP Protocol Specification

2.3 Sediment Removal Efficiency Testing

Removal efficiency testing was conducted using the Mass Capture Test Method in accordance with Sections 4B and 4C of the NJDEP Protocol for HDS MTDs. Two flow rates were tested: 25% and 75% of the target Maximum Treatment Flow Rate (MTFR). As was the case for the original testing, the target MTFR was 1.5 cfs (673 gpm). The flow rate was logged once every minute. All flow rates were within 10% of the targeted value, and the coefficient of variance (COV) did not exceed 0.03. Flow continued for one detention time after sediment feed was stopped to allow for sediment that would not normally be captured to pass through the MTD. The water temperature was recorded at one-minute intervals and did not exceed 80°F.

Background samples were collected at the background sample port upstream of the doser port. Eight background samples were taken at evenly spaced intervals during each run. Each sample was a minimum of 500 mL. A Chain of Custody (COC) form was used for each test run to record sampling date and time for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory. All background samples were analyzed by Fredericktowne Labs in accordance with ASTM D3977-97 “Standard Test Methods for Determining Sediment Concentrations in Water Samples.” The background TSS concentrations did not exceed 20.0 mg/L.

The test sediment feed rate and total mass of test sediment introduced during each test run were each a known quantity and were introduced at a rate within $\pm 10\%$ of the targeted value of 200 mg/L influent concentration. A minimum of 25 lbs of sediment was fed into the unit for every test. The total sediment introduced to the system was determined from the difference in weights on the Coperion K-tron D5 XPC3 scale at the beginning and end of each test. The times of sediment calibration samples, sediment feed start, sediment feed stop, and flow start/stop were recorded for every run.

Six sediment feed calibration samples were taken from the injection point at evenly spaced intervals during each test. Calibration samples were collected over timed intervals not exceeding one minute but resulting in a minimum size of 20.0 g. Each sample was weighed under the observation of SSSE. The coefficient of variance (COV) of the sediment rate calibration samples did not exceed 0.10.

After each test, the test unit was decanted by means of a sump pump. Recovered test sediment was placed into pre-weighed non-ferrous trays and dried in a vented oven until a constant weight was obtained when cooled to room temperature, as determined by two successive measurements taken no less than two hours apart which showed no more than a 0.1% difference in measured mass weighed to a precision of 10 grams. The sediment mass captured in the MTD and the inlet pipe were quantified and reported separately.

Removal efficiency was calculated for each test run using the following equation:

$$\text{Removal Efficiency (\%)} = \left(\frac{\text{Total Mass Collected in MTD}}{\text{Total Mass Input During Run}} \right) \times 100$$

2.4 Scour Testing

Scour testing was performed on all three alternate configurations. The false floor was placed 4 inches below the 50% maximum sediment storage volume and covered with 4 inches of scour test sediment. The sediment was leveled, and the test unit was filled with clear water to its normal dry weather operating depth. Scour testing began within 96 hours of pre-loading the unit.

The MTFR for scour testing was 1.68 cfs (754 gpm), as this was the flow rate at which the Arcadia achieved an annualized removal efficiency of 50.08% in the original testing. Scour testing began by conveying clear water to the unit and ramping up the flow rate until it reached

200% of the MTR within three minutes of commencing flow. The flow rate remained constant at the target 200% MTR rate for the remainder of the test duration. The flow rate was recorded once per minute.

A total of 15 effluent samples were taken over the duration of the test at 1, 3, and 5 minutes after commencement of conveying clear water through the MTD, and then every two minutes thereafter for an additional 12 samples (i.e., 7, 9, 11...29 minutes). The effluent samples were collected using the grab sampling method with a minimum sample volume of 500 mL.

Eight background samples were collected at evenly spaced intervals throughout the duration of the test. The background samples were drawn from the background sample port located upstream of the test unit. All background samples were a minimum volume of 500 mL. A Chain of Custody (COC) form was used for each test run to record sampling date and time for externally analyzed samples. SSSE was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory.

All samples were analyzed by Fredericktowne Labs in accordance with ASTM D3977-97. All background samples were less than 20.0 mg/L. All 15 adjusted effluent sample concentrations were included in the calculation of the average effluent concentration.

2.5 Laboratory Proficiency

Prior to the start of testing, to demonstrate laboratory proficiency in executing ASTM D3977, in accordance with Section 3B of the NJDEP Protocol, under the observation of SSSE, ADS prepared six spiked SSC samples at two known concentrations -- three at 20 (± 5) mg/L, and three at 50 (± 5) mg/L -- using the same test sediment as for the removal efficiency testing. Fredericktowne Labs analyzed these samples in accordance with ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentrations in Water Samples." Results are shown in **Table 3**.

Table 3 Laboratory Proficiency SSC Results

Sample	Prepared Concentration (mg/L)	FTL Reported Concentration (mg/L)	Recovery (%)	QA/QC
A1	24.7	23.2	93.9	
A2	22.3	24.3	109.0	
A3	23.3	23.0	98.7	
		Average	100.5	PASS
B1	52.4	53.3	101.7	
B2	52.4	52.9	101.0	
B3	51.0	53.2	104.3	
		Average	102.3	PASS

The SSC recovery for both concentrations were within the required $\pm 15\%$ required by the Protocol.

3. Performance Claims

Per the NJDEP verification procedure and based on the laboratory testing conducted for the Arcadia, the following are the performance claims made by Advanced Drainage Systems, Inc.

Total Suspended Solids (TSS) Removal Efficiency

For the particle size distribution and weighted calculation method required by the NJDEP HDS Protocol, the Arcadia achieved a weighted TSS removal efficiency of 50.1% for an MTFR of 1.68 cfs.

Maximum Treatment Flow Rate (MTFR)

The MTFR for the 4-ft Arcadia was demonstrated to be 1.68 cfs (754 gpm), with a total sedimentation area of 12.57 ft², which corresponds to a surface loading rate of 60.0 gpm/ft².

Maximum Sediment Storage Depth and Volume

The maximum sediment storage depth is 18-inches, which corresponds to 18.85 ft³ of sediment storage volume for the Arcadia 4-ft model. A sediment storage depth of 9 inches corresponds to the 50% maximum sediment storage volume (9.42 ft³).

Effective Treatment and Sedimentation Area

The effective treatment and sedimentation area of the Arcadia varies with model size, as it is dependent upon the surface area of the model, which varies with diameter. The effective treatment sedimentation area of the 4-ft model of the Arcadia is 12.57 ft².

Detention Time and Volume

The Arcadia detention time depends on flow rate and model size. The Arcadia model tested had a detention time of approximately 45 seconds for a flow rate of 1.68 cfs (754 gpm). Detention time is calculated by dividing the treatment chamber wet volume by the flow rate. The wet volume is defined as the volume between the pipe invert and the false floor. However, since the operating water volume in the Arcadia increases as flow increases during testing, the 3X detention time was calculated up to the operating head for all test runs.

Online Installation

Per the results of the Scour Test shown in Section 4.2 of this report, the Arcadia qualifies for online installation.

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. This information was provided to NJCAT and is available upon request.

4.1 Removal Efficiency Results

Removal efficiency test runs were completed on the Arcadia 4-ft model at flow rates of 10%, 25%, 50%, 75%, 100%, 125% and 150% of the target MTFR (1.5 cfs), at a target average influent concentration of 200 mg/L, in accordance with the NJDEP HDS protocol. Average flow rate was determined from the data collected from the flow data logger in one-minute intervals. No background concentration exceeded the 20.0 mg/L concentration specified by the NJDEP HDS Protocol. At no point did the water temperature exceed 80 °F.

A mass balance on the system was used to calculate the sediment removal efficiencies at each flow rate for each alternate configuration. These results are summarized and compared to those from the original testing in **Tables 4a through 4c**. For each of the three alternate configurations, the removal efficiencies achieved at 25% and 75% of the target MTFR are within $\pm 5\%$ of that achieved during the original testing of the Arcadia in the Straight-Through Configuration.

Table 4a Summarized Removal Efficiency from Captured Sediment for Angled Inlet

Configuration	Straight-Through		Angled Inlet	
%MTFR	25	75	25	75
Total Mass Injected (lb)	28.276	32.052	28.240	32.061
Calibration Sample Collection Time (sec)	60	30	30	30
Total Sediment Feed Calibration Samples (lb)	1.649	2.569	0.863	2.569
Sediment Retained in Inlet pipe (lb)	0.006	0.003	0.000	0.014
Sediment Feed into MTD (lb)	26.621	29.480	27.377	29.478
Sediment Captured in MTD (lb)	17.094	14.967	17.648	13.728
Removal Efficiency (%)	64.2	50.8	64.5	46.6
Difference in Removal Efficiency (%)	N/A	N/A	0.3	4.2

Table 4b Summarized Removal Efficiency from Captured Sediment for Grate Inlet

Configuration	Straight-Through		Grate Inlet	
%MTFR	25	75	25	75
Total Mass Injected (lb)	28.276	32.052	28.289	32.081
Calibration Sample Collection Time (sec)	60	30	30	30
Total Sediment Feed Calibration Samples (lb)	1.649	2.569	0.874	2.582
Sediment Retained in Inlet pipe (lb)	0.006	0.003	0.024	0.058
Sediment Feed into MTD (lb)	26.621	29.480	27.391	29.441
Sediment Captured in MTD (lb)	17.094	14.967	17.637	14.406
Removal Efficiency (%)	64.2	50.8	64.4	48.9
Difference in Removal Efficiency (%)	N/A	N/A	0.2	1.9

Table 4c Summarized Removal Efficiency from Captured Sediment for Horseshoe

Configuration	Straight-Through		Horseshoe	
	25	75	25	75
%MTFR				
Total Mass Injected (lb)	28.276	32.052	28.225	32.039
Calibration Sample Collection Time (sec)	60	30	30	30
Total Sediment Feed Calibration Samples (lb)	1.649	2.569	0.849	2.563
Sediment Retained in Inlet pipe (lb)	0.006	0.003	0.000	0.013
Sediment Feed into MTD (lb)	26.621	29.480	27.375	29.463
Sediment Captured in MTD (lb)	17.094	14.967	17.922	14.199
Removal Efficiency (%)	64.2	50.8	65.5	48.2
Difference in Removal Efficiency (%)	N/A	N/A	1.3	2.6

Individual test results for each flow rate in each alternate configuration tested are provided below, detailing the sample schedule, flow, temperature, and sediment measurements. All tests met the NJDEP Protocol requirements and QA/QC parameter

4.1.1 Angled Inlet, 25% of Target MTFR (0.375 cfs)

Table 5 Sampling Schedule: Angled 25% MTFR

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
15		2
20	2	
29		3
40	3	
43		4
57		5
60	4	
71		6
80	5	
85		7
99		8
100	6	
MTD Detention Time = 4.01 minutes		

Table 6 Flow: Angled 25% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	0.38	0.37	PASS	0.009	PASS
gpm	168	164.6			

Table 7 Temperature: Angled 25% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
76.6	PASS

Table 8 Background SSC: Angled 25% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	5.1	PASS
2	4.7	PASS
3	4.4	PASS
4	4.2	PASS
5	4.3	PASS
6	4.6	PASS
7	5.1	PASS
8	5.4	PASS

Table 9 Sediment Feed: Angled 25% MFTR

Sample #	Sediment Feed Rate (g/min)
1	139.16
2	126.47
3	128.19
4	127.85
5	133.63
6	127.51
Average	130.47
COV	0.04
QA/QC COV ≤0.10	PASS

Table 10 Sediment Injected: Angled 25% MTFR

Sediment Mass Used (lb)	28.240
Sediment Mass Used Adjusted for Feed Samples (lb) & Sediment in inlet Pipe	27.377
Water Volume During Sediment Addition (gal)	16,052
Average Sediment Concentration (mg/L)	204.4
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.2 Angled Inlet, 75% of Target MTFR (1.125 cfs)**Table 11 Sampling Schedule: Angled 75% MTFR**

Elapsed Time (minutes)	Sediment Feed Sample	Background sample
0	1	
1		1
6		2
7.5	2	
11		3
15	3	
16		4
21		5
22.5	4	
26		6
30	5	
31		7
36		8
37.5	6	
MTD Detention Time = 1.46 minutes		

Table 12 Flow: Angled 75% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			$\pm 10\%$	COV	COV ≤ 0.03
cfs	1.13	1.13	PASS	0.003	PASS
gpm	505	505.6			

Table 13 Temperature: Angled 75% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
71.9	PASS

Table 14 Background SSC: Angled 75% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	1.9	PASS
2	2.2	PASS
3	2.3	PASS
4	1.8	PASS
5	2.6	PASS
6	2.4	PASS
7	3.1	PASS
8	3.5	PASS

Table 15 Sediment Feed: Angled 75% MFTR

Sample #	Sediment Feed Rate (g/min)
1	399.36
2	402.61
3	384.15
4	374.38
5	383.27
6	386.44
Average	388.37
COV	0.03
QA/QC COV ≤0.10	PASS

Table 16 Sediment Injected: Angled 75% MTFR

Sediment Mass Used (lb)	32.061
Sediment Mass Used Adjusted for Feed Samples (lb) & Sediment in inlet Pipe	29.478
Water Volume During Sediment Addition (gal)	17,695
Average Sediment Concentration (mg/L)	199.6
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.3 Grate Inlet, 25% of Target MTFR (0.375 cfs)**Table 17 Sampling Schedule: Grate 25% MTFR**

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
15		2
20	2	
29		3
40	3	
43		4
57		5
60	4	
71		6
80	5	
85		7
99		8
100	6	
MTD Detention Time = 4.01 minutes		

Table 18 Flow: Grate 25% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			$\pm 10\%$	COV	$COV \leq 0.03$
cfs	0.38	0.37	PASS	0.006	PASS
gpm	168	168.0			

Table 19 Temperature: Grate 25% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
74.6	PASS

Table 20 Background SSC: Grate 25% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	1.4	PASS
2	1.4	PASS
3	1.5	PASS
4	1.4	PASS
5	1.6	PASS
6	2.0	PASS
7	2.2	PASS
8	3.1	PASS

Table 21 Sediment Feed: Grate 25% MFTR

Sample #	Sediment Feed Rate (g/min)
1	148.88
2	126.37
3	131.98
4	136.42
5	127.49
6	121.32
Average	132.08
COV	0.07
QA/QC COV ≤0.10	PASS

Table 22 Sediment Injected: Grate 25% MTFR

Sediment Mass Used (lb)	28.289
Sediment Mass Used Adjusted for Feed Samples (lb) & Sediment in inlet Pipe	27.391
Water Volume During Sediment Addition (gal)	16,379
Average Sediment Concentration (mg/L)	200.4
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.4 Grate Inlet, 75% of Target MTFR (1.125 cfs)**Table 23 Sampling Schedule: Grate 75% MTFR**

Elapsed Time (minutes)	Sediment Feed Sample	Background sample
0	1	
1		1
6		2
7.5	2	
11		3
15	3	
16		4
21		5
22.5	4	
26		6
30	5	
31		7
36		8
37.5	6	
MTD Detention Time = 1.46 minutes		

Table 24 Flow: Grate 75% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			$\pm 10\%$	COV	COV ≤ 0.03
cfs	1.13	1.13	PASS	0.002	PASS
gpm	505	505.8			

Table 25 Temperature: Grate 75% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
74.5	PASS

Table 26 Background SSC: Grate 75% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	6.1	PASS
2	5.7	PASS
3	5.7	PASS
4	6.0	PASS
5	6.1	PASS
6	6.3	PASS
7	7.2	PASS
8	7.5	PASS

Table 27 Sediment Feed: Grate 75% MFTR

Sample #	Sediment Feed Rate (g/min)
1	442.72
2	382.03
3	367.19
4	386.22
5	379.54
6	385.00
Average	390.45
COV	0.07
QA/QC COV ≤0.10	PASS

Table 28 Sediment Injected: Grated 75% MTFR

Sediment Mass Used (lb)	32.081
Sediment Mass Used Adjusted for Feed Samples (lb) & Sediment in inlet Pipe	29.441
Water Volume During Sediment Addition (gal)	17,702
Average Sediment Concentration (mg/L)	199.3
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.5 Horseshoe Configuration, 25% of Target MTFR (0.375 cfs)**Table 29 Sampling Schedule: Horseshoe 25% MTFR**

Elapsed Time (minutes)	Sediment Feed Sample	Background Sample
0	1	
1		1
15		2
20	2	
29		3
40	3	
43		4
57		5
60	4	
71		6
80	5	
85		7
99		8
100	6	
MTD Detention Time = 4.01 minutes		

Table 30 Flow Horseshoe 25% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			$\pm 10\%$	COV	COV ≤ 0.03
cfs	0.38	0.37	PASS	0.009	PASS
gpm	168	168.1			

Table 31 Temperature: Horseshoe 25% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
72.6	PASS

Table 32 Background SSC: Horseshoe 25% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	2.7	PASS
2	1.6	PASS
3	1.7	PASS
4	1.9	PASS
5	2.1	PASS
6	1.7	PASS
7	2.4	PASS
8	2.6	PASS

Table 33 Sediment Feed: Horseshoe 25% MFTR

Sample #	Sediment Feed Rate (g/min)
1	128.73
2	128.45
3	128.54
4	128.81
5	128.61
6	127.21
Average	128.39
COV	0.01
QA/QC COV ≤0.10	PASS

Table 34 Sediment Injected: Horseshoe 25% MTFR

Sediment Mass Used (lb)	28.225
Sediment Mass Used Adjusted for Feed Samples (lb) & Sediment in inlet Pipe	27.375
Water Volume During Sediment Addition (gal)	16,391
Average Sediment Concentration (mg/L)	200.1
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.1.6 Horseshoe Configuration, 75% of Target MTFR (1.125 cfs)**Table 35 Sampling Schedule: Horseshoe 75% MTFR**

Elapsed Time (minutes)	Sediment Feed Sample	Background sample
0	1	
1		1
6		2
7.5	2	
11		3
15	3	
16		4
21		5
22.5	4	
26		6
30	5	
31		7
36		8
37.5	6	
MTD Detention Time = 1.46 minutes		

Table 36 Flow: Horseshoe 75% MTFR

Units	Target Flow	Actual Flow	QA/QC		
			$\pm 10\%$	COV	COV ≤ 0.03
cfs	1.13	1.13	PASS	0.003	PASS
gpm	505	505.9			

Table 37 Temperature: Horseshoe 75% MTFR

Maximum Temperature (°F)	QA/QC
	≤ 80°F
72.7	PASS

Table 38 Background SSC: Horseshoe 75% MTFR

Sample ID	Concentration (mg/L)	QA/QC
		≤ 20.0 mg/L
1	5.8	PASS
2	5.8	PASS
3	5.2	PASS
4	5.9	PASS
5	6.3	PASS
6	6.1	PASS
7	7.5	PASS
8	8.0	PASS

Table 39 Sediment Feed: Horseshoe 75% MFTR

Sample #	Sediment Feed Rate (g/min)
1	402.41
2	384.48
3	384.87
4	386.51
5	386.16
6	380.86
Average	387.55
COV	0.02
QA/QC COV ≤0.10	PASS

Table 40 Sediment Injected: Horseshoe 75% MTFR

Sediment Mass Used (lb)	32.039
Sediment Mass Used Adjusted for Feed Samples (lb) & Sediment in inlet Pipe	29.463
Water Volume During Sediment Addition (gal)	17,707
Average Sediment Concentration (mg/L)	199.4
QA/QC	
Total Mass Added \geq 25 lbs	PASS
Average Concentration within $\pm 10\%$ of 200 mg/L	PASS

4.2 Scour Testing

Scour testing was performed according to Section 5 of the NJDEP Protocol at 200% MTFR to verify the Arcadia's suitability for online use in all three alternate configurations. The sample schedule is provided in **Table 41**. QA/QC checks are provided in **Tables 42 through 47**. Effluent, background, and adjusted effluent SSC concentrations are provided in **Tables 48 through 50**. Adjusted effluent concentration was calculated by subtracting the paired background concentration from the raw measured effluent concentration. For effluent samples that were not paired with a background sample, the average of the surrounding background samples was used to calculate the adjusted SSC concentration. All background samples were below 20.0 mg/L. For sample concentrations below the detection limit of 1.0 mg/L, a value of one half the detection limit (0.5 mg/L) was used. The average adjusted effluent concentration was below 20.0 mg/L for all three alternate configurations, thus qualifying the Arcadia for online installation in those configurations.

Table 41 Sampling Schedule: Scour

Elapsed Time (minutes)	Effluent Sample	Background Sample
0		
1	1	1
3	2	
5	3	2
7	4	
9	5	3
11	6	
13	7	4
15	8	
17	9	5
19	10	
21	11	6
23	12	
25	13	7
27	14	
29	15	8

Table 42 Flow: Angled Inlet Scour

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	3.36	3.36	PASS	0.001	PASS
gpm	1508	1508.4			

Table 43 Temperature: Angled Inlet Scour

Maximum Temperature (°F)	QA/QC
	≤ 80°F
71.9	PASS

Table 44 Flow: Grate Inlet Scour

Units	Target Flow	Actual Flow	QA/QC		
			±10%	COV	COV≤0.03
cfs	3.36	3.36	PASS	0.001	PASS
gpm	1508	1508.2			

Table 45 Temperature: Grate Inlet Scour

Maximum Temperature (°F)	QA/QC
	≤ 80°F
73.6	PASS

Table 46 Flow: Horseshoe Configuration Scour

Units	Target Flow	Actual Flow	QA/QC	
			±10%	COV
cfs	3.36	3.36	PASS	0.003
gpm	1508	1508.6		

Table 47 Temperature: Horseshoe Configuration Scour

Maximum Temperature (°F)	QA/QC
	≤ 80°F
72.4	PASS

Table 48 SSC Angled Inlet Scour

Sample ID	Effluent Concentration (mg/L)	Background Concentration (mg/L)	BG QA/QC	Adjusted Effluent Concentration (mg/L)
			≤ 20.0 mg/L	
1	0.5	1.6	PASS	0.0
2	18.4		PASS	17.4
3	9.0	0.5	PASS	8.5
4	6.6		PASS	5.9
5	7.0	1.0	PASS	6.0
6	6.7		PASS	5.5
7	10.3	1.5	PASS	8.8
8	8.0		PASS	6.3
9	8.5	2.0	PASS	6.5
10	10.4		PASS	8.3
11	7.3	2.2	PASS	5.1
12	8.1		PASS	5.8
13	11.2	2.4	PASS	8.8
14	7.5		PASS	5.1
15	7.2	2.5	PASS	4.7
AVERAGE			PASS	6.8

Table 49 SSC Grate Inlet Scour

Sample ID	Effluent Concentration (mg/L)	Background Concentration (mg/L)	BG QA/QC	Adjusted Effluent Concentration (mg/L)
			≤ 20.0 mg/L	
1	0.5	3.7	PASS	0.0
2	2.9		PASS	0.0
3	2.5	3.3	PASS	0.0
4	3.0		PASS	0.0
5	3.2	3.1	PASS	0.1
6	3.1		PASS	0.0
7	3.0	4.3	PASS	0.0
8	4.0		PASS	0.0
9	4.0	5.1	PASS	0.0
10	5.3		PASS	0.0
11	5.0	5.8	PASS	0.0
12	5.7		PASS	0.0
13	6.2	7.1	PASS	0.0
14	6.9		PASS	0.0
15	6.6	7.4	PASS	0.0
AVERAGE			PASS	0.0

Table 50 SSC Horseshoe Configuration Scour

Sample ID	Effluent Concentration (mg/L)	Background Concentration (mg/L)	BG QA/QC	Adjusted Effluent Concentration (mg/L)
			≤ 20.0 mg/L	
1	0.5	2.4	PASS	0.0
2	32.4		PASS	30.1
3	25.0	2.3	PASS	22.7
4	19.0		PASS	16.7
5	16.4	2.3	PASS	14.1
6	17.4		PASS	14.6
7	16.4	3.3	PASS	13.1
8	17.0		PASS	13.7
9	18.3	3.3	PASS	15.0
10	19.1		PASS	15.0
11	19.1	4.9	PASS	14.2
12	17.1		PASS	12.2
13	17.2	4.9	PASS	12.3
14	19.9		PASS	14.7
15	18.4	5.6	PASS	12.8
AVERAGE			PASS	14.7

5. Statements

The following signed statements from the manufacturer (Advanced Drainage Systems, Inc.), third-party observer (Sustainable Stormwater Solutions Engineering, LLC), 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.



August 28, 2025

Dr. Richard S. Magee, Sc.D., P.E., BCEE
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 the Arcadia

Dr. Richard Magee,

Advanced Drainage Systems has completed verification testing for the ADS Arcadia Alternate Configurations in accordance with the *"New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device"* (April 25, 2023). ADS is pleased to provide this letter as our statement that all procedures and requirements identified in the protocol were met and exceeded. The testing was performed at the Hydraulic Laboratory in the ADS Engineering & Technology Center, located in Hilliard, Ohio under the direct supervision of independent consultant Dr. Ryan Winston in compliance with all applicable protocol and process criteria. All data pertaining to the Arcadia Alternate Configurations NJDEP Protocol test is included in the Verification Report.

If you have any questions or comments regarding the verification, please do not hesitate to contact us.

Regards,

Bo Liu, P.E. Ph.D.
Advanced Drainage Systems
Senior Engineer
Phone (301)252-0418
e-mail: bo.liu@adspipe.com

cc Joe Chylik, ADS

Our reason is water.™

Advanced Drainage Systems, Inc. 4640 Trueman Boulevard, Hilliard, OH 43026 Tel: (614)658-0050 adspipe.com



Sustainable Stormwater Solutions Engineering

September 8, 2025

To: Gordon Baugh, Advanced Drainage Systems, Inc. (ADS)
From: Ryan Winston, PhD, P.E., Sustainable Stormwater Solutions Engineering, LLC
Subject: Third Party Verification of Alternate Configurations of the Arcadia™ Hydrodynamic Separator
CC: Bo Liu, Advanced Drainage Systems, Inc. (ADS)

**Subject: Witness Statement
Third Party Observer**

Sustainable Stormwater Solutions Engineering (SSSE) served as the third-party observer for Alternate Configurations testing performed on the Arcadia™ Hydrodynamic Separator model AR4 in the Hydraulics Laboratory of ADS, Inc., located in their Engineering and Technology Center at 4671 Raindrop Way, Hilliard, Ohio. Hydraulics, removal efficiency, and scour tests were performed in July and August 2025 following QAPP approval in July 2025. Tests were conducted to confirm performance of Alternate Configurations through the New Jersey Department of Environmental Protection (NJDEP) according to the *Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (NJDEP protocol). This document was dated January 1, 2021, and subsequently updated on April 25, 2023. I was on site during all tests documented in the attached report and verified the compliance with the test protocol above. I was present to observe all testing procedures including sampling intervals, sample volumes, flow rates, water temperature measurements, head loss calculations, sediment feed rate, sediment recovery, and sediment mass captured in the inlet pipes and test unit. I was present and witnessed labeling, completion of COC forms, and packaging of samples for shipment to the external laboratory.

I have reviewed the data, calculations, and conclusions associated with the hydraulic, removal efficiency, and scour testing in the Arcadia™ Hydrodynamic Separator report by ADS, Inc. dated September 2025. I state that the results presented therein conform to what I observed during my supervision as a third-party observer.

Thank you,



Ryan J. Winston, PhD, P.E.
Sustainable Stormwater Solutions Engineering

Sustainable Stormwater Solutions Engineering

September 8, 2025

To: Gordon Baugh, Advanced Drainage Systems, Inc. (ADS)
From: Ryan Winston, PhD, P.E., Sustainable Stormwater Solutions Engineering, LLC
Subject: Third Party Verification of Alternate Configurations of the ~~Arcadia~~TM Hydrodynamic Separator
CC: Bo Liu, Advanced Drainage Systems, Inc. (ADS)

Subject: Conflict of Interest Statement

Sustainable Stormwater Solutions Engineering, LLC (SSSE) served as the third-party observer for hydraulic, removal efficiency, and scour tests performed on Alternate Configurations of the ~~Arcadia~~TM AR4 Hydrodynamic Separator in July and August 2025. Tests were conducted to achieve certification through the New Jersey Department of Environmental Protection (NJDEP) according to the *Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (NJDEP protocol). SSSE has no financial conflict of interest regarding the test results of this stormwater treatment device. SSSE and ADS have no relationships beyond this testing agreement that would constitute a conflict of interest. For instance, SSSE does not own stock in ADS, have partial ownership of the company, nor have licensing agreements with the company. SSSE has not received funds from ADS beyond those associated for third party observation of testing for the ~~Arcadia~~TM.

Thank you,



Ryan J. Winston, PhD, P.E.
Sustainable Stormwater Solutions Engineering



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

September 20, 2025

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

Dear Mr. Mahon,

Based on my review, evaluation and assessment of the testing conducted on the ADS Arcadia™ Hydrodynamic Separator Alternative Configurations, the test protocol requirements contained in the “*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*” (NJDEP HDS Protocol, January 1, 2021- Updated April 25, 2023) were met or exceeded consistent with the NJDEP Approval Process. Specifically:

Test Sediment Feed

The mean PSD of the test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be finer than the sediment blend specified by the protocol ($<75\ \mu\text{m}$); the test sediment D_{50} was 54 microns, significantly finer the test sediment used to verify the Arcadia with flow passing straight through, i.e., inlet and outlet pipes set opposite to each other, offset at 180 degrees,. The scour test sediment PSD analysis was plotted against the NJDEP scour test PSD specification and shown to meet the protocol specifications.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on an Arcadia ARC4 test unit comprised of full-scale, commercially available internal components to demonstrate the ability of the Arcadia ARC4 to remove the NJDEP protocol specified test sediment at 25%, and 75%, of the previously target MTFR for three alternate pipe inlet/outlet configurations.

All three configurations successfully demonstrated sediment removal rates within $\pm 5\%$ of the original configuration test results as required by the protocol. As a result, these three alternate configurations performances are now NJCAT verified and can be NJDEP certified.

Scour Testing

The scour testing was conducted at 1508 gpm which is equal to 200% of the MTFR. The scour test was conducted with the unit preloaded with 4.0" of levelled sediment to the 50% capacity level for each configuration prior to conducting the test. A total of 15 effluent samples were collected throughout the test. The average calculated concentrations, adjusted for background, ranged from 0.0 mg/L for the grate inlet, to 6.8 mg/L for the angled inlet, to 14.7 mg/L for the horseshoe configuration, qualifying the Arcadia for online installation for all three configurations.

Sincerely,



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

6. References

Advanced Drainage Systems, Inc. 2025. *Quality Assurance Project Plan for ADS Arcadia™ Testing Addendum*. Prepared by Advanced Drainage Systems, Inc. July, 2024.

ASTM (2017). *Standard Test Methods for Particle-Size Distribution (Gradation of Soils Using Sieve Analysis)*, Annual Book of ASTM Standards, D6913/D6913M-17, Vol. 4.09.

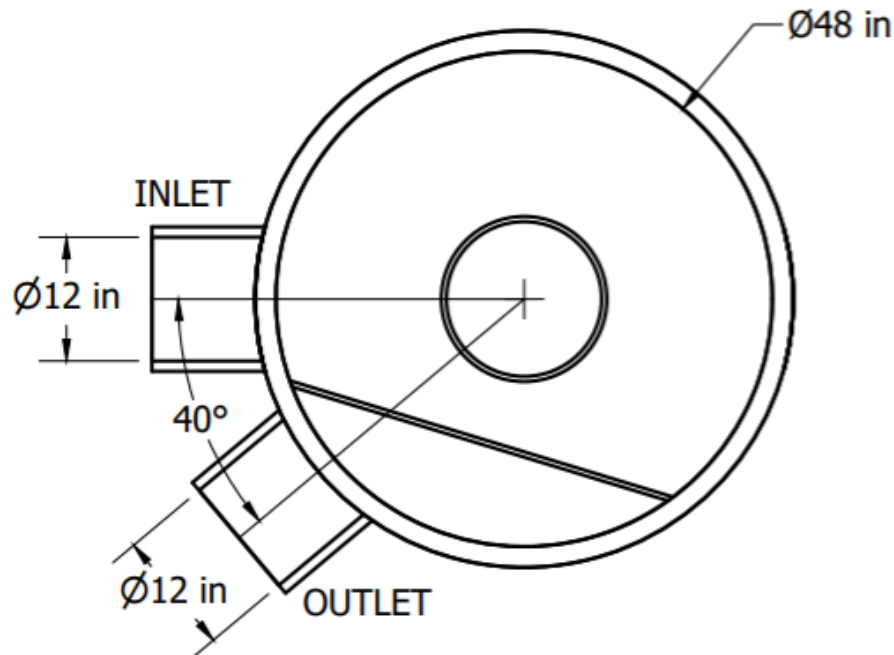
ASTM (2019). *Standard Test Methods for Determining Concentrations in Water Samples*, Annual Book of ASTM Standards, D3977-97, Vol. 11.02.

NJDEP (2021). *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. August 4, 2021.

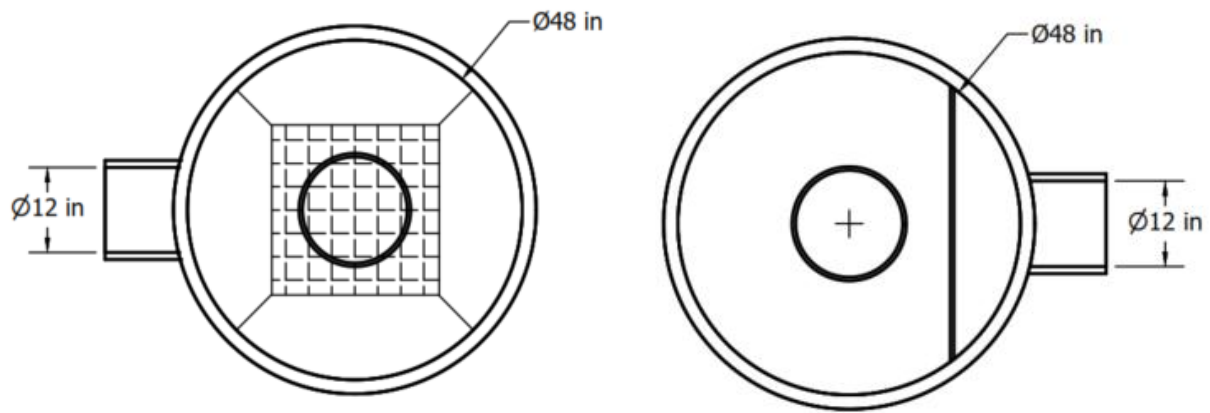
NJDEP (2021). *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device*. Trenton, NJ. January 1, 2021 (updated April 25, 2023).

VERIFICATION APPENDIX

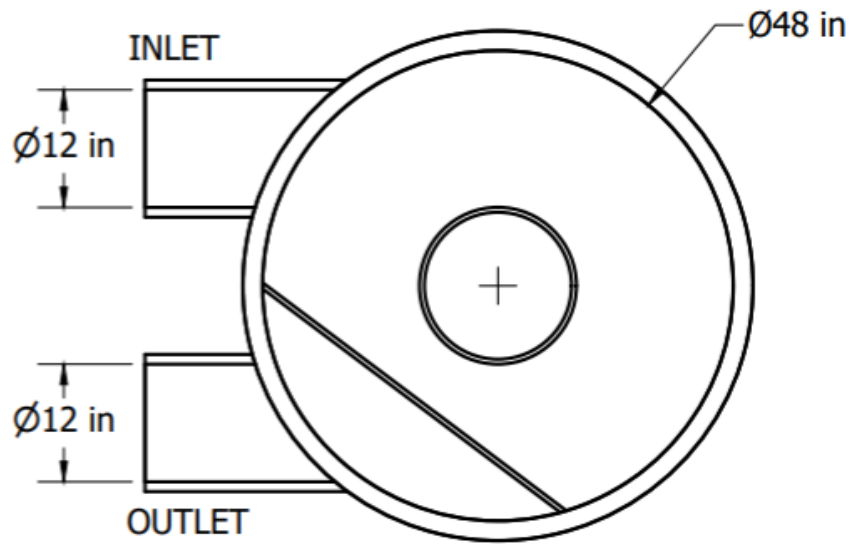
To allow for greater flexibility during design and installation the performance of the Arcadia™ Hydrodynamic Separator was tested in accordance with the requirements of Section 1 of the NJDEP HDS Protocol. Arcadia models previously NJCAT verified in May 2025 (**Tables A-1 and A-2** on pages, 40-41) with flow passing straight through, i.e., inlet and outlet pipes set opposite to each other, offset at 180 degrees, have successfully demonstrated alternate pipe configurations performance. Three (3) alternate piping configurations were tested at 25% and 75% of the original manufacture's MTFR target as required by the Protocol. All three configurations successfully demonstrated sediment removal rates within $\pm 5\%$ of the original configuration test results. As a result, these three configurations pictured below are now NJCAT verified and can be NJDEP certified.



Plan View of the Arcadia in Angled Inlet Configuration



Plan View of the Arcadia in Grate Inlet Configuration



Plan View of the Arcadia in Horseshoe Configuration