NJCAT TECHNOLOGY VERIFICATION

Modular Wetlands® 360
Biofiltration
Stormwater Treatment Device

Contech Engineered Solutions, LLC
a Quikrete Company

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1. Description of Technology

The Modular Wetlands® 360 is a biofiltration system designed by Contech Engineered Solutions, LLC (Contech), a Quikrete company.

The Modular Wetlands® 360 (MW360) is designed to optimize the treatment of entering stormwater utilizing a biofiltration chamber that includes one or more round horizontal flow biofilter media beds. The system has no moving parts and operates utilizing the principles of gravity separation and biofiltration.

Runoff is directed into the system via an inflow pipe (or curb/grate opening) and enters the system as illustrated in **Figure 1**. Depending on the configuration, runoff can either enter directly into the biofiltration chamber (**Figure 2**) or via an optional peak diversion chamber that functions as an upstream bypass, as illustrated in **Figure 3**. Systems can be either under ground or open planter. In open planter systems the top tray covers the sedimentation area, and the mulch is for aesthetic purposes to integrate with the surrounding landscaping. The testing outlined in this report was done on the standalone biofiltration chamber without the peak diversion chamber or top tray. Water enters the void area surrounding the biofilter media bed, which acts as a peripheral sedimentation/pre-treatment chamber. As water travels around the void area, larger sediments and debris will settle out. This area also allows for the storage of floatables and trash.

The MW360 contains a round/cylindrical media bed containing a granular biofiltration media. The outer perimeter of the media bed is contained with a wire mesh cage and fabric netting. On the influent side of the cage there is a pre-treatment fabric wrap that protects the surface of the media from organic material and debris that could coat the surface of the media bed.

Water travels through the media bed radially from the outer perimeter to the inner and centrally located vertical underdrain. The underdrain contains an internal multi-level orifice riser that controls the loading rate through the media as shown in **Figure 1**. As water passes down through the middle of the orifice riser it flows towards the horizontal underdrain (a manifold in systems with multiple media beds) on the floor of the chamber. From there, treated water exits the system through the sidewall. The MW360 can contain one or more cylindrical media beds as shown in **Figure 2**. In models with multiple media beds, the horizontal underdrain manifold connects the beds in series before exiting the system. Models with multiple rows of media beds include multiple horizontal underdrain manifolds installed in parallel. For this evaluation, a MW360-4-4 was tested, which has a singular media bed.

The MW360 can be configured with an optional upstream diversion for flows that exceed the MTFR by directing water from a peak diversion chamber directly into the discharge chamber to ensure the system is functionally offline and prevent scouring of previously captured sediment.

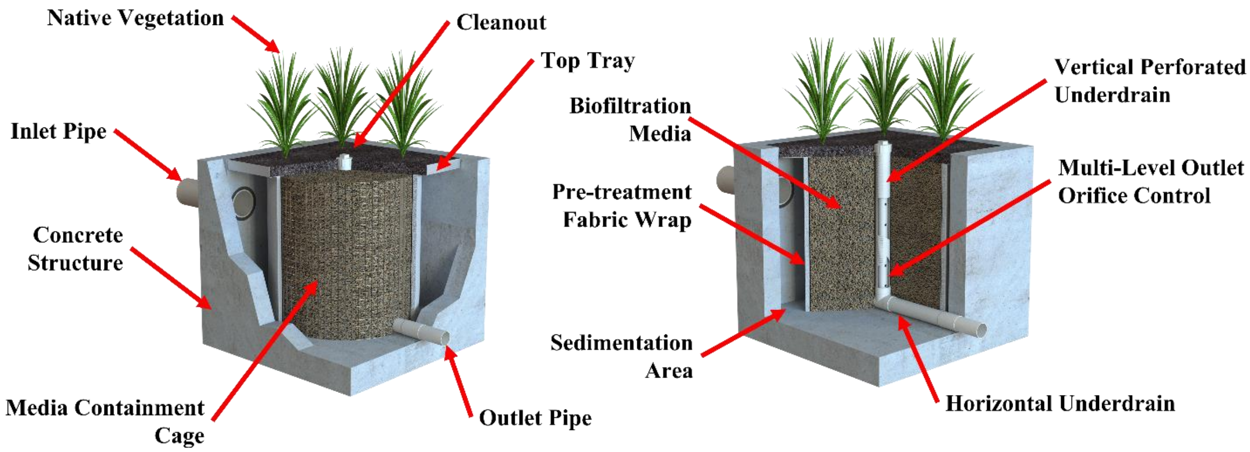

Figure 1 Modular Wetlands® 360 Operation Overview

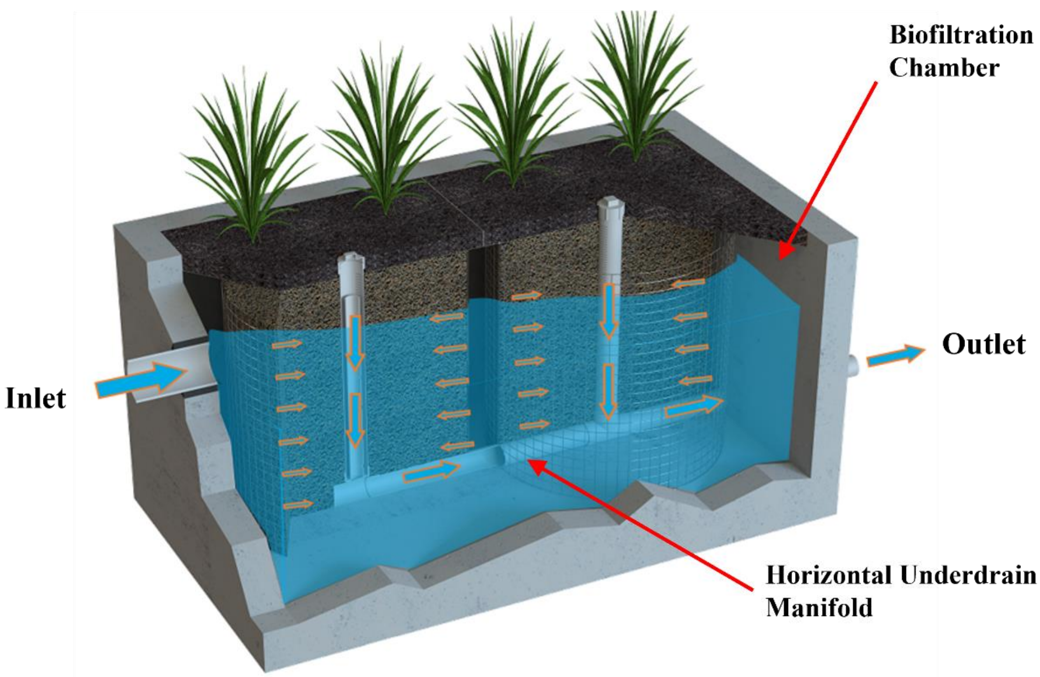

Figure 2 Treatment Flow Path - Cutaway View

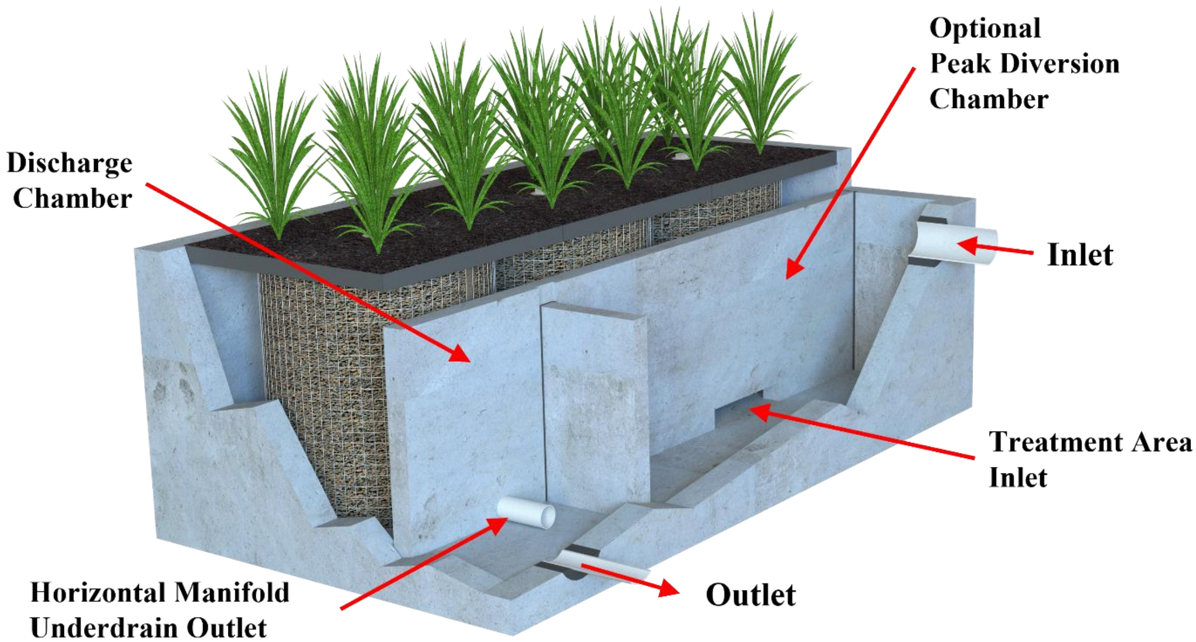

Figure 3 Cutaway View – Peak Diversion Chamber

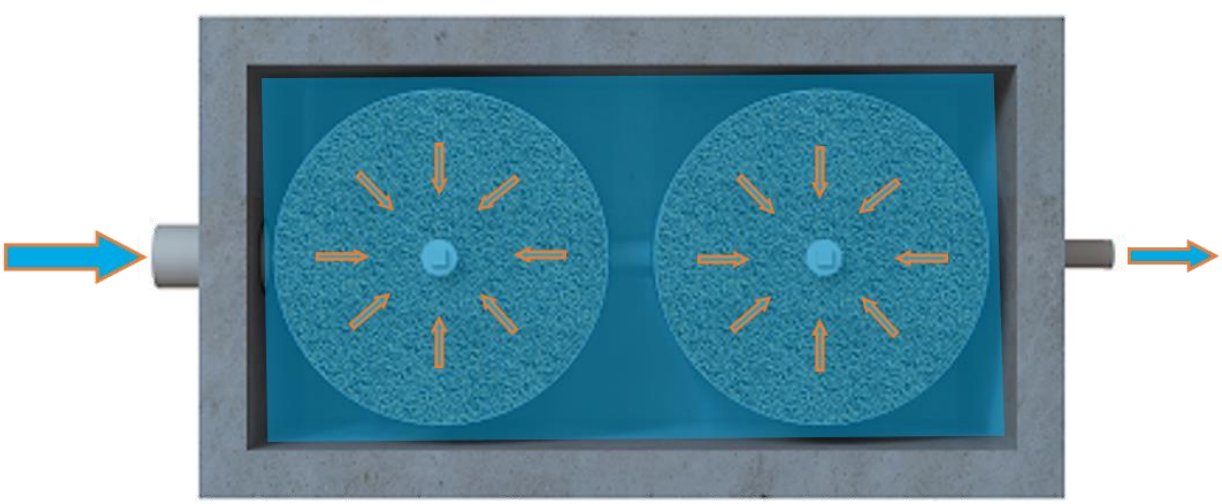

Figure 4 Treatment Flow Path - Top View

2. Laboratory Testing

Testing was performed to determine:

- The hydraulic characterization of the full-scale MW360-4-4.
- The sediment cumulative removal efficiency (80% target) using the grab sample test method.
- The sediment mass load capacity (until >10% reduction in flow capacity or a reduction in cumulative sediment removal efficiency below 80%).

Testing was completed in July-August 2022 at Contech's Laboratory in Oceanside, California. Testing was completed in accordance with the *New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January 14, 2022)*. Independent third-party observation was provided by Charlie Davidson, Regional Manager/Senior Scientist, and Jillian Wulf, Environmental Scientist, at Kinnetic Environmental, vetted and approved by Dr. Richard Magee prior to testing per the protocol. Mr. Davidson and Ms. Wulf have extensive background in water quality monitoring. Mr. Davidson and Ms. Wulf have no conflicts of interest that would disqualify them from serving as the independent third-party observer during this testing process.

The test unit is a 48-inch by 48-inch wooden structure **Figure 5**. It is designed to replicate a MW360-4-4 model. The test unit contains standard internal components and biofiltration media (**Figure 6**). In commercial systems, the internal components are typically housed in a concrete, plastic, or fiberglass structure. The wooden test unit is equivalent to the commercial concrete structure in all key internal dimensions. Thus, the effective sedimentation treatment area (ESTA) and related ratio to effective filtration treatment area (EFTA) is precisely the same as the commercially available concrete model. Contech's Oceanside Laboratory has limited lifting capacity and available space, so a lightweight housing was necessary.

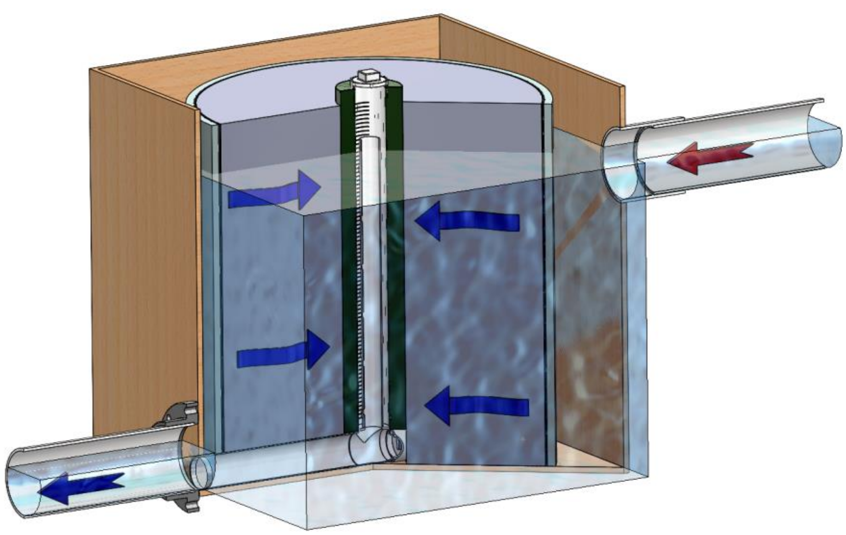

Figure 5 MW360-4-4 Test Unit - Cutaway View - Flow Path Shown

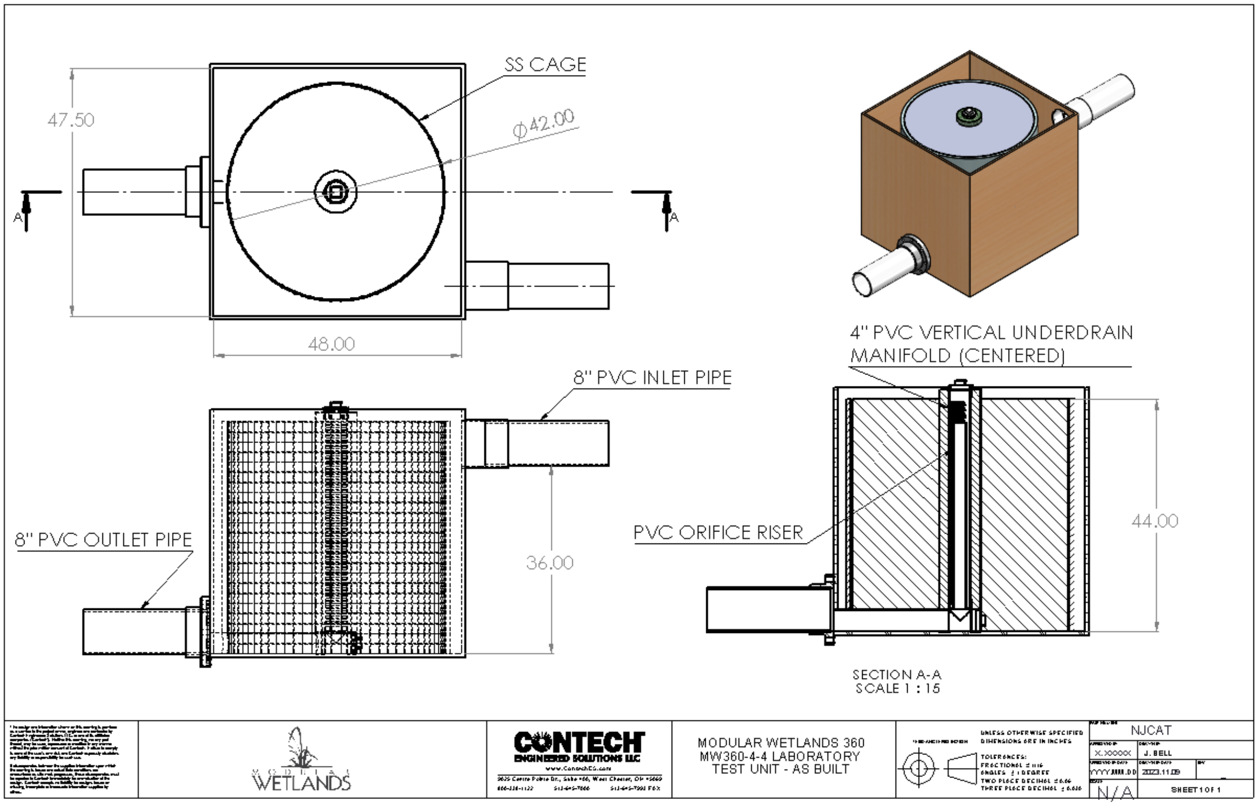

Figure 6 MW360-4-4 Detailed Drawing

2.1 Test Setup

The design specifications of the Modular Wetlands® 360 Model MW360-4-4 tested are provided in **Table 1**. The test unit had a single media cage with a surface area of 36.65 ft^2 per cylinder. The maximum treatment flow rate (MTFR) tested on the MW360 test unit was 62 gpm, or 0.138 cfs.

Table 1 Modular Wetlands® 360 – MW360-4-4 – Test Unit Dimensions

MTFR		Length (in)	Width (in)	Operational Height (in)	Media Surface Area per Cylinder (ft^2)	Total Cartridges (#)	Loading Rate (gpm/ft^2)
(cfs)	(gpm)						
0.138	62	48.0	47.5	40	36.65	1	1.7

The laboratory test set-up was a recirculating test loop, capable of moving water across a range of flowrates. The test loop, illustrated in **Figure 7**, was comprised of water supply/storage tanks, pumps, sediment filters, receiving tanks and flow meters. The configuration for performance and mass load testing utilized a centrifugal pump to deliver flow through a pressurized filter vessel prior to reaching the test unit.

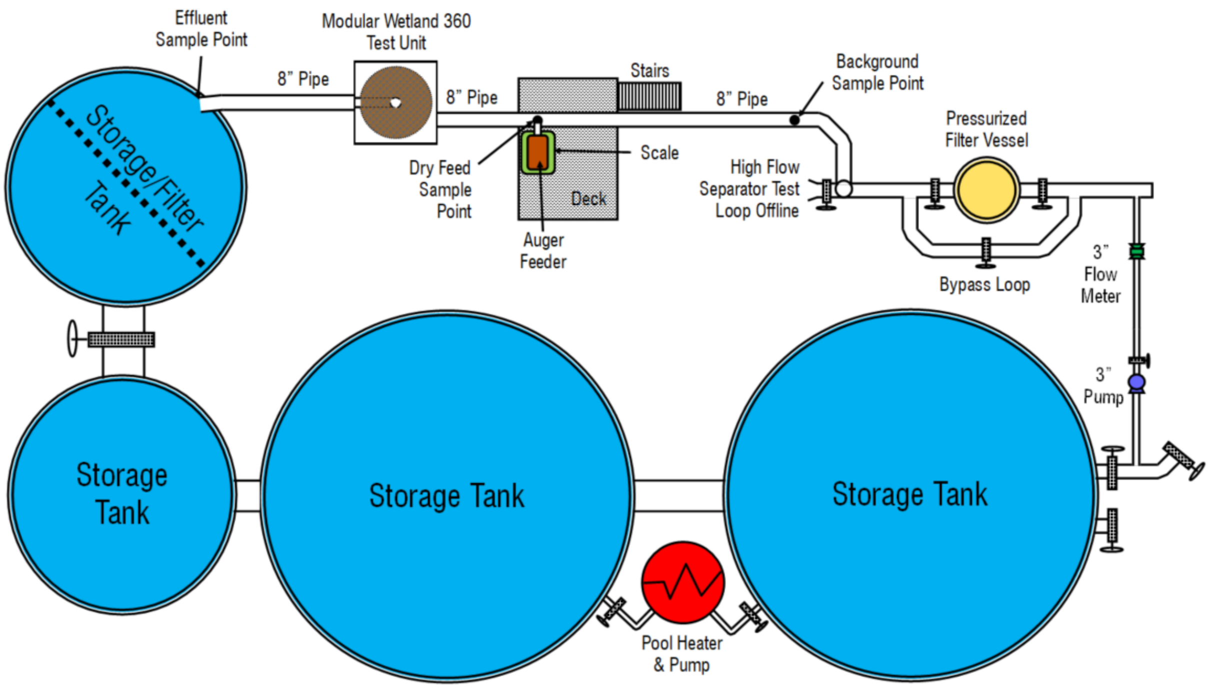

Figure 7 Laboratory Test Flow Apparatus - Performance Evaluation

Water Flow and Measurement

Water was pumped from the supply tanks using a Xylem AC e-1500, 3x3x9.5C 5 HP (10 - 200 gpm) centrifugal pump during all removal efficiency and mass loading test runs. The pump was controlled by an Aquavar IPC AVA20200B0F0x0x1 Variable Frequency Drive (VFD). Flow measurement was done using a Toshiba LF654 Flanged Mount Magmeter (combined type) electromagnetic flow meter with an accuracy of ± 0.5% of reading with 3-inch flanges calibrated prior to testing in accordance with manufacturer recommendations. The data logger was a MadgeTech CurrentX4 30MA, 4-Channel, current type with related software, configured to record a flow measurement once every 5 seconds.

Prior to sediment injection, water passes through a pressurized filter vessel containing high-efficiency, high-surface area pleated paper filters with a 1.0 micron (µm) absolute rating. Filtering the water prior to entering the test unit serves to ensure background TSS concentrations remain below 20 mg/L. The influent pipe was 8-inches in diameter with a slope of 2.0%. Sediment was introduced to the influent pipe via an Acrison Model 105X volumetric screw feeder with a spout attachment and motor controller that delivered sediment to a 5-inch diameter port at the crown of the influent pipe 36.0-inches upstream of the MW360 test unit. The feeder has a 1 cubic foot hopper at the upper end of the auger to provide a constant supply of sediment.

After entering the test unit and passing through the biofiltration media, treated flow exits the MW360 through an 8-inch diameter outlet pipe that terminates with a free-fall into a receiving tank (Storage/Filter Tank) to complete the flow loop. The length of the 8-inch diameter outlet pipe is 108-inches with a slope of 2.0%. Observations documented that no sediment was deposited in either the inlet or outlet pipe during any of the test runs.

Sample Collection

Background water samples were grabbed by hand in 1-L narrow-mouth bottles from a 0.75-inch sampling port located 198-inches upstream of the sediment auger feeder. The sampling port was controlled manually by a ball valve that was opened approximately 0.5 seconds prior to sampling to purge any collected sediment (**Figure 8**).

Effluent samples were also collected by hand by sweeping a wide-mouth 1-L bottle through the stream of freely discharging effluent flow such that the jar was full after a single pass (**Figure 9**). Draw-down effluent samples were also collected by the same sampling method.

Sediment feed rate samples were collected during each test run at the spout of the Acrison screw feeder in 500 mL jars. The jar was held in the stream of freely discharging sediment flow for a duration of 1 minute (**Figure 10**) since at the target loading rate the collection interval of one minute was achieved before a volume of 0.1 liter.

Figure 8 Background Sampling Port

Figure 9 Effluent Discharge and Sampling Point

Figure 10 Sediment Injection and Sampling Point

Other Instrumentation and Measurement

Water temperature was taken inside the filter chamber using an Elitech RC-5+ PDF USB Temperature Data Logger that automatically logs the temperature in 1-minute intervals. The maximum temperature from each run was selected from the data log.

A water surface level (WSL) reading was recorded manually at the beginning and end of each run (**Figure 11**). A yardstick mounted to the inside of the wall of the filter chamber was visually observed (to within 1/8 inch) to record the levels. The ending water level in the chamber was used to time the two drain-down samples based on two-thirds and one-third of the volume during that run. Run and sampling times were measured using a Thomas Scientific NIST traceable stopwatch, manufactured by Control Company Model 8788V77.

Figure 11 Water Surface Elevation Reading and Temperature Sensor Location

The sediment feed samples taken during each run were weighed on a precision balance (Mettler Toledo, MS1003TS/00). The total mass of sediment in the auger feeder was determined by weighing it on an Arlyn Scales, Model-SAW-MXL Ultra Precision balance at the beginning and end of each run to determine the mass injected during the run. The balance was placed permanently under the auger to allow the before and after weights to be taken without manually removing the sediment after each run. To maintain a consistent feed rate, the volume of sediment in the feeder was kept approximately constant by the addition of sediment during each test run. The additional sediment came from a 5-gallon container that was weighed on a balance (Mettler Toledo, PBA655-B60 US) at the beginning and end of each run.

2.2 Test Sediment

Due to the number of runs completed, two separate lots of test sediment were used. Both lots of test sediment were purchased from and custom blended by GHL (Good Harbours Laboratories, Mississauga, Ontario, Canada) using various commercially available silica sands. GHL lot A028-095 was used for Runs 1 - 66, and GHL lot A029-151 was used for Runs 67 - 118. Test sediment was analyzed for particle size distribution using ASTM method 6913 (Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis) and ASTM D7928 (Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis).

For lot A028-095, test sediment was provided by GHL in sealed 55-gallon drums. Bureau Veritas (Calgary, Alberta, Canada) was utilized to complete particle size distribution analysis (PSD) on composite samples from the sediment lot to ensure protocol compliance.

Prior to sampling for PSD compliance, each drum of sediment was opened, and the security seals were removed in the presence of the third-party observer. Representative samples were taken from each drum (at the top, middle and bottom of the drum) and were composited into three separate five-gallon buckets. Once all the drums were sampled, each of the three composite sample buckets were thoroughly mixed, and a single sample was taken from each bucket to be sent for analysis. Samples of approximately 500 grams were placed into glass jars, which were then sealed, labelled, and packaged for transport to the testing laboratory for analysis. Sample jars were immediately packaged and shipped to Bureau Veritas. Chain of Custody (COC) paperwork was provided to the laboratory requesting analysis per ASTM D6913-17 (sieve) and ASTM D7928-21 (hydrometer). The PSD results are summarized in **Table 2** and shown graphically in **Figure 12**. The measured and interpolated results indicate compliance with the requirements of the *New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January 14, 2022)* with no average particle size coarser than the target by two percentage points and a the average d_{50} not greater than 75µm.

Table 2 PSD of Removal Efficiency Test Sediment (Runs 1 – 66)

Particle Size (Microns)	Test Sediment Particle Size (% Less Than)[1]				Specification[2] (Minimum % Less Than)	QA/QC
	Sample 1	Sample 2	Sample 3	Average		
1000	99.8	100.0	99.8	99.9	100	PASS
500	97.4	98.0	97.6	97.7	95	PASS
250	88.9	90.2	89.9	89.7	90	PASS
150	78.9	78.5	79.0	78.8	75	PASS
100	57.9	59.4	57.4	58.2	60	PASS
75	51.9	52.7	51.6	52.1	50	PASS
50	43.5	42.9	43.5	43.3	45	PASS
20	34.4	34.4	35.2	34.7	35	PASS
8	19.2	21.3	20.0	20.2	20	PASS
5	13.4	14.8	13.8	14.0	10	PASS
2	7.7	8.6	8.4	8.2	5	PASS
d_{50}	69.3	68.1	70.1	**69.2**	≤ 75 µm	PASS

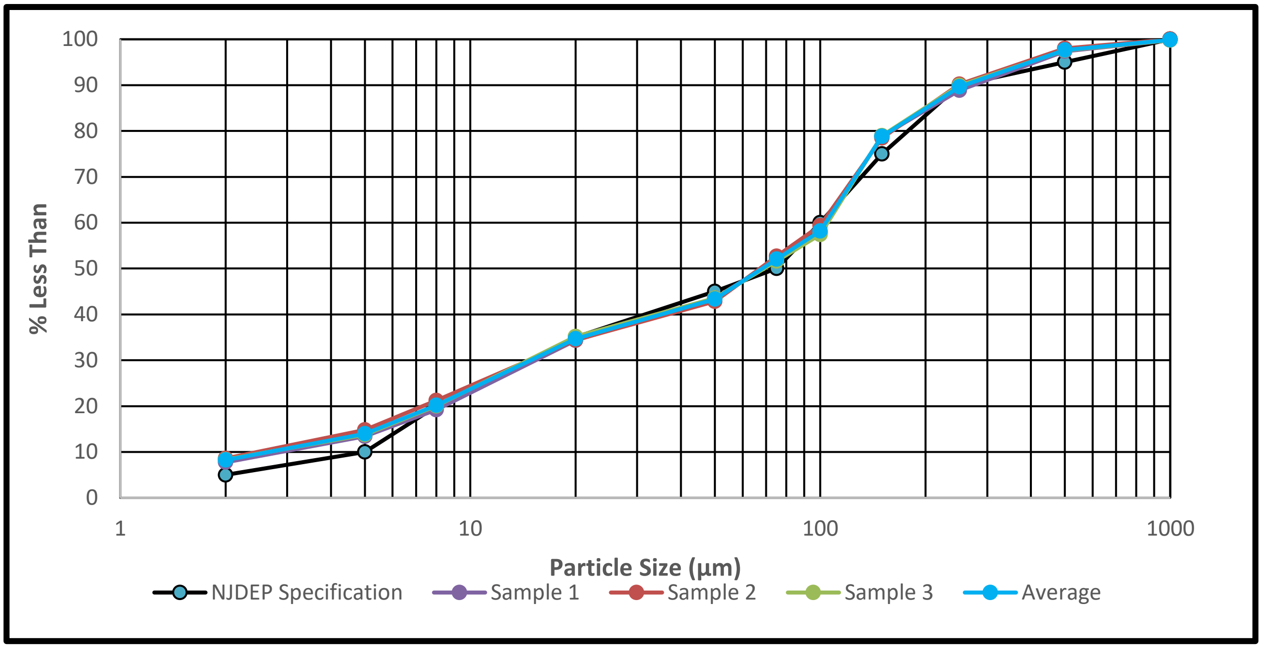

Figure 12 Particle Size Distribution of Removal Efficiency Test Sediment (Runs 1 – 66)

To ensure compliance of Lot A029-151 (runs 67-118) with NJDEP PSD requirements, each drum was opened, and the security seals were removed to facilitate sampling. Representative samples were taken from each drum (at the top, middle, and bottom of the drum) and were composited into three separate five-gallon buckets. When all drums were sampled and composites placed into the buckets, the buckets were thoroughly mixed, and a single sample was taken from each bucket to be sent for analysis. Samples of approximately 500 grams were placed into glass jars, which were then sealed, labelled, and packaged for transport to IAS Laboratories in Phoenix, AZ for analysis per ASTM D6913-17 (sieve) and ASTM D7928-21 (hydrometer). IAS Laboratories was used to complete the analysis to accommodate the testing schedule and reduce lead times. All handling of the sediment drums, sampling, and preparation for shipment was done in the presence of the third-party observer. The PSD results are summarized in **Table 3** and shown graphically in **Figure 13.** The measured and interpolated results indicate compliance with the requirements of the protocol with no average particle size coarser than the target by two percentage points and the average d_{50} not greater than 75 µm.

Table 3 Removal Efficiency Test Sediment PSD (Runs 67 – 118)

Particle Size (Microns)	Test Sediment Particle Size (% Less Than)[1]				Specification[2] (Minimum % Less Than)	QA/QC
	Sample 1	Sample 2	Sample 3	Average		
1000	100.0	100.0	100.0	100.0	100	PASS
500	95.4	95.4	95.4	95.4	95	PASS
250	88.9	88.8	88.8	88.8	90	PASS
150	80.0	79.9	79.0	79.5	75	PASS
100	59.0	59.1	59.2	59.1	60	PASS
75	51.4	51.4	51.4	51.4	50	PASS
50	48.3	46.5	48.3	47.7	45	PASS
20	44.9	39.6	40.9	41.8	35	PASS
8	30.3	30.3	30.3	30.3	20	PASS
5	25.2	24.1	24.1	24.5	10	PASS
2	15.2	14.4	14.4	14.7	5	PASS
d_{50}	68.7	69.8	68.4	**69.0**	≤ 75 µm	PASS

[1] Where required, particle size data has been interpolated to allow for comparison to the required NJDEP particle size specification.

[2] Per NJDEP, a measured value (three-sample average) may be lower than a target minimum % less than value by up to two percentage points provided that the measured d_{50} value does not exceed 75 microns.

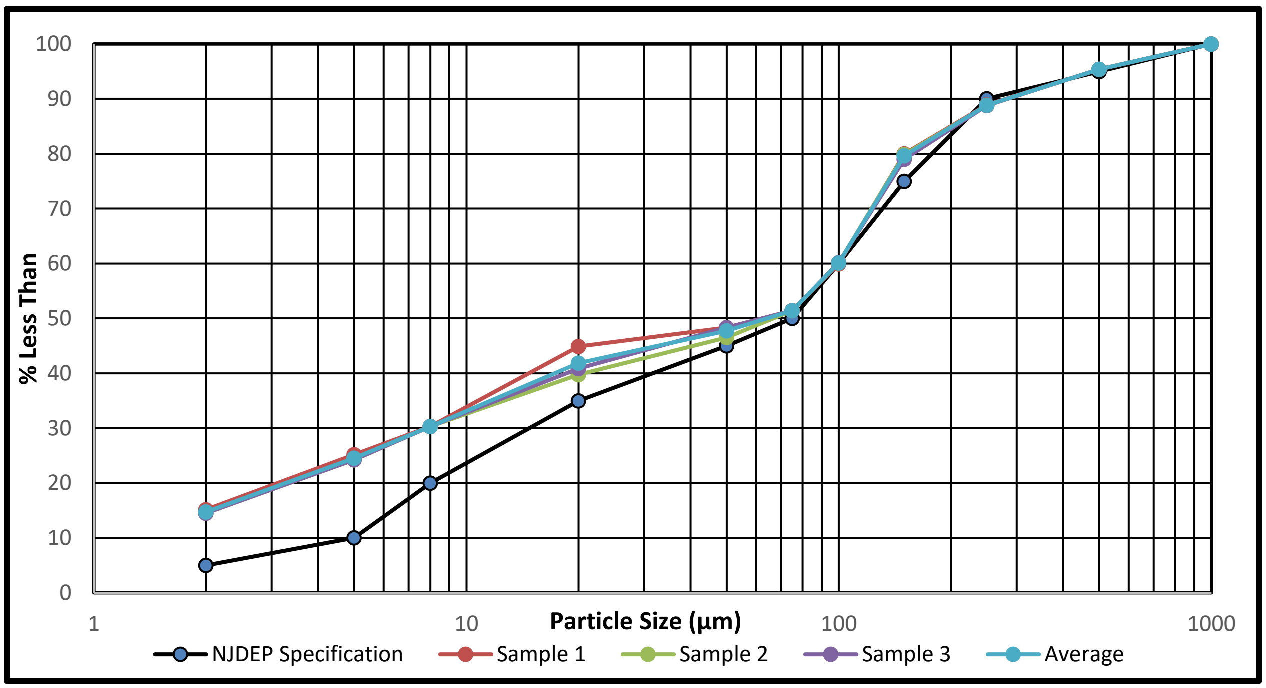

Figure 13 Particle Size Distribution of Removal Efficiency Test Sediment (Runs 67 – 118)

2.3 Removal Efficiency Testing Procedure

Removal efficiency testing was conducted on a clean unit. Removal efficiency testing was performed as specified in Section 4 of the NJDEP Laboratory Protocol for Filtration MTDs. While the protocol only requires a minimum of 10 runs for removal efficiency testing an additional 5 runs were completed in case of any unforeseen QC issues with specific runs, for a total of 15 removal efficiency test runs.

At the beginning of each run, flow was introduced to the test unit at the target MTFR, and the water surface elevation allowed to stabilize. Time zero coincides with the start of sediment feed. The test sediment feed was sampled three times per run to confirm the sediment feed rate. Each sediment feed sample was collected in a 500-mL bottle over a one-minute interval timed to the nearest hundredth of a second. Feed samples were evenly spaced over the duration of the 45-min run, with the first at time zero, one in the middle, and one at the end of the run as listed in **Table 4**.

To ensure consistency across all runs, the detention time for the sampling plan was based on the maximum possible water surface elevation in the test unit at a height of 44-in corresponding to a detention time of 5.72-min. Since the water surface elevation did not reach the maximum possible elevation, all effluent grab sampling began more than three MTD detention times after the initial sediment feed sample was taken. The time interval between effluent samples was 5 minutes, however, when the test sediment feed was interrupted for measurement, the next effluent sample was collected following more than three MTD detention times from the time the sediment feed was re-established. A total of 6 effluent samples were taken during each run to determine the amount of mass captured by the system. A total of 3 background samples were taken paired with the odd-numbered effluent samples.

Two evenly spaced volume paced drawdown samples were taken at one-third and two-thirds of the drawdown volume after the flow was cut off at the end of each run. Prior to testing, the drawdown volume was quantified as a function of water surface elevation within the unit by filling the test unit with clean water and quantifying the volume. The water level in the biofilter chamber at the end of each run was used to establish the water levels that each of the two drawdown samples were taken. Since the ending water level increased over the course of the testing, the water surface levels when the drawdown samples were taken changed proportionally. The drawdown mass was calculated using **Equation 6** (page 17) and used in **Equation 7** in the removal efficiency calculation.

After completion of 15 removal efficiency test runs, an additional 103 mass loading test runs were completed. The mass loading runs were the same as the removal efficiency test runs except that the influent concentration was increased to 400 mg/L per the protocol to accelerate loading. Feed sample duration and timing, effluent timing, background sampling timing were the same for all 118 runs as listed in **Table 4**.

Table 4 Removal Efficiency and Sediment Mass Capacity Sampling Schedule

Elapsed Time	Feed Rate Sample	Effluent Sample	Background Sample
0:00:00	1		
0:20:00		1	1
0:21:00		2	
0:22:00		3	2
0:22:30	2		
0:42:00		4	
0:43:00		5	3
0:44:00		6	
0:44:30	3		
1/3 Drawdown		7	
2/3 Drawdown		8	

Alpha Analytical Laboratories, Inc. of Carlsbad, California performed analysis of all background, drawdown, and effluent samples under test method ASTM D3977-97 (2019) "Standard Test Methods for Determining Sediment Concentrations in Water Samples". Prior to official testing spiked samples were sent to Alpha Analytical Laboratories to ensure proficiency with ASTM D3977-97 (2019) in accordance with the applicable version of the NJDEP protocol. As shown in **Table 5**, two samples were prepared within the 20-50 mg/L concentration range, while also being separated by at least 15 mg/L, using the GHL lot A028-095 test sediment. Recovery results for the samples were 92.2% and 89.8% respectively, meeting the +/- 15% of actual threshold required by the NJDEP Laboratory Protocol.

Table 5 Laboratory Proficiency Testing - Spike Samples

Sample ID	Prepared Concentration (mg/L)	Official Concentration (mg/L)	Percent Recovery (%)
EFF A	25.0	22.8	91.2%
EFF B	45.0	40.4	89.8%

2.4 Scour Testing Procedure

No scour testing was performed within the scope of this project.

3. Performance Claims

Total Suspended Solids (TSS) Removal Rate

The Modular Wetlands® 360 exceeded the NJDEP requirement of a total suspended solids (TSS) removal rate >80% at an MTFR of 62 gpm. A cumulative removal efficiency of 91.44% was determined based on the first 10 runs according to the procedure and calculations described in the NJDEP Protocol and rounded down to 80% per Section 5.C in the Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology (Verification Procedure) dated August 4, 2021.

Maximum Treatment Flow Rate (MTFR).

The Modular Wetlands® 360 demonstrated a maximum treatment flow rate (MTFR) of 0.138 cfs (62 gpm). This corresponds to a hydraulic loading rate of 1.7 gpm/ft^2 of effective filtration treatment area.

Effective Filtration Treatment Area (EFTA)

Each Modular Wetlands® 360 cylindrical biofiltration media bed has an EFTA of 36.65 ft^2 at a height of 40 in.

Effective Sedimentation Treatment Area (ESTA).

The Modular Wetlands® 360 test unit (Model MW360-4-4) has an ESTA of 6.2 ft^2 for the floor area around the cylindrical media bed. The test unit has an ESTA/EFTA = 0.169.

Sediment Mass Load Capacity

The Modular Wetlands® 360 test unit treated a mass load of 989.6 lbs over the 118 test runs and captured 828.8 lbs, which equates to 22.6 lbs/ft^2 of EFTA.

Maximum Allowable Inflow Drainage Area

Each Modular Wetlands® 360 Model MW360-4-4 can treat a maximum inflow area of 1.38 acres based on a sediment mass capture of 828.8 lbs and an annual sediment load of 600 pounds/acre.

Detention Time and Volume

The maximum operational wet volume (WV) of 30.33 ft^3 for the 48 x 47.5-inch Modular Wetlands® 360 test unit equates to a detention time of 3.66 minutes at an MTFR of 62 gpm and a water surface elevation of 40 in.

Online/Offline Installation

No scour testing was performed on the Modular Wetlands® 360 Model MW360-4-4 since it is designed for offline installation.

4. Supporting Documentation

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

4.1 Removal Efficiency and Mass Load Capacity Results

A total of 15 removal efficiency testing runs were completed in accordance with the NJDEP Filtration protocol. The target flow rate was 62 gpm and the target influent sediment concentration was 200 mg/L. The cumulative removal efficiency for the first 10 runs was 91.44%, qualifying the Modular Wetlands® 360 for an 80% TSS removal efficiency certification. An additional 103 runs were completed for sediment mass capacity testing, at the same target flow rate and an influent sediment concentration of 400 mg/L. A total of 118 qualifying runs were completed. **Equation 7** and **Equation 8** were used to calculate the individual run efficiency and overall cumulative removal efficiency.

The total water volume and average flow rate per run were calculated from the data collected by the flow data logger, one reading every 5 seconds. The average influent sediment concentration for each test run was determined by mass balance using **Equation 2**. The amount of sediment fed into the auger feeder during dosing, and the amount remaining at the end of a run, was used to determine the amount of sediment fed during each run. The sediment mass was corrected for the mass of the three feed rate samples taken during each run. The total mass of the sediment fed during each run was divided by the volume of water that flowed through the Modular Wetlands® 360 test unit during dosing to determine the average influent sediment concentration for each run using **Equation 3**. The total cumulative sediment mass injected and retained were calculated using **Equation 9** and **Equation 10**.

Three sediment feed rate samples were collected, at evenly spaced time intervals, during each test run to ensure the rate was stable and within the allowable range from the target concentration. The COV (coefficient of variance) of the samples for each run was $\leq$ 0.10 as is required by the NJDEP protocol. Feed rate was calculated using **Equation 1**. The feed rate samples were also used to calculate an influent concentration to double-check the concentration calculated by mass balance.

The average effluent sediment concentration was adjusted for the background sediment concentration using **Equation 4**. In cases where the reported background sediment concentration was less than 1.0 mg/L (the method quantitation limit), 0.5 mg/L was used in calculating the adjusted effluent concentration. Removal efficiencies, drawdown adjustments, and mass load capacities for each test run were computed using the following equations:

$$\boldsymbol{Feed\ Rate}\ (g/min) = \left(\frac{Mass_{sample+bottle\ (g)} - Mass_{bottle\ (g)}}{Time\ collection\ (s) x\ (\frac{\text{min}}{60\ \text{s}})}\right) \times (1 - Sediment\ Moisture\ Content)$$

(Equation 1)

$$\boldsymbol{Influent\ Mass\ (kg)} = (1 - Sediment\ Moisture\ Content) x [Mass_{pre\ test}\ (kg) - Mass_{post\ test}\ (kg)] - \sum Mass_{feed\ sample}\ (g) x \left(\frac{kg}{1E3\ g}\right)$$

(Equation 2)

$$\boldsymbol{Average\ Influent\ Concentration\ (mg/L)} = \left(\frac{Influent\ Mass\ (kg)\ x\ (\frac{1E6\ mg}{kg})}{Avg.Flow\ Rate\ \left(\frac{ft3}{s}\right) x \left(\frac{28.3168L}{ft^3}\right) x \left(\frac{60\ s}{min}\right)\ x\ Time_{sediment\ injection}\ (\mathrm{min})}\right)$$

(Equation 3)

$$\boldsymbol{Average\ Adjusted\ Effluent\ SSC\ Conentration\ (mg/L)} = Avg.Effluent\ Concentration\ \left({}^{mg}/_{L}\right) - Avg.Background\ Concentration\ \left({}^{mg}/_{L}\right)$$

(Equation 4)

$$\boldsymbol{Effluent\ Mass\ (mg)} = Avg.\ Adjusted\ Effluent\ SSC\ \left({}^{mg}/_{L}\right) x \left(\left(\left(Time_{sediment\ injection}\ (\mathrm{min})\ x\ Average\ Flow\ Rate\ (gpm)\right) - Drain\ Down\ Volume\ (gal)\right) x\ 3.78541\right)$$

(Equation 5)

$$\boldsymbol{Drawdown\ Flow\ Mass\ (mg)} = \left(Avg.\ Drawdown\ Effluent\ SSC\ \left({}^{mg}/_{L}\right) - Avg.Background\ SSC\ \left({}^{mg}/_{L}\right)\right) x\ Drawdown\ Flow\ Volume\ (L)$$

(Equation 6)

$$\boldsymbol{Removal\ Efficiency}\ (\%) = \left(\frac{Influent\ Mass\ (mg) - Effluent\ Mass\ (mg) - Drawdown\ Mass\ (mg)}{Influent\ Mass\ (mg)}\right) \times 100$$

(Equation 7)

$$\boldsymbol{Cumulative\ Removal\ Efficiency}\ (\%) = \left(\frac{\sum Influent\ Mass\ (mg) - \sum Effluent\ Mass\ (mg) - \sum Drawdown\ Mass\ (mg)}{\sum Influent\ Mass\ (mg)}\right) \times 100$$

(Equation 8)

$$Cumulative\ Mass\ Load\ (lbs) = \frac{\sum Influent\ Mass\ (mg)}{\frac{453{,}592mg}{lb}}$$

(Equation 9)

$$Cumulative\ Mass\ Load\ Capacity\ (lb) = \left(\frac{\sum Influent\ Mass\ (mg) - \sum Effluent\ Mass\ (mg) - \sum Drawdown\ Mass\ (mg)}{\frac{453{,}592mg}{lb}}\right)$$

(Equation 10)

NOTE: As is commonly the case, it was found that the moisture content of the silica sediment used for testing was negligible and therefore no correction was required. PSD testing showed that the percentage moisture was below the detectable limit of 0.3% for all three samples.

All removal efficiency and mass loading test run data is presented below in **Tables 6-13**.

Table 6 Removal Efficiency Results

PERFORMANCE SUMMARY - Removal Efficiency Testing											
Run #	Total Water Volume (gal)	Sediment Mass Injected (lb)	Influent TSS Based on Mass Injected (mg/L)	Average Adjusted Effluent TSS (mg/L)	Effluent Mass (lb)	Average Adjusted Draw-down TSS (mg/L)	Draw-down Volume (gal)	Draw-down Mass (lb)	Cumulative Mass Captured (lb)	Removal Efficiency (%)	Cumulative Removal Efficiency (%)
1	2418	4.35	197.1	19.7	0.397	12.5	225.3	0.024	3.93	90.33%	90.33%
2	2432	4.16	187.4	14.5	0.295	11.0	223.9	0.021	7.77	92.41%	91.35%
3	2416	4.49	203.8	19.4	0.392	14.7	224.6	0.028	11.84	90.67%	91.11%
4	2413	4.53	205.8	17.5	0.352	17.3	223.9	0.032	15.99	91.52%	91.22%
5	2415	4.64	210.6	17.4	0.351	15.3	223.9	0.029	20.25	91.81%	91.34%
6	2414	4.64	210.4	14.7	0.296	15.2	223.9	0.028	24.56	93.00%	91.63%
7	2411	4.62	209.8	18.6	0.374	14.4	223.2	0.027	28.78	91.33%	91.58%
8	2405	4.63	211.0	19.1	0.383	10.7	223.2	0.020	33.01	91.30%	91.55%
9	2412	4.46	202.4	16.5	0.331	10.4	223.2	0.019	37.11	92.13%	91.61%
10	2403	4.51	205.4	21.6	0.433	12.0	223.9	0.022	41.16	89.89%	91.44%
11	2406	4.59	209.1	22.3	0.448	15.2	223.9	0.028	45.28	89.63%	91.27%
12	2404	4.59	209.0	21.9	0.440	14.9	224.6	0.028	49.40	89.81%	91.15%
13	2402	4.60	210.0	22.4	0.449	13.7	223.9	0.026	53.53	89.69%	91.03%
14	2410	4.57	207.9	22.6	0.454	18.9	224.6	0.035	57.61	89.28%	90.91%
15	2414	4.58	207.7	23.4	0.471	15.9	225.3	0.030	61.68	89.04%	90.78%

Table 7 Mass Load Capacity Results - Run 16 - Run 50

PERFORMANCE SUMMARY – Sediment Mass Capacity Testing											
Run #	Total Water Volume (gal)	Sediment Mass Injected (lb)	Influent TSS Based on Mass Injected (mg/L)	Average Adjusted Effluent TSS (mg/L)	Effluent Mass (lb)	Average Adjusted Draw-down TSS (mg/L)	Draw-down Volume (gal)	Draw-down Mass (lb)	Cumulative Mass Captured (lb)	Removal Efficiency (%)	Cumulative Removal Efficiency (%)
16	2416	8.81	399.9	48.0	0.968	27.1	223.9	0.051	69.47	88.44%	90.51%
17	2417	8.89	403.1	50.1	1.010	37.6	226.1	0.071	77.28	87.84%	90.24%
18	2418	8.82	399.9	48.4	0.977	44.6	225.3	0.084	85.04	87.97%	90.02%
19	2417	8.91	404.1	41.5	0.838	35.8	224.6	0.067	93.04	89.85%	90.01%
20	2418	8.98	407.3	47.5	0.959	37.4	225.3	0.070	100.99	88.54%	89.89%
21	2417	8.95	406.1	46.1	0.930	42.4	224.6	0.079	108.93	88.73%	89.81%
22	2421	8.97	406.2	54.9	1.108	50.6	224.6	0.095	116.69	86.58%	89.58%
23	2416	8.83	400.6	50.1	1.010	47.4	225.3	0.089	124.42	87.54%	89.45%
24	2405	8.89	405.3	55.4	1.112	35.8	225.3	0.067	132.13	86.73%	89.29%
25	2410	8.93	406.4	54.8	1.103	55.4	225.3	0.104	139.86	86.49%	89.13%
26	2413	8.94	406.4	57.3	1.154	40.1	224.6	0.075	147.57	86.26%	88.98%
27	2415	9.10	413.0	62.1	1.252	41.3	224.6	0.077	155.34	85.39%	88.79%
28	2413	9.00	409.2	53.3	1.073	43.1	224.6	0.081	163.19	87.19%	88.71%
29	2415	8.92	404.9	59.9	1.207	62.5	224.6	0.117	170.78	85.15%	88.55%
30	2416	8.94	405.5	46.9	0.945	41.8	223.9	0.078	178.69	88.55%	88.55%
31	2413	8.99	408.8	57.4	1.155	36.3	225.3	0.068	186.46	86.39%	88.45%
32	2410	9.00	409.4	59.3	1.192	43.9	225.3	0.083	194.19	85.84%	88.35%
33	2412	9.09	413.1	61.6	1.241	45.3	225.3	0.085	201.95	85.41%	88.23%
34	2412	9.08	412.9	53.7	1.081	44.6	225.3	0.084	209.87	87.18%	88.19%
35	2416	9.02	409.3	47.5	0.957	34.0	225.3	0.064	217.87	88.68%	88.21%
36	2417	8.92	404.5	64.2	1.295	51.2	225.0	0.096	225.39	84.40%	88.08%
37	2405	8.94	407.7	61.0	1.225	51.2	225.3	0.096	233.02	85.23%	87.98%
38	2415	8.95	406.6	52.9	1.065	54.9	224.6	0.103	240.80	86.96%	87.95%
39	2390	9.06	415.4	64.5	1.287	38.0	224.6	0.071	248.50	85.01%	87.85%
40	2416	9.09	412.6	64.6	1.302	46.5	224.6	0.087	256.20	84.72%	87.75%
41	2416	9.12	413.9	58.5	1.179	54.1	224.6	0.101	264.04	85.95%	87.70%
42	2418	8.86	401.8	58.9	1.188	55.4	225.3	0.104	271.61	85.41%	87.63%
43	2415	8.91	404.6	58.5	1.179	68.5	224.6	0.128	279.21	85.33%	87.57%
44	2415	8.95	406.5	63.6	1.282	54.1	224.6	0.101	286.78	84.55%	87.49%
45	2416	8.92	404.7	53.3	1.074	51.4	224.6	0.096	294.53	86.88%	87.47%
46	2418	8.95	406.0	62.5	1.262	88.7	223.9	0.166	302.05	84.05%	87.38%
47	2427	8.99	406.4	68.1	1.379	73.8	225.3	0.139	309.52	83.12%	87.28%
48	2415	8.76	397.8	62.3	1.256	78.0	225.3	0.147	316.88	83.99%	87.20%
49	2425	8.88	401.9	67.9	1.374	71.3	224.6	0.134	324.26	83.03%	87.10%
50	2418	9.03	409.4	68.6	1.384	82.6	226.1	0.156	331.75	82.94%	87.00%

Table 8 Mass Load Capacity Results - Run 51 - Run 85

PERFORMANCE SUMMARY – Sediment Mass Capacity Testing											
Run #	Total Water Volume (gal)	Sediment Mass Injected (lb)	Influent TSS Based on Mass Injected (mg/L)	Average Adjusted Effluent TSS (mg/L)	Effluent Mass (lb)	Average Adjusted Draw-down TSS (mg/L)	Draw-down Volume (gal)	Draw-down Mass (lb)	Cumulative Mass Captured (lb)	Removal Efficiency (%)	Cumulative Removal Efficiency (%)
51	2410	8.95	407.1	67.2	1.351	83.1	224.6	0.156	339.19	83.16%	86.91%
52	2413	8.95	406.8	92.9	1.870	96.0	224.6	0.180	346.09	77.10%	86.69%
53	2424	8.97	406.2	70.8	1.431	98.4	224.6	0.184	353.45	82.00%	86.59%
54	2424	8.69	393.5	65.3	1.320	72.9	225.3	0.137	360.69	83.24%	86.52%
55	2421	9.03	409.0	49.4	0.999	86.9	224.6	0.163	368.55	87.13%	86.53%
56	2424	9.03	408.8	61.3	1.240	101.7	225.3	0.191	376.15	84.16%	86.48%
57	2413	9.02	409.8	38.9	0.783	76.1	224.6	0.143	384.24	89.73%	86.55%
58	2404	9.07	413.5	58.1	1.165	118.0	224.6	0.221	391.92	84.71%	86.51%
59	2416	9.14	414.8	90.7	1.829	106.7	224.6	0.200	399.04	77.80%	86.34%
60	2420	8.72	395.0	69.3	1.399	101.8	226.8	0.193	406.16	81.74%	86.25%
61	2422	8.91	403.4	62.9	1.270	62.7	226.1	0.118	413.68	84.41%	86.22%
62	2413	8.97	407.6	51.5	1.037	103.1	226.1	0.194	421.41	86.27%	86.22%
63	2423	8.92	403.9	51.5	1.041	120.5	226.8	0.228	429.07	85.78%	86.21%
64	2422	9.01	407.8	49.4	0.999	118.0	225.3	0.222	436.85	86.44%	86.22%
65	2420	9.04	409.8	60.0	1.212	110.4	225.3	0.208	444.47	84.30%	86.18%
66	2418	8.77	397.9	69.3	1.398	90.1	226.1	0.170	451.68	82.13%	86.11%
67	2423	8.87	401.6	75.8	1.533	121.0	226.8	0.229	458.79	80.14%	86.01%
68	2430	8.89	401.3	74.0	1.501	125.5	227.5	0.238	465.94	80.43%	85.92%
69	2420	8.91	403.8	88.9	1.795	134.0	226.8	0.254	472.80	77.00%	85.78%
70	2428	8.98	405.9	75.4	1.527	138.0	228.9	0.264	479.99	80.06%	85.69%
71	2426	9.02	407.9	84.0	1.701	148.5	230.4	0.286	487.02	77.98%	85.57%
72	2426	8.93	403.6	80.9	1.637	161.0	228.2	0.307	494.00	78.22%	85.45%
73	2428	8.92	403.3	65.5	1.327	158.5	227.5	0.301	501.30	81.75%	85.40%
74	2422	8.93	404.5	74.5	1.505	163.0	227.2	0.309	508.41	79.69%	85.31%
75	2424	8.95	404.8	72.5	1.467	133.5	225.3	0.251	515.64	80.80%	85.24%
76	2425	8.90	402.4	56.7	1.147	242.0	230.4	0.465	522.93	81.88%	85.19%
77	2431	9.01	406.6	75.9	1.539	136.5	230.4	0.262	530.13	80.00%	85.12%
78	2419	9.00	408.3	69.6	1.404	279.5	229.7	0.536	537.20	78.45%	85.02%
79	2419	8.96	406.1	61.2	1.235	232.0	228.9	0.443	544.48	81.26%	84.97%
80	2423	9.05	409.5	69.1	1.397	348.5	228.2	0.664	551.46	77.22%	84.86%
81	2429	8.80	397.6	62.0	1.258	182.0	221.0	0.336	558.67	81.90%	84.82%
82	2424	8.93	403.9	58.5	1.183	161.5	229.7	0.310	566.10	83.28%	84.80%
83	2419	9.07	411.4	69.1	1.394	254.5	228.9	0.486	573.30	79.28%	84.73%
84	2425	8.75	396.0	65.3	1.321	202.0	226.8	0.382	580.35	80.55%	84.68%
85	2413	8.83	401.5	60.6	1.220	409.5	231.1	0.790	587.17	77.25%	84.58%

Table 9 Mass Load Capacity Results - Run 86 - Run 118

PERFORMANCE SUMMARY – Sediment Mass Capacity Testing											
Run #	Total Water Volume (gal)	Sediment Mass Injected (lb)	Influent TSS Based on Mass Injected (mg/L)	Average Adjusted Effluent TSS (mg/L)	Effluent Mass (lb)	Average Adjusted Draw-down TSS (mg/L)	Draw-down Volume (gal)	Draw-down Mass (lb)	Cumulative Mass Captured (lb)	Removal Efficiency (%)	Cumulative Removal Efficiency (%)
86	2419	8.88	402.6	61.9	1.249	176.0	229.7	0.337	594.46	82.13%	84.55%
87	2411	8.91	405.3	54.4	1.094	223.5	229.7	0.428	601.86	82.92%	84.53%
88	2422	8.93	404.6	60.1	1.215	188.0	228.2	0.358	609.22	82.39%	84.50%
89	2409	8.98	408.6	65.1	1.309	229.5	228.2	0.437	616.45	80.55%	84.46%
90	2436	8.80	396.5	64.1	1.304	212.0	226.8	0.401	623.54	80.63%	84.41%
91	2422	8.80	398.3	63.4	1.281	218.5	229.7	0.419	630.64	80.67%	84.37%
92	2418	8.87	402.5	58.4	1.179	154.2	228.2	0.294	638.04	83.40%	84.35%
93	2422	8.95	405.1	62.2	1.257	190.0	228.2	0.362	645.37	81.90%	84.33%
94	2415	9.08	412.3	96.0	1.935	248.5	228.9	0.475	652.03	73.46%	84.20%
95	2417	8.97	407.2	62.2	1.254	223.5	228.9	0.427	659.33	81.27%	84.16%
96	2437	8.70	391.7	56.1	1.141	167.5	227.5	0.318	666.57	83.22%	84.15%
97	2408	8.95	407.5	63.3	1.271	100.0	229.7	0.192	674.05	83.66%	84.15%
98	2396	9.13	417.4	64.4	1.288	196.5	228.9	0.375	681.52	81.77%	84.12%
99	2401	9.02	411.8	65.4	1.311	161.5	229.7	0.310	688.91	82.03%	84.10%
100	2428	9.12	412.2	58.6	1.187	243.5	229.7	0.467	696.38	81.87%	84.07%
101	2416	9.13	414.3	63.4	1.279	199.0	228.9	0.380	703.85	81.82%	84.05%
102	2423	8.80	398.4	59.4	1.202	194.0	228.2	0.369	711.08	82.14%	84.03%
103	2428	8.86	400.3	56.9	1.152	152.0	230.4	0.292	718.49	83.69%	84.03%
104	2427	8.88	401.4	59.6	1.206	347.5	230.4	0.668	725.50	78.89%	83.97%
105	2426	9.09	411.3	56.8	1.150	168.5	229.7	0.323	733.12	83.80%	83.97%
106	2423	9.14	413.8	55.7	1.125	157.0	230.4	0.302	740.83	84.39%	83.98%
107	2421	9.03	408.9	57.8	1.167	259.0	228.9	0.495	748.20	81.59%	83.95%
108	2424	8.79	397.9	55.6	1.124	314.0	229.7	0.602	755.27	80.38%	83.92%
109	2428	8.96	404.7	68.5	1.388	236.0	230.4	0.454	762.38	79.44%	83.87%
110	2418	8.97	407.0	56.7	1.143	248.0	229.7	0.475	769.73	81.96%	83.85%
111	2421	9.15	414.6	52.9	1.069	257.5	230.4	0.495	777.32	82.90%	83.84%
112	2426	8.97	405.6	57.4	1.163	266.7	229.7	0.511	784.61	81.33%	83.82%
113	2430	8.51	384.1	58.8	1.192	72.4	230.4	0.139	791.79	84.35%	83.83%
114	2427	8.82	398.5	59.8	1.212	119.5	234.0	0.233	799.16	83.61%	83.82%
115	2421	8.98	407.1	58.8	1.188	252.0	232.6	0.489	806.47	81.34%	83.80%
116	2418	9.02	409.2	60.0	1.211	176.0	231.1	0.339	813.94	82.82%	83.79%
117	2428	9.09	410.9	60.9	1.233	253.5	231.1	0.489	821.31	81.06%	83.77%
118	2416	9.08	412.1	57.9	1.167	218.2	231.1	0.421	828.80	82.51%	83.75%

Table 10 Individual Run Data – Removal Efficiency Testing

PERFORMANCE CONCENTRATIONS – Removal Efficiency Testing											
Run #	Effluent1 (mg/L)	Effluent2 (mg/L)	Effluent3 (mg/L)	Effluent4 (mg/L)	Effluent5 (mg/L)	Effluent6 (mg/L)	Back-ground 1 (mg/L)	Back-ground 2 (mg/L)	Back-ground 3 (mg/L)	Draw-down 1 (mg/L)	Draw-down 2 (mg/L)
1	14.9	15.2	22.2	22.9	22.9	22.9	0.5	0.5	0.5	8.95	17.1
2	13.1	15.3	12.8	14.6	16.7	17.7	0.5	0.5	0.5	6.73	16.3
3	18.5	19.0	15.2	24.5	22.7	19.6	0.5	0.5	0.5	10.2	20.2
4	19.2	19.4	13.5	13.5	19.8	22.5	0.5	0.5	0.5	15.0	20.6
5	19.1	19.1	13.4	17.9 [1]	19.6	18.5	0.5	0.5	0.5	13.6	18.0
6	19.2	19.5	17.9	11.7	10.0	12.9	0.5	0.5	0.5	11.2	20.2
7	19.3	16.3	19.0	18.8	20.6	20.4	0.5	0.5	0.5	12.2	17.5
8	19.1	20.9	17.7	19.8	19.2	20.8	0.5	0.5	0.5	8.31	14.1
9	16.5	14.8	15.5	17.5	18.1	19.3	0.5	0.5	0.5	9.33	12.4
10	13.5	22.0	22.7	24.9	25.0	24.5	0.5	0.5	0.5	8.33	16.7
11	23.0	22.4	23.5	23.0	23.4	21.5	0.5	0.5	0.5	10.4	21.0
12	21.4	22.4	22.6	21.1	23.2	23.8	0.5	0.5	0.5	11.3	19.4
13	22.2	22.6	22.9	22.4	23.6	23.8	0.5	0.5	0.5	9.99	18.4
14	23.0	23.5	23.6	23.1	22.4	23.0	0.5	0.5	0.5	16.5	22.3
15	23.4	23.4	23.9	23.7	24.6	24.4	0.5	0.5	0.5	11.0	21.8

[1] Run 5 – Effluent 4, calculated as average of other effluent values as Alpha reported sample as non-detect

Table 11 Individual Run Data – Mass Load Capacity Testing - Run 16 – Run 50

PERFORMANCE CONCENTRATIONS – Removal Efficiency Testing											
Run #	Effluent1 (mg/L)	Effluent2 (mg/L)	Effluent3 (mg/L)	Effluent4 (mg/L)	Effluent5 (mg/L)	Effluent6 (mg/L)	Back-ground 1 (mg/L)	Back-ground 2 (mg/L)	Back-ground 3 (mg/L)	Draw-down 1 (mg/L)	Draw-down 2 (mg/L)
16	47.3	49.5	49.3	49.2	46.8	48.9	0.5	0.5	0.5	20.8	34.4
17	50.7	49.7	50.6	50.8	51.1	50.4	0.5	0.5	0.5	31.8	44.3
18	53.5	45.7	48.8	50.6	48.7	46.2	0.5	0.5	0.5	51.1	39.0
19	15.1	47.2	49.4	44.6	45.0	50.8	0.5	0.5	0.5	33.4	39.1
20	48.1	51.4	45.1	45.5	48.2	49.8	0.5	0.5	0.5	33.5	42.2
21	46.6	41.2	48.0	50.5	47.0	46.2	0.5	0.5	0.5	33.2	52.5
22	55.4	55.2	55.0	52.4	54.0	60.2	0.5	0.5	0.5	51.4	50.8
23	51.6	45.2	55.7	53.3	49.9	47.9	0.5	0.5	0.5	45.5	50.3
24	57.0	57.0	54.8	55.9	54.1	56.7	0.5	0.5	0.5	33.7	38.9
25	56.8	55.2	55.7	57.6	50.9	55.8	0.5	0.5	0.5	62.2	49.6
26	54.8	59.9	57.2	57.2	58.6	59.2	0.5	0.5	0.5	35.8	45.3
27	66.1	63.6	58.6	66.4	59.1	61.8	0.5	0.5	0.5	38.5	45.1
28	44.8	55.0	56.9	50.7	60.5	54.8	0.5	0.5	0.5	47.8	39.3
29	65.6	59.6	60.2	57.4	61.7	57.9	0.5	0.5	0.5	70.7	55.3
30	54.8	28.0	40.4	50.6	55.7	54.8	0.5	0.5	0.5	35.8	48.7
31	60.6	60.4	66.7	57.3	44.2	58.1	0.5	0.5	0.5	28.8	44.8
32	61.6	60.9	58.1	60.0	58.3	59.6	0.5	0.5	0.5	43.7	45.1
33	60.5	61.6	71.5	61.8	58.5	58.9	0.5	0.5	0.5	49.2	42.3
34	55.8	54.0	58.0	51.9	60.6	51.6	0.5	0.5	3.2	46.3	49.4
35	47.0	39.3	50.0	40.8	55.2	55.4	0.5	0.5	0.5	39.8	29.1
36	66.1	66.6	68.9	62.6	68.2	55.8	0.5	0.5	0.5	48.9	54.5
37	57.9	60.3	59.3	64.5	61.5	65.6	0.5	0.5	0.5	49.3	54.1
38	53.8	65.4	44.8	43.4	61.7	51.0	0.5	0.5	0.5	53.3	57.4
39	55.4	63.3	99.3	52.0	61.6	58.6	0.5	0.5	0.5	33.2	43.8
40	68.9	63.6	63.9	63.9	66.0	64.0	0.5	0.5	0.5	48.6	45.3
41	60.5	61.3	61.9	47.5	62.8	60.0	0.5	0.5	0.5	52.2	56.9
42	59.8	65.4	63.2	52.6	59.8	55.4	0.5	0.5	0.5	54.6	57.1
43	41.1	56.9	62.2	62.2	60.7	70.9	0.5	0.5	0.5	63.6	74.3
44	68.5	59.9	58.8	67.6	65.1	64.8	0.5	0.5	0.5	55.2	53.9
45	52.7	63.3	51.4	43.8	64.2	47.2	0.5	0.5	0.5	49.9	53.8
46	67.4	59.4	57.8	63.2	65.6	64.8	0.5	0.5	0.5	109	69.3
47	64.0	71.2	66.7	66.0	67.1	76.4	0.5	0.5	0.5	71.2	77.3
48	63.6	62.0	64.1	61.9	63.8	61.5	0.5	0.5	0.5	79.6	77.3
49	66.5	64.8	67.8	73.1	69.7	68.5	0.5	0.5	0.5	72.8	70.7
50	71.6	74.6	68.6	64.7	67.4	67.6	0.5	0.5	0.5	83.8	82.3

Table 12 Individual Run Data – Mass Load Capacity Testing – Run 51 – Run 85

PERFORMANCE CONCENTRATIONS – Removal Efficiency Testing											
Run #	Effluent1 (mg/L)	Effluent2 (mg/L)	Effluent3 (mg/L)	Effluent4 (mg/L)	Effluent5 (mg/L)	Effluent6 (mg/L)	Back-ground 1 (mg/L)	Back-ground 2 (mg/L)	Back-ground 3 (mg/L)	Draw-down 1 (mg/L)	Draw-down 2 (mg/L)
51	67.8	67.3	68.0	71.7	65.4	65.8	0.5	0.5	0.5	82.5	84.6
52	90.3	149.0	95.9	77.8	77.1	70.2	0.5	0.5	0.5	99.8	93.2
53	49.1	70.8	75.6	82.5	76.2	73.4	0.5	0.5	0.5	101	96.8
54	69.0	69.0	65.6	57.7	73.8	59.6	0.5	0.5	0.5	80.1	66.7
55	60.1	44.1	60.6	49.5	52.9	32.4	0.5	0.5	0.5	87.9	86.9
56	56.8	74.2	74.3	63.3	57.1	47.2	0.5	1.6	0.5	106	98.3
57	55.8	48.0	42.2	39.1	24.3	27.0	0.5	0.5	0.5	87.7	65.5
58	70.5	63.3	58.5	62.7	59.9	36.6	0.5	0.5	0.5	125	112
59	73.6	75.9	197.0	68.1	66.1	66.6	0.5	0.5	0.5	129	85.4
60	71.0	63.8	66.6	74.8	69.9	73.5	1.1	0.5	0.5	111	93.5
61	73.1	48.9	78.4	70.0	71.3	38.4	0.5	0.5	0.5	41.9	84.4
62	68.6	33.4	44.6	57.7	42.8	65.0	0.5	0.5	0.5	108	99.1
63	53.1	54.5	65.7	58.4	20.4	59.7	0.5	0.5	0.5	126	116
64	61.5	46.1	56.7	47.2	42.9	45.2	0.5	0.5	0.5	126	111
65	63.6	63.6	62.2	64.7	64.6	62.0	1.1	0.5	7.1	119	116
66	60.6	76.0	73.9	60.0	74.1	76.1	1.9	0.5	0.5	81.9	99.2
67	84.3	91.4	71.6	93.7	57.9	59.0	0.5	0.5	0.5	102	141
68	67.3	75.9	66.8	86.3	76.0	74.7	0.5	0.5	0.5	104	148
69	124.0	90.3	76.9	85.1	76.4	83.8	0.5	0.5	0.5	109	160
70	76.0	73.8	78.9	86.8	70.3	70.3	1.0	0.5	0.5	118	159
71	84.2	77.0	80.3	81.1	84.5[1]	99.9	0.5	0.5	0.5	128	170
72	82.7	106.0	99.1	73.7	61.8	66.9	1.8	0.5	0.5	146	177
73	55.6	64.1	80.1	57.3	68.5	70.5	0.5	0.5	0.5	148	170
74	67.3	79.7	79.5	72.0	80.5	71.8	1.2	0.5	0.5	144	183
75	73.5	77.2	69.5	74.2	71.5	74.0	1.8	0.5	0.5	105	163
76	64.5	58.8	59.3	54.6	54.3	51.6	0.5	0.5	0.5	257	228
77	86.2	74.1	77.4	80.5	75.6	64.3	0.5	0.5	0.5	118	156
78	64.8	74.9	74.4	75.4	67.1	67.4	2.9	0.5	0.5	271	289
79	73.8	59.2	57.7	63.2	60.8	60.4	3.9	0.5	0.5	246	219
80	66.0	67.2	67.6	73.5	73.0	72.9	2.4	0.5	0.5	385	313
81	61.8	66.1	61.6	59.8	65.3	62.2	1.5	0.5	0.5	152	213
82	63.6	53.7	48.5	82.6	60.2	45.3	0.5	0.5	0.5	141	183
83	66.2	68.7	73.6	67.7	69.2	71.9	0.5	0.5	0.5	281	229
84	63.5	68.3	62.6	66.0	66.0	68.2	0.5	0.5	0.5	187	218
85	64.8	63.7	61.1	61.0	58.9	57.0	0.5	0.5	0.5	489	331

[1] Run 71 – Effluent 5, calculated as average of other effluent values as Alpha reported sample as non-detect.

Table 13 Individual Run Data - Mass Load Capacity Testing - Run 86 - Run 118

PERFORMANCE CONCENTRATIONS – Removal Efficiency Testing											
Run #	Effluent1 (mg/L)	Effluent2 (mg/L)	Effluent3 (mg/L)	Effluent4 (mg/L)	Effluent5 (mg/L)	Effluent6 (mg/L)	Back-ground 1 (mg/L)	Back-ground 2 (mg/L)	Back-ground 3 (mg/L)	Draw-down 1 (mg/L)	Draw-down 2 (mg/L)
86	64.5	63.5	63.7	59.5	60.7	62.3	0.5	0.5	0.5	159	194
87	53.9	53.7	53.0	55.7	57.0	57.3	1.4	0.5	0.5	220	228
88	58.6	59.9	54.5	63.9	60.7	66.1	0.5	0.5	0.5	171	206
89	68.3	66.4	66.4	68.0	63.4	62.9	1.6	0.5	0.5	212	248
90	68.1	62.1	59.2	74.2	63.0	61.2	0.5	0.5	0.5	211[1]	214
91	64.5	64.2	65.2	61.4	63.7	64.3	0.5	0.5	0.5	210	228
92	61.6	57.9	58.7	60.0	57.2	58.2	0.5	0.5	0.5	252	57.3
93	60.5	62.5	66.5	62.3	61.6	64.7	1.8	0.5	0.5	155	226
94	57.9	57.4	158.0	181.0	62.7	63.4	0.5	1.2	0.5	255	243
95	75.0	60.9	63.2	60.4	58.0	59.8	0.5	1.2	0.5	211	237
96	57.5	56.1	51.2	59.4	57.6	59.5	1.6	0.5	0.5	143	193
97	60.9	62.4	62.7	62.1	65.0	69.4	0.5	0.5	0.5	181	19.9
98	65.7	66.1	67.7	61.3	64.3	64.5	0.5	0.5	0.5	181	213
99	66.0	64.6	64.6	67.6	66.5	66.3	0.5	0.5	0.5	132	192
100	62.4	57.1	58.4	58.9	60.6	57.1	0.5	0.5	0.5	229	259
101	63.2	62.5	65.9	62.7	65.8	63.5	0.5	0.5	0.5	192	207
102	63.0	61.3	60.4	57.0	56.6	61.3	0.5	0.5	0.5	178	211
103	57.5	61.8	55.6	55.6	57.2	56.5	0.5	0.5	0.5	113	192
104	57.8	56.9	61.6	61.2	62.1	60.8	0.5	0.5	0.5	348	348
105	58.2	55.6	57.8	55.5	58.4	58.3	0.5	0.5	0.5	131	207
106	56.9	58.5	60.5	53.5	53.0	54.5	0.5	0.5	0.5	113	202
107	54.8	56.0	58.0	58.0	60.9	61.9	0.5	0.5	0.5	255	264
108	55.3	52.6	54.5	56.6	60.1	57.2	0.5	0.5	0.5	365	264
109	53.3	53.9	49.5	131.0	74.6	51.6	0.5	0.5	0.5	229	244
110	57.0	58.0	58.9	55.1	58.6	55.4	0.5	0.5	0.5	215	282
111	54.0	53.1	52.4	53.5	54.3	53.3	0.5	0.5	0.5	246	270
112	68.2	60.8	59.4	55.2	55.1	54.2	1.6	1.3	1.3	258	278
113	64.4	60.5	61.2	59.2	57.0	54.7	1.4	0.5	0.5	106	39.8
114	57.1	64.8	63.7	57.0	60.8	58.5	0.5	0.5	0.5	74.0	166
115	62.9	75.4	61.1	55.7	47.2	53.4	0.5	0.5	0.5	260	245
116	62.9	68.5	61.6	52.8	61.1	56.0	0.5	0.5	0.5	144	209
117	59.7	50.6	66.0	63.9	64.8	63.1	0.5[2]	0.5	0.5	259	249
118	62.5	55.7	55.4	59.7	58.6	58.5	0.5	0.5	0.5	75.3	362

[1] Run 90 - Drawdown 1 - average of Run 89 DD1 and Run 91 DD1 as Alpha result was non-detect. It is assumed this was an error by the lab during processing.

[2] Run 117 – Background 1 – shown as 0.5 mg/L as Alpha result was 301 mg/L It is assumed this was an error by the lab during processing. An average of the other background samples was used as a substitute.

4.2 Water Surface Levels and Detention Times

The water levels were monitored during each test run in the Modular Wetlands® 360 biofilter chamber. Water levels minimally increased over the course of the testing at MTFR as shown in **Figure 14.** As shown in **Table 14** through **Table 17** the observed water levels were less than the maximum water level of 44-in used to calculate the detention time. Thus, calculated detention times used for sample pacing were longer than the minimum required by the protocol requirements were exceeded.

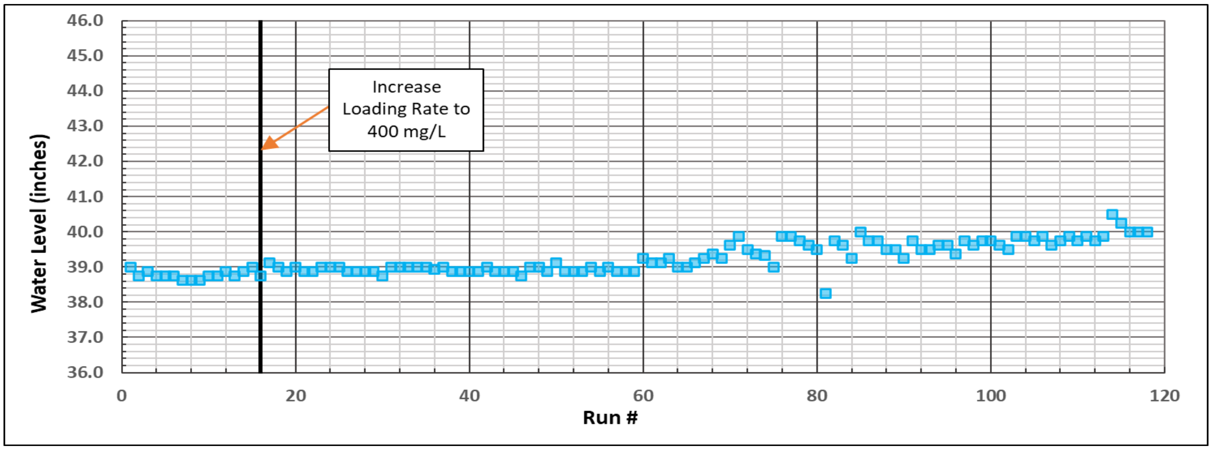

Figure 14 Water Levels in the Treatment Chamber Per Run

Table 14 Removal Efficiency Detention Times and Water Levels

DETENTION TIME AND WATER LEVELS – Removal Efficiency Testing							
Run #	**Average Inflow Rate (gpm)** (±10%)	**Filter Chamber Max Water Level (in)**	**Active Wet Volume (cu ft)**	**Detention Time (min)**	**3X Detention Time (min)**	**Time Used In Sampling Schedule (min)**	**Detention Time Compliant?**
1	62.21	39.00	29.57	3.56	10.67	20	YES
2	62.53	38.75	29.38	3.51	10.54	20	YES
3	62.15	38.88	29.48	3.55	10.64	20	YES
4	62.08	38.75	29.38	3.54	10.62	20	YES
5	62.13	38.75	29.38	3.54	10.61	20	YES
6	62.10	38.75	29.38	3.54	10.62	20	YES
7	62.03	38.63	29.29	3.53	10.59	20	YES
8	61.90	38.63	29.29	3.54	10.62	20	YES
9	62.06	38.63	29.29	3.53	10.59	20	YES
10	61.85	38.75	29.38	3.55	10.66	20	YES
11	61.94	38.75	29.38	3.55	10.64	20	YES
12	61.88	38.88	29.48	3.56	10.69	20	YES
13	61.81	38.75	29.38	3.56	10.67	20	YES
14	62.00	38.88	29.48	3.56	10.67	20	YES
15	62.11	39.00	29.57	3.56	10.68	20	YES

Table 15 Sediment Mass Capacity Detention Times and Water Levels - Run 16 - Run 50

DETENTION TIME AND WATER LEVELS Sediment Mass Capacity Testing							
Run #	**Average Inflow Rate (gpm)** ($\pm$10%)	**Filter Chamber Max Water Level (in)**	**Active Wet Volume (cu ft)**	**Detention Time (min)**	**3X Detention Time (min)**	**Time Used in Sampling Schedule (min)**	**Detention Time Compliant?**
16	62.11	38.75	29.38	3.54	10.62	20	YES
17	62.16	39.13	29.67	3.57	10.71	20	YES
18	62.16	39.00	29.57	3.56	10.68	20	YES
19	62.16	38.88	29.48	3.55	10.64	20	YES
20	62.16	39.00	29.57	3.56	10.68	20	YES
21	62.12	38.88	29.48	3.55	10.65	20	YES
22	62.23	38.88	29.48	3.54	10.63	20	YES
23	62.10	39.00	29.57	3.56	10.69	20	YES
24	61.86	39.00	29.57	3.58	10.73	20	YES
25	61.98	39.00	29.57	3.57	10.71	20	YES
26	62.04	38.88	29.48	3.55	10.66	20	YES
27	62.10	38.88	29.48	3.55	10.65	20	YES
28	62.04	38.88	29.48	3.55	10.66	20	YES
29	62.09	38.88	29.48	3.55	10.65	20	YES
30	62.12	38.75	29.38	3.54	10.61	20	YES
31	62.05	39.00	29.57	3.56	10.69	20	YES
32	61.99	39.00	29.57	3.57	10.70	20	YES
33	62.02	39.00	29.57	3.57	10.70	20	YES
34	62.03	39.00	29.57	3.57	10.70	20	YES
35	62.13	39.00	29.57	3.56	10.68	20	YES
36	62.14	38.94	29.52	3.55	10.66	20	YES
37	61.87	39.00	29.57	3.58	10.73	20	YES
38	62.11	38.88	29.48	3.55	10.65	20	YES
39	61.51	38.88	29.48	3.58	10.75	20	YES
40	62.13	38.88	29.48	3.55	10.65	20	YES
41	62.11	38.88	29.48	3.55	10.65	20	YES
42	62.18	39.00	29.57	3.56	10.67	20	YES
43	62.12	38.88	29.48	3.55	10.65	20	YES
44	62.09	38.88	29.48	3.55	10.65	20	YES
45	62.14	38.88	29.48	3.55	10.64	20	YES
46	62.17	38.75	29.38	3.53	10.60	20	YES
47	62.38	39.00	29.57	3.55	10.64	20	YES
48	62.11	39.00	29.57	3.56	10.68	20	YES
49	62.32	38.88	29.48	3.54	10.61	20	YES
50	62.23	39.13	29.67	3.57	10.70	20	YES

Table 16 Sediment Mass Capacity Detention Times and Water Levels - Run 51 - Run 85

DETENTION TIME AND WATER LEVELS Sediment Mass Capacity Testing							
Run #	**Average Inflow Rate (gpm)** (±10%)	**Filter Chamber Max Water Level (in)**	**Active Wet Volume (cu ft)**	**Detention Time (min)**	**3X Detention Time (min)**	**Time Used in Sampling Schedule (min)**	**Detention Time Compliant?**
51	61.99	38.88	29.48	3.56	10.67	20	YES
52	62.05	38.88	29.48	3.55	10.66	20	YES
53	62.31	38.88	29.48	3.54	10.62	20	YES
54	62.30	39.00	29.57	3.55	10.65	20	YES
55	62.22	38.88	29.48	3.54	10.63	20	YES
56	62.28	39.00	29.57	3.55	10.65	20	YES
57	62.05	38.88	29.48	3.55	10.66	20	YES
58	61.84	38.88	29.48	3.57	10.70	20	YES
59	62.12	38.88	29.48	3.55	10.65	20	YES
60	62.22	39.25	29.76	3.58	10.73	20	YES
61	62.26	39.13	29.67	3.56	10.69	20	YES
62	62.04	39.13	29.67	3.58	10.73	20	YES
63	62.29	39.25	29.76	3.57	10.72	20	YES
64	62.28	39.00	29.57	3.55	10.66	20	YES
65	62.22	39.13	29.67	3.56	10.69	20	YES
66	62.18	39.13	29.67	3.57	10.71	20	YES
67	62.29	39.25	29.76	3.57	10.72	20	YES
68	62.46	39.38	29.85	3.58	10.73	20	YES
69	62.22	39.25	29.76	3.58	10.73	20	YES
70	62.39	39.63	30.04	3.60	10.81	20	YES
71	62.36	39.75	30.14	3.61	10.84	20	YES
72	62.35	39.50	29.95	3.59	10.78	20	YES
73	62.42	39.38	29.85	3.58	10.73	20	YES
74	62.27	39.38	29.85	3.58	10.74	20	YES
75	62.29	39.00	29.57	3.55	10.65	20	YES
76	62.33	39.88	30.23	3.63	10.88	20	YES
77	62.48	39.88	30.23	3.62	10.86	20	YES
78	62.19	39.75	30.14	3.63	10.88	20	YES
79	62.20	39.63	30.04	3.61	10.84	20	YES
80	62.30	39.50	29.95	3.60	10.79	20	YES
81	62.43	39.25	29.76	3.56	10.69	20	YES
82	62.31	39.75	30.14	3.62	10.85	20	YES
83	62.19	39.63	30.04	3.61	10.84	20	YES
84	62.34	39.25	29.76	3.57	10.71	20	YES
85	62.05	40.00	30.33	3.66	10.97	20	YES

Table 17 Sediment Mass Capacity Detention Times and Water Levels - Run 86 - Run 118

DETENTION TIME AND WATER LEVELS Sediment Mass Capacity Testing							
Run #	**Average Inflow Rate (gpm)** (±10%)	**Filter Chamber Max Water Level (in)**	**Active Wet Volume (cu ft)**	**Detention Time (min)**	**3X Detention Time (min)**	**Time Used in Sampling Schedule (min)**	**Detention Time Compliant?**
86	62.19	39.75	30.14	3.63	10.88	20	YES
87	62.01	39.75	30.14	3.64	10.91	20	YES
88	62.26	39.50	29.95	3.60	10.79	20	YES
89	61.93	39.50	29.95	3.62	10.85	20	YES
90	62.59	39.25	29.76	3.56	10.67	20	YES
91	62.27	39.75	30.14	3.62	10.86	20	YES
92	62.17	39.50	29.95	3.60	10.81	20	YES
93	62.27	39.50	29.95	3.60	10.79	20	YES
94	62.09	39.63	30.04	3.62	10.86	20	YES
95	62.15	39.63	30.04	3.62	10.85	20	YES
96	62.60	39.38	29.85	3.57	10.70	20	YES
97	61.94	39.75	30.14	3.64	10.92	20	YES
98	61.65	39.63	30.04	3.65	10.94	20	YES
99	61.76	39.75	30.14	3.65	10.95	20	YES
100	62.39	39.75	30.14	3.61	10.84	20	YES
101	62.10	39.63	30.04	3.62	10.86	20	YES
102	62.28	39.50	29.95	3.60	10.79	20	YES
103	62.41	39.88	30.23	3.62	10.87	20	YES
104	62.38	39.88	30.23	3.63	10.88	20	YES
105	62.35	39.75	30.14	3.62	10.85	20	YES
106	62.30	39.88	30.23	3.63	10.89	20	YES
107	62.25	39.63	30.04	3.61	10.83	20	YES
108	62.32	39.75	30.14	3.62	10.85	20	YES
109	62.40	39.75	30.14	3.61	10.83	20	YES
110	62.16	39.75	30.14	3.63	10.88	20	YES
111	62.25	39.88	30.23	3.63	10.90	20	YES
112	62.35	39.75	30.14	3.62	10.85	20	YES
113	62.57	39.88	30.23	3.61	10.84	20	YES
114	62.39	40.50	30.71	3.68	11.04	20	YES
115	62.24	40.25	30.52	3.67	11.00	20	YES
116	62.18	40.00	30.33	3.65	10.95	20	YES
117	62.41	40.00	30.33	3.64	10.91	20	YES
118	62.11	40.00	30.33	3.65	10.96	20	YES

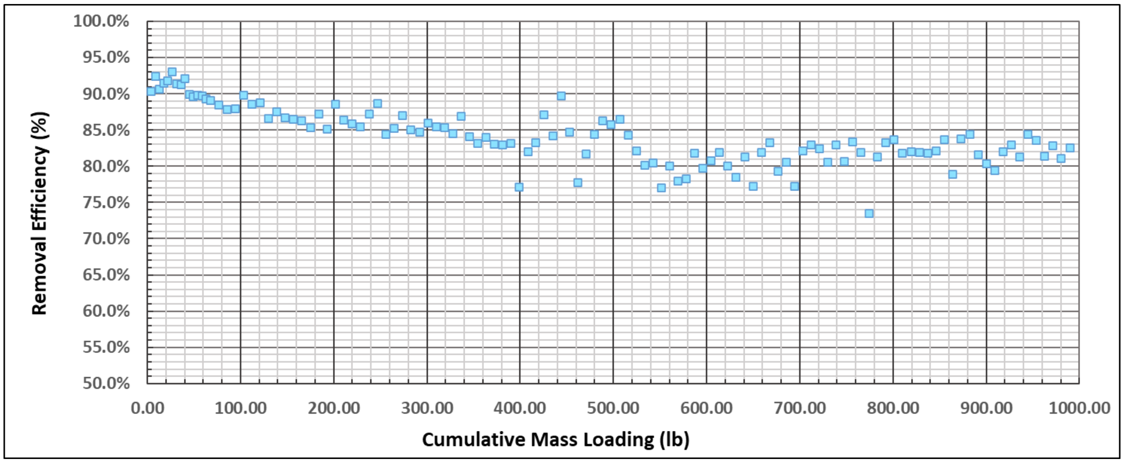

Figure 15 Removal Efficiencies vs. Cumulative Mass Loading

4.3 QA/QC

All test runs met the NJDEP protocol requirements of an allowable variation of ±10% for the targeted flow rate with a coefficient of variance ≤0.03 and the maximum temperature did not exceed 80.0 degrees Fahrenheit as shown in **Tables 18 – 21.**

Likewise, all test runs met the NJDEP protocol requirements for background concentrations of ≤20 mg/L, and sediment feed rate of ±10% of the targeted value (200 mg/L or 400 mg/L) with a COV ≤0.10 as shown in **Tables 22 – 25.** Each background and effluent sample were weighed (subtracting out the weight of the empty bottle) after the test run and recorded to ensure that all samples were of sufficient volume prior to shipping. As shown in **Tables 22 – 25**, all samples were greater than the SSC Sample Volume of 0.5 L minimum requirement in the protocol.

Table 18 Summary of Removal Efficiency Flow Rates and Temperature - Run 1-Run 30

FLOW RATE AND WATER TEMPERATURE – Removal Efficiency Testing					
Run #	**QA/QC PASS/FAIL**	**Target Inflow Rate (gpm)**	**Average Inflow Rate (gpm)**(±10%)	**Inflow Rate COV** (≤0.03)	**Maximum Water Temperature (°F)** (≤80 ° F)
1	PASS	62.0	62.21	0.004	73.4
2	PASS	62.0	62.53	0.006	73.4
3	PASS	62.0	62.15	0.004	73.4
4	PASS	62.0	62.08	0.005	73.4
5	PASS	62.0	62.13	0.004	73.4
6	PASS	62.0	62.10	0.004	73.5
7	PASS	62.0	62.03	0.005	73.7
8	PASS	62.0	61.90	0.003	73.7
9	PASS	62.0	62.06	0.003	73.7
10	PASS	62.0	61.85	0.005	73.7
11	PASS	62.0	61.94	0.003	73.7
12	PASS	62.0	61.88	0.007	73.7
13	PASS	62.0	61.81	0.006	73.9
14	PASS	62.0	62.00	0.005	74.1
15	PASS	62.0	62.11	0.005	74.1
16	PASS	62.0	62.11	0.003	74.4
17	PASS	62.0	62.16	0.004	74.1
18	PASS	62.0	62.16	0.004	74.3
19	PASS	62.0	62.16	0.004	74.3
20	PASS	62.0	62.16	0.005	74.4
21	PASS	62.0	62.12	0.003	74.4
22	PASS	62.0	62.23	0.007	74.4
23	PASS	62.0	62.10	0.004	74.4
24	PASS	62.0	61.86	0.004	74.4
25	PASS	62.0	61.98	0.004	74.4
26	PASS	62.0	62.04	0.004	74.6
27	PASS	62.0	62.10	0.003	74.6
28	PASS	62.0	62.04	0.003	74.6
29	PASS	62.0	62.09	0.003	74.6
30	PASS	62.0	62.12	0.004	74.6

Table 19 Summary of Removal Efficiency Flow Rates and Temperature – Run 31 – Run 60

FLOW RATE AND WATER TEMPERATURE – Removal Efficiency Testing					
Run #	**QA/QC PASS/FAIL**	**Target Inflow Rate (gpm)**	**Average Inflow Rate (gpm)**(±10%)	**Inflow Rate COV** (≤0.03)	**Maximum Water Temperature (°F)** (≤80 ° F)
31	PASS	62.0	62.05	0.004	74.6
32	PASS	62.0	61.99	0.003	74.6
33	PASS	62.0	62.02	0.004	74.6
34	PASS	62.0	62.03	0.003	74.8
35	PASS	62.0	62.13	0.004	74.8
36	PASS	62.0	62.14	0.003	74.6
37	PASS	62.0	61.87	0.005	74.6
38	PASS	62.0	62.11	0.004	74.6
39	PASS	62.0	61.51	0.055	74.8
40	PASS	62.0	62.13	0.003	74.8
41	PASS	62.0	62.11	0.003	75.0
42	PASS	62.0	62.18	0.005	74.8
43	PASS	62.0	62.12	0.003	74.8
44	PASS	62.0	62.09	0.005	74.8
45	PASS	62.0	62.14	0.005	75.0
46	PASS	62.0	62.17	0.004	75.0
47	PASS	62.0	62.38	0.007	75.2
48	PASS	62.0	62.11	0.004	75.0
49	PASS	62.0	62.32	0.005	74.8
50	PASS	62.0	62.23	0.007	74.8
51	PASS	62.0	61.99	0.005	75.0
52	PASS	62.0	62.05	0.005	75.0
53	PASS	62.0	62.31	0.008	75.2
54	PASS	62.0	62.30	0.005	75.0
55	PASS	62.0	62.22	0.006	75.0
56	PASS	62.0	62.28	0.006	75.0
57	PASS	62.0	62.05	0.006	75.2
58	PASS	62.0	61.84	0.007	75.0
59	PASS	62.0	62.12	0.005	75.2
60	PASS	62.0	62.22	0.004	76.6

Table 20 Summary of Removal Efficiency Flow Rates and Temperature - Run 61 - Run 90

FLOW RATE AND WATER TEMPERATURE – Removal Efficiency Testing					
Run #	**QA/QC PASS/FAIL**	**Target Inflow Rate (gpm)**	**Average Inflow Rate (gpm)**(±10%)	**Inflow Rate COV** (≤0.03)	**Maximum Water Temperature (°F)** (≤80 ° F)
61	PASS	62.0	62.26	0.005	75.5
62	PASS	62.0	62.04	0.004	75.5
63	PASS	62.0	62.29	0.004	75.9
64	PASS	62.0	62.28	0.006	75.7
65	PASS	62.0	62.22	0.006	75.9
66	PASS	62.0	62.18	0.004	75.9
67	PASS	62.0	62.29	0.003	75.9
68	PASS	62.0	62.46	0.004	76.2
69	PASS	62.0	62.22	0.004	76.1
70	PASS	62.0	62.39	0.003	75.9
71	PASS	62.0	62.36	0.005	75.9
72	PASS	62.0	62.35	0.005	76.1
73	PASS	62.0	62.42	0.003	76.1
74	PASS	62.0	62.27	0.003	76.1
75	PASS	62.0	62.29	0.003	76.4
76	PASS	62.0	62.33	0.004	76.1
77	PASS	62.0	62.48	0.006	75.9
78	PASS	62.0	62.19	0.006	76.2
79	PASS	62.0	62.20	0.005	76.1
80	PASS	62.0	62.30	0.005	76.2[1]
81	PASS	62.0	62.43	0.006	77.1
82	PASS	62.0	62.31	0.007	76.2
83	PASS	62.0	62.19	0.005	76.4
84	PASS	62.0	62.34	0.007	77.3
85	PASS	62.0	62.05	0.007	77.0
86	PASS	62.0	62.19	0.004	77.0
87	PASS	62.0	62.01	0.009	77.0
88	PASS	62.0	62.26	0.005	77.1
89	PASS	62.0	61.93	0.007	77.1[1]
90	PASS	62.0	62.59	0.004	77.3

[1] Data recorder failed; max temperature as recorded by 3rd party observer during run

Table 21 Summary of Removal Efficiency Flow Rates and Temperature - Run 91 - Run 118

FLOW RATE AND WATER TEMPERATURE – Removal Efficiency Testing					
Run #	**QA/QC PASS/FAIL**	**Target Inflow Rate (gpm)**	**Average Inflow Rate (gpm)**(±10%)	**Inflow Rate COV** (≤0.03)	**Maximum Water Temperature (°F)** (≤80 ° F)
91	PASS	62.0	62.27	0.004	77.3
92	PASS	62.0	62.17	0.004	77.3
93	PASS	62.0	62.27	0.005	77.5
94	PASS	62.0	62.09	0.006	77.5
95	PASS	62.0	62.15	0.005	77.5
96	PASS	62.0	62.60	0.005	77.5
97	PASS	62.0	61.94	0.004	77.5
98	PASS	62.0	61.65	0.008	77.5
99	PASS	62.0	61.76	0.008	77.7
100	PASS	62.0	62.39	0.006	77.7
101	PASS	62.0	62.10	0.006	77.9
102	PASS	62.0	62.28	0.004	78.2
103	PASS	62.0	62.41	0.005	78.2
104	PASS	62.0	62.38	0.004	78.2
105	PASS	62.0	62.35	0.006	78.4
106	PASS	62.0	62.30	0.005	78.2
107	PASS	62.0	62.25	0.009	78.2
108	PASS	62.0	62.32	0.004	77.0
109	PASS	62.0	62.40	0.005	77.0
110	PASS	62.0	62.16	0.004	77.0
111	PASS	62.0	62.25	0.004	77.0
112	PASS	62.0	62.35	0.009	77.0
113	PASS	62.0	62.57	0.004	75.5
114	PASS	62.0	62.39	0.006	75.5
115	PASS	62.0	62.24	0.005	75.5
116	PASS	62.0	62.18	0.006	75.7
117	PASS	62.0	62.41	0.005	75.7
118	PASS	62.0	62.11	0.006	75.7

Table 22 Summary of Removal Efficiency Feed Rate and Concentration - Run 1 - Run 30

FEED RATE AND CONCENTRATIONS - Removal Efficiency Testing									
Run #	**QAQC PASS/FAIL**	**Target Influent TSS (mg/L)**	**Mass Influent TSS (mg/L)** (+10%)	**Feed Rate (g/min)**			**Feed Rate COV** (≤0.10)	**Average Background SSC** (≤20 mg/L)	**Minimum SSC/DD Sample Volume** (≥0.5 L)
1	PASS	200	197.1	46.76	46.60	47.36	0.008	0.5	0.836
2	PASS	200	187.4	46.76	47.92	47.72	0.013	0.5	0.810
3	PASS	200	203.8	46.36	48.31	48.77	0.027	0.5	0.791
4	PASS	200	205.8	49.39	46.27	48.47	0.033	0.5	0.787
5	PASS	200	210.6	49.76	50.31	49.05	0.013	0.5	0.794
6	PASS	200	210.4	48.88	49.41	49.00	0.006	0.5	0.755
7	PASS	200	209.8	48.88	48.35	49.55	0.012	0.5	0.745
8	PASS	200	211.0	48.71	49.01	50.43	0.019	0.5	0.783
9	PASS	200	202.4	48.08	46.34	48.20	0.022	0.5	0.764
10	PASS	200	205.4	46.76	47.12	48.87	0.024	0.5	0.776
11	PASS	200	209.1	45.70	46.60	48.13	0.044	0.5	0.694
12	PASS	200	209.0	48.25	50.28	47.87	0.027	0.5	0.687
13	PASS	200	210.0	49.54	48.03	50.22	0.023	0.5	0.749
14	PASS	200	207.9	48.58	50.06	50.22	0.018	0.5	0.753
15	PASS	200	207.7	48.82	48.03	50.04	0.021	0.5	0.717
16	PASS	400	399.9	48.88	95.43	95.11	0.003	0.5	0.753
17	PASS	400	403.1	48.88	95.03	96.23	0.006	0.5	0.748
18	PASS	400	399.9	48.71	93.78	94.06	0.005	0.5	0.792
19	PASS	400	404.1	92.46	94.05	94.81	0.013	0.5	0.712
20	PASS	400	407.3	94.80	94.79	96.52	0.010	0.5	0.777
21	PASS	400	406.1	96.13	94.82	96.06	0.008	0.5	0.737
22	PASS	400	406.2	94.38	97.12	96.06	0.014	0.5	0.755
23	PASS	400	400.6	92.92	96.04	95.20	0.017	0.5	0.746
24	PASS	400	405.3	94.79	96.12	94.25	0.010	0.5	0.746
25	PASS	400	406.4	96.68	96.20	95.05	0.009	0.5	0.790
26	PASS	400	406.4	93.92	95.45	94.73	0.008	0.5	0.826
27	PASS	400	413.0	96.65	98.12	97.19	0.008	0.5	0.794
28	PASS	400	409.2	96.28	95.82	96.73	0.005	0.5	0.731
29	PASS	400	404.9	96.01	96.18	95.56	0.003	0.5	0.764
30	PASS	400	405.5	94.24	94.62	94.28	0.002	0.5	0.810

Table 23 Summary of Removal Efficiency Feed Rate and Concentration - Run 31 - Run 60

FEED RATE AND CONCENTRATIONS - Removal Efficiency Testing									
Run #	**QAQC PASS/FAIL**	**Target Influent TSS (mg/L)**	**Mass Influent TSS (mg/L)** (+10%)	**Feed Rate (g/min)**			**Feed Rate COV** (≤0.10)	**Average Background SSC** (≤20 mg/L)	**Minimum SSC/DD Sample Volume** (≥0.5 L)
31	PASS	400	408.8	94.13	96.55	97.12	0.017	0.5	0.768
32	PASS	400	409.4	97.11	95.31	97.73	0.013	0.5	0.748
33	PASS	400	413.1	96.43	97.43	97.56	0.006	0.5	0.742
34	PASS	400	412.9	96.08	96.38	95.93	0.002	1.4	0.833
35	PASS	400	409.3	96.15	97.47	97.11	0.007	0.5	0.788
36	PASS	400	404.5	95.48	95.37	96.85	0.009	0.5	0.752
37	PASS	400	407.7	96.45	95.64	95.68	0.005	0.5	0.811
38	PASS	400	406.6	96.89	94.77	95.90	0.011	0.5	0.794
39	PASS	400	415.4	96.84	96.42	96.19	0.003	0.5	0.775
40	PASS	400	412.6	95.91	96.74	97.26	0.007	0.5	0.780
41	PASS	400	413.9	96.08	97.14	97.66	0.008	0.5	0.790
42	PASS	400	401.8	94.51	95.60	95.64	0.007	0.5	0.810
43	PASS	400	404.6	95.48	96.02	96.73	0.007	0.5	0.760
44	PASS	400	406.5	95.78	96.67	96.38	0.005	0.5	0.736
45	PASS	400	404.7	94.17	96.22	95.64	0.011	0.5	0.743
46	PASS	400	406.0	96.99	95.80	95.88	0.007	0.5	0.729
47	PASS	400	406.4	97.10	94.95	98.16	0.017	0.5	0.784
48	PASS	400	397.8	95.16	94.58	94.74	0.003	0.5	0.701
49	PASS	400	401.9	95.04	94.33	94.87	0.004	0.5	0.758
50	PASS	400	409.4	94.28	96.57	96.75	0.014	0.5	0.754
51	PASS	400	407.1	94.94	94.51	96.06	0.008	0.5	0.784
52	PASS	400	406.8	97.07	95.99	95.53	0.008	0.5	0.711
53	PASS	400	406.2	94.79	96.12	96.57	0.010	0.5	0.765
54	PASS	400	393.5	92.77	92.75	93.38	0.004	0.5	0.744
55	PASS	400	409.0	97.35	97.57	96.62	0.005	0.5	0.772
56	PASS	400	408.8	95.75	97.38	97.45	0.010	0.9	0.700
57	PASS	400	409.8	95.05	95.70	95.21	0.004	0.5	0.705
58	PASS	400	413.5	95.73	97.27	97.26	0.009	0.5	0.702
59	PASS	400	414.8	97.33	96.26	96.63	0.006	0.5	0.754
60	PASS	400	395.0	92.86	94.26	95.39	0.013	0.7	0.725

Table 24 Summary of Removal Efficiency Feed Rate and Concentration - Run 61 - Run 90

FEED RATE AND CONCENTRATIONS - Removal Efficiency Testing									
Run #	**QAQC PASS/FAIL**	**Target Influent TSS (mg/L)**	**Mass Influent TSS (mg/L)** (+10%)	**Feed Rate (g/min)**			**Feed Rate COV** (≤0.10)	**Average Background SSC** (≤20 mg/L)	**Minimum SSC/DD Sample Volume** (≥0.5 L)
61	PASS	400	403.4	95.37	96.49	94.95	0.008	0.5	0.748
62	PASS	400	407.6	95.45	95.71	94.62	0.006	0.5	0.728
63	PASS	400	403.9	93.86	94.10	95.98	0.012	0.5	0.744
64	PASS	400	407.8	95.31	95.49	96.55	0.007	0.5	0.754
65	PASS	400	409.8	95.77	96.96	96.20	0.006	2.9	0.779
66	PASS	400	397.9	92.81	92.24	94.29	0.011	1.0	0.735
67	PASS	400	401.6	94.67	94.50	94.98	0.003	0.5	0.759
68	PASS	400	401.3	93.09	93.43	94.80	0.010	0.5	0.774
69	PASS	400	403.8	92.70	95.71	97.20	0.024	0.5	0.759
70	PASS	400	405.9	96.10	97.69	95.34	0.012	0.7	0.747
71	PASS	400	407.9	96.72	97.35	95.77	0.008	0.5	0.763
72	PASS	400	403.6	95.11	96.09	96.41	0.007	0.9	0.776
73	PASS	400	403.3	94.57	94.60	93.14	0.009	0.5	0.760
74	PASS	400	404.5	94.36	94.01	96.00	0.011	0.7	0.754
75	PASS	400	404.8	94.38	96.93	96.95	0.015	0.9	0.777
76	PASS	400	402.4	99.36	99.13	93.08	0.037	0.5	0.802
77	PASS	400	406.6	95.22	98.67	96.58	0.018	0.5	0.760
78	PASS	400	408.3	95.02	96.90	96.22	0.010	1.3	0.816
79	PASS	400	406.1	96.76	96.08	93.64	0.017	1.6	0.747
80	PASS	400	409.5	97.34	96.30	93.08	0.023	1.1	0.790
81	PASS	400	397.6	96.27	96.20	96.57	0.002	0.8	0.796
82	PASS	400	403.9	97.97	92.79	96.23	0.028	0.5	0.764
83	PASS	400	411.4	92.67	95.93	95.61	0.019	0.5	0.757
84	PASS	400	396.0	93.00	95.14	99.25	0.033	0.5	0.758
85	PASS	400	401.5	94.07	99.69	93.87	0.035	0.5	0.792
86	PASS	400	402.6	92.69	92.79	95.94	0.020	0.5	0.745
87	PASS	400	405.3	95.76	95.10	92.28	0.020	0.8	0.783
88	PASS	400	404.6	99.21	97.60	95.99	0.016	0.5	0.720
89	PASS	400	408.6	96.39	98.11	97.76	0.009	0.9	0.788
90	PASS	400	396.5	93.54	94.71	101.06	0.042	0.5	0.791

Table 25 Summary of Removal Efficiency Feed Rate and Concentration - Run 91 - Run 118

FEED RATE AND CONCENTRATIONS - Removal Efficiency Testing									
Run #	**QAQC PASS/FAIL**	**Target Influent TSS (mg/L)**	**Mass Influent TSS (mg/L)** (±10%)	**Feed Rate (g/min)**			**Feed Rate COV** (≤0.10)	**Average Background SSC** (≤20 mg/L)	**Minimum SSC/DD Sample Volume** (≥0.5 L)
91	PASS	400	398.3	94.68	94.15	94.20	0.003	0.5	0.762
92	PASS	400	402.5	90.20	92.11	92.15	0.012	0.5	0.785
93	PASS	400	405.1	91.55	93.26	93.95	0.013	0.9	0.771
94	PASS	400	412.3	93.87	97.80	99.05	0.028	0.7	0.740
95	PASS	400	407.2	95.39	94.02	98.40	0.023	0.7	0.764
96	PASS	400	391.7	90.67	98.04	94.12	0.039	0.9	0.798
97	PASS	400	407.5	94.33	98.51	96.24	0.022	0.5	0.779
98	PASS	400	417.4	95.36	100.39	96.19	0.028	0.5	0.763
99	PASS	400	411.8	95.95	101.85	97.11	0.032	0.5	0.784
100	PASS	400	412.2	94.78	96.65	97.80	0.016	0.5	0.809
101	PASS	400	414.3	101.46	94.64	95.90	0.037	0.5	0.768
102	PASS	400	398.4	92.07	94.38	94.85	0.016	0.5	0.764
103	PASS	400	400.3	92.05	92.73	96.43	0.025	0.5	0.711
104	PASS	400	401.4	96.28	93.23	95.92	0.018	0.5	0.765
105	PASS	400	411.3	92.96	92.53	98.03	0.032	0.5	0.786
106	PASS	400	413.8	95.77	94.78	98.15	0.018	0.5	0.748
107	PASS	400	408.9	97.71	94.22	94.51	0.020	0.5	0.759
108	PASS	400	397.9	93.53	94.23	90.68	0.020	0.5	0.769
109	PASS	400	404.7	93.16	97.15	97.16	0.024	0.5	0.763
110	PASS	400	412.2	94.23	95.03	95.15	0.005	0.5	0.755
111	PASS	400	414.6	100.03	97.88	99.78	0.012	0.5	0.758
112	PASS	400	405.6	94.05	101.29	91.03	0.055	1.4	0.725
113	PASS	400	384.1	92.59	93.01	84.98	0.050	0.8	0.741
114	PASS	400	398.5	97.96	96.13	96.58	0.010	0.5	0.717
115	PASS	400	407.1	94.28	93.98	94.92	0.005	0.5	0.762
116	PASS	400	409.2	96.34	94.85	97.53	0.014	0.5	0.769
117	PASS	400	410.9	104.21	94.83	102.62	0.050	0.5	0.742
118	PASS	400	412.1	95.32	104.94	94.94	0.058	0.5	0.727

4.4 Scour Results

No scour testing was performed on the Modular Wetlands® 360 Model MW360-4-4 as this configuration is not intended to have internal bypass functionality and is designed for offline installation.

5. Design and Installation Limitations

Contech Engineered Solutions, LLC. provides engineering support to clients on all projects. Each system is professionally designed/sized to meet site-specific conditions and applicable regulatory criteria. All site and design constraints will be addressed during the design and manufacturing process.

Required Soil Characteristics

The Modular Wetlands® 360 is delivered to the jobsite as a pre-assembled unit housed in a concrete structure designed for site-specific soil conditions, corrosiveness, and ground water. Note: Some project specific conditions may warrant the need to deliver systems not fully assembled which may require some filter module assembly or installation. Plastic or fiberglass housing may also be available. The system can be used in most soil types proved the structure is properly designed for project specific loading, ground water, and corrosive soil conditions. A copy of the geotechnical report along with surface loading requirements will be reviewed and verified for each project if provided.

Slope

In general, it is not recommended that the pipe slope into the system exceed 5% or be less than 0.5%. Slopes higher than 5% will cause increased velocities, which could affect the performance. Slopes less the 0.5% could cause sediment accumulation in the bottom of the inflow pipe and affect its hydraulic capacity.

The Modular Wetlands® 360 is usually not affected by slope variations of the finished grade if the unit is buried underground on a level surface. Risers of various heights can be used to bring access to the system up to the finished grade. For units installed at the surface with an open vegetated planter, the slope of the finish surface may require custom designed top slabs and installation procedures that should be addressed during the design process. For these configurations the finish surface slope is more constraining and will require design review to ensure feasibility.

Delivery and Unloading/Lifting

The Modular Wetlands® 360 is delivered to the jobsite as a pre-assembled unit(s) in coordination with the Contractor. The Contractor requires spreader bars, a set of suitable lifting hooks, knuckles, shackles, and eyebolts and chains/cables to lift the main structure and risers safely and securely. (See project specific drawings for weights and lifting details. Contact Contech for additional lifting details.)

Inspection

Inspection of the units and all parts contained in or shipped outside of the unit shall be inspected at time of delivery by the site Engineer/Inspector and the Contractor. Any non-conformance to approved drawings or damage to any part of the system shall be documented on the shipping ticket. Damage to the unit during and after unloading shall be corrected at no cost to Contech Engineered Solutions. Any necessary repairs to the units shall be made to the acceptance of the Engineer/Inspector.

Site Preparation

The Contractor is responsible for providing adequate and complete vault protection when the unit is installed prior to final site stabilization, such as full landscaping, grass cover, final paving, and street sweeping is completed. The Contractor shall adhere to all jurisdictional and/or OSHA safety rules in providing temporary shoring of the excavation. The Contractor or Owner is responsible for appropriately barricading the unit from traffic in accordance with local codes.

Installation

Each unit shall be constructed based on the location, elevations, and sizes shown on the approved drawings. Any modifications to the elevation or location shall be at the direction of and approved by the Engineer. Changes to the approved drawings may incur additional charges from Contech Engineered Solutions. The unit shall be placed on level, compacted sub-grade with a minimum 6-inch gravel base. Compact undisturbed sub-grade materials per Geotechnical/Soils report. Unsuitable material below sub-grade shall be replaced to site engineer's approval. Once the unit is set, the top section shall be sealed onto the base section before backfilling, using a non-shrink grout, butyl rubber, or similar watertight sealant.

Pipe connections shall be aligned and sealed to meet the approved drawings with modifications necessary to meet site conditions and local regulations. The inlet and outlet will be marked separately on the unit. Once the unit is set, the system shall be protected from construction runoff. Contractor will be responsible for cleaning and replacing media, filters, screens, and internal components if unit is contaminated by construction runoff and associated pollutants and damage (i.e. concrete wash water). Backfilling shall be performed in a careful manner, bringing the appropriate fill material up in 6-inch lifts on all sides. Precast sections shall be set in a manner that will result in a watertight joint.

In all instances, installation of the unit shall conform to ASTM specification C891 "Standard Practice for Installation of Underground Precast Utility Structures" unless specified otherwise in contract documents. If required, it is the responsibility of the Contractor to provide curb and gutter and transition to the unit for proper stormwater flow into the system through the throat, pipe, or grate opening. A standard drawing of the throat and gutter detail is available; however, the plans and contract documents supersede all standard drawings. Several variations of the standard design are available. Effective bypass for an offline unit is essential for correct operation (i.e., bypass to an overflow at lower elevation).

Maintenance Requirements

Requirements pertaining to maintenance of the Modular Wetlands® 360 will vary depending on pollutant loading and individual site conditions. It is recommended that the system be inspected at least twice during the first year to determine loading conditions for each site. These first-year inspections can be used to establish inspection and maintenance frequency for subsequent years.

Driving Head

Driving head will vary for a given Modular Wetlands® 360 model based on the site-specific configuration. Maximum treatment flow, pipe slope and diameter will be assessed. At the conclusion of mass load testing the water level reached 40 inches. This should be used as the minimum driving head requirement for design. It is recommended that pipe fall between the inflow and outflow pipe be provided to minimize or eliminate the amount of sur-charge required. Contech Engineered Solutions provides design support for each project. Site-specific drawings (cut sheet) will be provided that show pipe inverts, finish surface elevation, flow rates, and hydraulic grade lines. The hydraulic grade line will be assessed for its effect on the overall drainage system to ensure no flooding at peak flow.

Installation Limitations

With each installation, Contech Engineered Solutions provides contractors with instructions prior to delivery. Contractors can request onsite assistance from an installation technician during delivery and installation. Pick weights and lifting details are also provided prior to delivery so the contractor can have appropriate equipment onsite to set the unit.

Configurations

The Modular Wetlands® 360 is intended for offline installation only.

Structural Load Limitations

The Modular Wetlands® 360 is typically housed in a pre-cast concrete structure. Most standard structures are designed to handle indirect traffic loads with open planter configurations. For deeper installation, or installation requiring direct traffic rating or higher, the structure will be designed and modified with potentially thicker tops, bottoms and/or walls to handle the additional loading. Various access hatch options are available for parkway, indirect traffic, direct traffic, and other higher loading requirements such as airports or loading docks.

Pre-treatment Requirements

The Modular Wetlands® 360 was tested in a standalone configuration with no pre-treatment. Water was pumped directly into the biofiltration chamber, which contains the Modular Wetlands® 360 cylindrical media bed. Therefore, pre-treatment prior to the biofilter chamber is not required.

Limitations in Tailwater

Site-specific tailwater conditions must 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

High groundwater conditions will not affect the operation of the Modular Wetlands® 360, as it is a closed system. In conditions where high groundwater is present, various measures are employed by Contech Engineered Solutions' engineering department to ensure that there are no negative consequences caused by the high groundwater. Various measures can be employed such as waterproofing the inside and outside of the structure with an approved coating. A footing can also be added to the bottom of the structure to increase its footprint and offset any buoyancy concerns.

6. Maintenance Plans

As with all stormwater BMPs, inspection and maintenance on the Modular Wetlands® 360 is necessary. Stormwater regulations require that all BMPs be inspected and maintained to ensure they are operating as designed to allow for effective pollutant removal and provide protection to receiving water bodies. It is recommended that inspections be performed multiple times during the first year to assess site specific loading conditions as pollutant loading can vary greatly from site to site. The first year of inspections can be used to set inspection and maintenance intervals for subsequent years to ensure appropriate maintenance is provided. If in subsequent years observations show a need for changed inspection and maintenance protocols, they should be implemented. Without appropriate maintenance, a BMP can exceed its storage capacity, which can negatively affect its continued performance in removing and retaining captured pollutants. The Modular Wetlands® 360 Operation and Maintenance Manual is available at: https://www.conteches.com/Portals/0/Documents/Maintenance%20Guides/ModWet360-OM-Manual.pdf

Inspection Equipment

Following is a list of equipment to allow for simple and effective inspection of the Modular Wetlands® 360:

- Modular Wetlands 360 Inspection Form.
- Flashlight.
- Manhole hook or appropriate tools to access the device via hatches and covers.
- Maintenance and Protection of Traffic Plan and appropriate traffic control signage.
- Measuring pole and/or tape measure.
- Protective clothing and eye protection.
- Impact Driver with 9/16" socket
- 9/16" open or closed ended wrench or ratchet with 9/16" socket
- Note: entering a confined space requires appropriate safety and certification. However, it is generally not required for routine inspections of the system that can be accomplished from the surface.

Inspection Steps

The core to any successful stormwater BMP maintenance program is routine inspections. The inspection steps required on the Modular Wetlands® 360 are quick and easy. As mentioned above the first year should be seen as the maintenance interval establishment phase. During the first year more frequent inspections should occur to gather loading data and maintenance requirements for that specific site. It can be advantageous to also inspect the unit during a rain event as well as dry periods. This information can be used to establish a base for long term inspection and maintenance interval requirements.

The Modular Wetlands® 360 can be inspected though visual observation without entry into the system. All necessary pre-inspection steps must be carried out before inspection occurs, especially traffic control and other safety measures to protect the inspector and near-by pedestrians from any dangers associated with an open access hatch or manhole. Once completed, the inspection process can proceed:

- Prepare the inspection form by writing in the necessary information including project name, location, date, time, unit number and other info (see inspection form).
- Observe the inside of the system by removing the top tray covers and looking into the biofiltration chamber to inspect the sedimentation area around the media containment cage. If the unit is underground, observe the system through the access covers. If minimal light is available and vision into the unit is impaired utilize a flashlight to see inside the biofilter chamber.
- Look for any out of the ordinary obstructions in the inflow pipe, the sedimentation area around the media containment cage, or outflow pipe. Write down any observations on the inspection form.
- Through observation and/or digital photographs estimate the amount of trash and debris accumulated in the sedimentation area around the media containment cage. Utilizing a tape measure or measuring stick estimate the amount of sediment in the biofiltration chamber. Record this depth on the inspection form.
- Through visual observation, inspect the condition of the pre-treatment fabric wrap. Look for excessive build-up of sediment on the wrap. Record this information on the inspection form.
- The biofiltration chamber is generally maintenance-free due to the system's sedimentation area around the media containment cage and the pre-treatment fabric wrap. If necessary, the vertical surface of the media can be power washed/back washed to restore flow capacity. For units with open planters with vegetation, its is recommended that the vegetation be inspected and maintained. Look for any plants that are dead or showing signs of disease or other negative stressors. Record the general health of the plants on the inspection form and indicate through visual observation or digital photographs if trimming of the vegetation is needed.
- Finalize inspection report for analysis by the maintenance manager to determine if maintenance is required

Maintenance Indicators

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

- Obstructions in the system or its inlet or outlet.
- Excessive accumulation of trash and debris in the sedimentation area around the media containment cage in which the area is fully impacted more than 18-inches.
- Excessive accumulation of sediment in the sedimentation area around the media containment cage of more than 6-inches in depth as established using a stadia rod or similar.
- Excessive accumulation of sediment on the pre-treatment fabric wrap.
- Excessive buildup of sediments on the surface of the media bed.
- Excessive standing water in the biofiltration chamber.

Inspection Notes

- Following maintenance and/or inspection, it is recommended that the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and the condition of the system.
- The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection up request at any time.
- Transport all debris, trash, organics, and sediments to an approved facility for disposal in accordance with local and state requirements.
- Entry into biofiltration chamber may require confined space training based on state and local regulations.
- No fertilizer shall be used in the biofiltration chamber.
- Irrigation should be provided as recommended by the manufacturer and/or landscape architect. The amount of irrigation required is dependent on plant species. Some plants may not require irrigation after initial establishment.

Maintenance Procedures

It is recommended that maintenance occurs at least three days after the most recent rain to allow for drain down of the system and any upstream detention systems designed to drain down over an extended period of time. Maintaining the system while flows are still entering it will increase the time and complexity required for maintenance. Cleaning of the biofiltration chamber can be performed from the finish surface without entry into the vault utilizing a vacuum truck. Once all safety measures have been set up cleaning can proceed as followed:

- Remove the mulch and top tray(s) to access the sedimentation area around the media containment cage, and then position the vacuum truck accordingly. To remove the top tray(s), remove the nuts from the wedge anchors using either a ratchet or impact gun with a 9/16” socket. Once nuts are removed, lift and remove the top tray. For underground units or units with peak diversion chambers, remove the access cover(s) and position the vacuum truck accordingly.
- With a pressure washer, spray down pollutants accumulated on the walls of the biofiltration chamber and pre-treatment fabric wrap. For units with peak diversion chambers, spray down pollutants in the peak diversion chamber first then proceed to spraying down the biofiltration chamber.
- Vacuum out sedimentation area and remove all accumulated pollutants including trash, debris, and sediments. Be sure to vacuum the floor until the floor of the biofiltration chamber is visible and clean first, then proceed to vacuuming out the biofiltration chamber.
- After successfully cleaning out the biofiltration chamber, enter the chamber and remove the pre-treatment fabric wrap. With the pressure washer, spray down the pre-treatment fabric wrap thoroughly to wash out any sediment in the fibers. The wrap should be reused, however, if necessary, replacement wraps can be ordered from one of Contech’s Maintenance Team members at https://www.conteches.com/maintenance. If replacing the wrap, be sure to transport the old one to an approved facility for disposal in accordance with local and state requirements.

- With the wrap removed, use the pressure washer to thoroughly spray down the surface of the media bed. This must be done to wash off any finer sediment that gets through the pre-treatment fabric wrap. Continue to spray down the media bed until pollutants are no longer washing out. After thoroughly washing the media, replace the pre-treatment fabric wrap (new or reused), exit the biofiltration chamber, and replace the top tray(s) and/or access cover(s).
- In general, the biofiltration chamber is maintenance-free with the exception of maintaining the vegetation. The MW360 utilizes vegetation similar to surrounding landscape areas, therefore, trim vegetation to match surrounding vegetation. If any plants have died, replace them with new ones.

As with all biofilter systems, at some point the biofiltration media will need to be replaced, either due to physical clogging or sorptive exhaustion of the media ion exchange capacity (to remove dissolved metals and phosphorous). The general life of this media is 10 to 20 years based on site specific conditions and pollutant loading, so replacing the biofiltration media should not be a common occurrence. In the event that the biofiltration media requires replacement, contact one of Contech's Maintenance Team members at https://www.conteches.com/maintenance to order new biofiltration media. The quantity of media needed can be determined by providing the model number and unit depth. Media will be provided in super sacks for easy installation. Each sack will weigh between 1000 and 2000 lbs. Biofiltration media replacement can be done following the steps below:

- Remove the mulch, vegetation, and top tray(s) to access the biofiltration media, and then position the vacuum truck accordingly. For underground units, remove the access cover(s) to gain access to the biofiltration media, and then position the vacuum truck accordingly. Utilize the vacuum truck to vacuum out all the media.
- Once all media is removed, use the pressure washer to spray down all the netting and center drain down tube on the inside of the media containment cage. Vacuum out any remaining debris after spraying down netting. Inspect the netting for any damage or holes. If the netting is damaged, it can be repaired or replaced with guidance by the manufacturer.
- Ensure that the chamber is fully cleaned prior to installation of new media. A lifting apparatus (backhoe, boom truck, or other) is recommended to position the super sack over the biofiltration chamber. Fill the media cage(s) up to the same level as the old media.
- Once the media has been replaced, replant the vegetation and replace the top tray(s). Fill the top tray(s) with approved mulch (see plan drawings for details). Where applicable, replace all access cover(s).
- All removed debris and pollutants shall be disposed of following local and state requirements.

7. Statements

The following attached pages are signed statements from the manufacturer (Contech Engineered Solutions, LLC), the third-party observers (Charlie Davidson and Jillian Wulf from Kinnetic Environmental), and NJCAT. These statements are a requirement of the verification process.

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

Contech Engineered Solutions LLC
9025 Centre Pointe Drive, Suite 400
West Chester, OH 45069
Phone: (513) 645-7000
Fax: (513) 645-7993
www.ContechES.com

11/1/2023

RE: Modular Wetland 360 NJDEP Testing

To Whom It May Concern,

We are providing this letter as our statement certifying that the protocol titled "New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device" (NJDEP Filter Protocol, January 14, 2022) has been strictly followed. Testing performed at Contech (formerly Bio Clean) Laboratories, in Oceanside, CA on the Modular Wetland 360 in July of 2022 under the strict supervision of Charlie Davidson, of Kinnetic Environmental, Inc., was conducted in full compliance with protocol requirements. All required documentation, data, and calculations have been provided in addition to the accompanying report.

We certify that all requirements and criteria were met and/or exceeded during testing of the Modular Wetland 360.

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

Sincerely,

Zachariha J. Kent

VP of Product Development

Contech, a Quikrete Company

Signature: ______________________ Date:____11/1/2023_______

A QUIKRETE® Company

Stormwater BMP Test Observation Statement

Date: November 6, 2023

Subject: Modular Wetland 360 Biofiltration Stormwater Treatment Device

To: Zachariha Kent, Contech Engineered Solutions, LLC

From: Charlie Davidson, Kinnetic Environmental Inc.

Kinnetic Environmental, Inc. has been engaged by Contech Engineered Solutions, LLC to act as the third-party observer for the Performance Verification Testing of their Modular Wetland 360 Biofilter as required by Procedure for Obtaining Verification of a stormwater manufactured Treatment Device from New Jersey Corporation for Advanced Technology (NJCAT). Performance Verification Testing was performed by Contech personnel under the direction of Mr. Zach Kent, Managing Director, and began on July 18, 2022, and ended on August 25, 2022. The Performance Verification was performed at Contech located at 398 Via El Centro, Oceanside, California 92008.

I, Charlie Davidson, Regional Manager, and Jillian Wulf, Environmental Scientist, were on site to observe the testing for its full duration. My review of the flow rates and frequency of sampling (including on-site measurements and collection of samples for laboratory analysis) reported by Contech for the performance tests as reported in their report "NJCAT Technology Verification" of November 2023 were reported accurately. Grain size analysis and sediment concentration in water samples collected by Contech for analysis was performed offsite by third party laboratories. The sampling occurred under my and Jillian's observation and the samples were transported and picked up from the laboratories themselves. The verification testing used applicable protocols as outlined in the Quality Assurance Project Plan (QAPP). I have personally reviewed the reported sampling methods and data sets in the Report referenced data files by Contech dated November 2023 and hereby state they conform to my recorded observations while acting as a third-party observer.

Please let me know if you have any questions or need any clarification on these statements.

Sincerely,

Charlie Davidson

Charlie Davidson, Senior Environmental Scientist
cdavidson@kinneticenv.com
(881) 517-1577

Jillian Wulf, Environmental Scientist
jwulf@kinneticenv.com

KINNETIC
ENVIRONMENTAL
Environmental & Oceanographic Research
760-438-8968 office *3132 Tiger Run Court, Carlsbad, CA 92010* *www.Kinneticenv.com*

Stormwater BMP Test Observation Statement of Disclosure

Date: November 6, 2023

Subject: Modular Wetland 360 Biofiltration Stormwater Treatment Device

To: Zach Kent, Contech Engineered Solutions, LLC

From: Charlie Davidson, Kinnetic Environmental Inc.

In accordance with the Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology (August 4, 2021) Section 4. B Conflict of Interest, Kinnetic Environmental Inc. would like to inform NJCAT that we have no disclosures that would represent a conflict of interest. Kinnetic Environmental Inc. has no personal, professional, or financial interest in the outcome of the Performance Verification Testing performed by Contech, and has no personal, professional, or financial interest in Contech or its parent company.

This engagement with Contech does not present a personal, professional, or financial conflict of interest as the engagement does not include:

- Having an ownership stake in the company
- Receiving commission for selling a Manufactured Treatment Device for a manufacturer
- Having a licensing agreement with the manufacturer; or
- Receiving funding or grants not associated with a testing program from the manufacturer

Please let either of us know if you have any questions or need any clarification to these statements.

Sincerely,

Charlie Davidson

Charlie Davidson, Senior Environmental Scientist
cdavidson@kinneticenv.com
(818) 517-1577

Jillian Wulf, Environmental Scientist
jwulf@kinneticenv.com

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

January 3, 2024

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 a commercially available Contech MW360-4-4 at Contech's Laboratory in Oceanside, CA in July-August 2022 the test protocol requirements contained in the "*New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device*" (NJDEP Filtration Protocol, January 14, 2022) were met or exceeded. Independent third-party observation was provided by Charlie Davidson, Regional Manager/Senior Scientist, and Jillian Wulf, Environmental Scientist, at Kinnetic Environmental, Carlsbad, CA. Specifically:

Test Sediment Feed

Due to the number of runs completed, two separate lots of test sediment were used. Both lots of test sediment were purchased from and custom blended by GHL (Good Harbours Laboratories, Mississauga, Ontario, Canada) using various commercially available silica sands. GHL lot A028-095 was used for Runs 1 - 66, and GHL lot A029-151 was used for Runs 67 - 118. Test sediment was analyzed for particle size distribution using ASTM method 6913 (Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis) and ASTM D7928 (Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis). Both lots complied with the NJDEP protocol PSD requirements with no average particle size coarser than the target by two percentage points and the average d_{50} not greater than 75µm.

Removal Efficiency (RE) Testing

Fifteen (15) removal efficiency test runs were completed in accordance with the NJDEP test protocol. The target flow rate and influent sediment concentration were 62.0 gpm and 200 mg/L for the removal efficiency testing. The MW360 achieved a cumulative removal efficiency of 91.44% for runs 1 through 10 at the target MTFR.

Sediment Mass Loading Capacity

Mass loading capacity testing was conducted as a continuation of removal efficiency testing for an additional 103 runs. Mass loading test runs were conducted using identical testing procedures and flow rate target as those used in the removal efficiency runs, except that the influent sediment concentration was increased to 400 mg/L. The flow rate was reduced to 90% of the MTFR after the maximum driving head was exceeded. Testing concluded after the 103 mass loading test runs. The Contech MW360 achieved a cumulative mass removal efficiency of 83.75% over the 118 runs.

The total influent mass loaded through Run 118 was 989.6 lbs and the total mass captured by the MW360 was 828.8. This is equivalent to a sediment mass loading capacity of 22.6 lbs/ft^2 of EFTA.

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

Scour Testing

No scour testing was performed on the MW360 as this configuration is not intended to have internal bypass functionality and is designed for offline installation.

Sincerely,

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

8. References

1. 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. August 4, 2021.

2. NJDEP 2022. New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device. January 14, 2022.

VERIFICATION APPENDIX

Introduction

- Manufacturer – Contech Engineered Solutions LLC, 9100 Centre Pointe Drive, Suite 400 West Chester, OH 45069, Website: http://www.ContechES.com Phone: (513) 645-7000.
- Modular Wetlands® 360 – Contech Modular Wetlands® 360 verified cage heights and models are shown in **Table A-1**.
- TSS Removal Rate – 80%
- Modular Wetlands® 360 MTD qualifies for offline installation for the New Jersey Water Quality Design Storm (NJWQDS).

Detailed Specification

- NJDEP sizing tables and physical dimensions of the Modular Wetlands® 360 verified models are attached (**Table A-1**). Both vault and manhole (MH) configurations are available.
- 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 Modular Wetlands® 360 40" Tall Cartridge has a maximum treatment flow rate (MTFR) of 0.138 cfs (62 gpm), which corresponds to a media surface loading rate of 1.7 gpm/ft^2.
- Prior to installation, Contech provides contractors with detailed installation and assembly instructions and is also available to consult onsite during installation. Pick weights and installation procedures vary slightly with model size. Design support is given by Contech for each project and pick weights and installation procedures will be provided prior to delivery.
- See Modular Wetlands® 360 Operations and Maintenance Manual for detailed maintenance information: https://www.conteches.com/Portals/0/Documents/Maintenance%20Guides/ModWet360-OM-Manual.pdf
- Under N.J.A.C. 7:8-5.5, NJDEP stormwater design requirements do not allow a filtration device such as the Modular Wetlands® 360 to be used in series with another filtration device to achieve an enhanced TSS removal rate.

Table A-1 Modular Wetlands® 360 Cartridge Heights and New Jersey Treatment Capacities

Cartridge Height (in)	EFTA (sf)	Hydraulic Loading Rate (gpm/sf)[1]	Cartridge MTFR		Mass Load (lbs)	Maximum Treatment Area[2] (ac)
			(gpm)	(cfs)		
26	23.8	1.7	40.3	0.090	538.7	0.90
32	29.3	1.7	49.6	0.111	663.0	1.11
40	36.7	1.7	62.0	0.138	828.8	1.38
44	40.3	1.7	68.2	0.152	911.7	1.52
52	47.6	1.7	80.6	0.180	1077.4	1.80
56	51.3	1.7	86.8	0.193	1160.3	1.93
58	53.1	1.7	89.9	0.200	1201.8	2.00
60	55.0	1.7	93.0	0.207	1243.2	2.07
68	62.3	1.7	105.4	0.235	1409.0	2.35
70	64.1	1.7	108.5	0.242	1450.4	2.42
76	69.6	1.7	117.8	0.262	1574.7	2.62
80	73.3	1.7	124.0	0.276	1657.6	2.76

1. Based on test results from tested model (MW360-4-4)
2. Based on 600 lbs of sediment per acre annually.

Table A-2 Modular Wetlands® 360 Standard Model Cartridge Count

Standard Models	Structure ESA (sf)	Maximum Cartridge Count by Cartridge Height											
		26”	32”	40”	44”	52”	56”	58”	60”	68”	70”	76”	80”
MW360-4-4	16	1	1	1									
MW360-4-8	32	2	2	2	1	1	1	1	1	1	1	1	1
MW360-4-12	48	3	3	3	2	2	2	2	2	1	1	1	1
MW360-4-16	64	4	4	4	3	3	3	3	3	2	2	2	2
MW360-4-20	80	5	5	5	4	4	3	3	3	3	3	2	2
MW360-8-8	64	4	4	4	3	3	3	3	2	2	2	2	2
MW360-8-12	96	6	6	6	5	5	4	4	4	3	3	3	3
MW360-8-16	128	8	8	8	7	6	6	6	5	5	4	4	4
MW360-8-20	160	10	10	10	9	8	7	7	7	6	6	5	5
MW360-5MH	19.6	1	1	1	1	1							
MW360-6MH	28.3	1	1	1	1	1	1	1	1	1	1	1	
MW360-8MH	50.3	2	2	2	2	2	2	2	2	2	1	1	1
MW360-10MH	78.5	4	4	4	4	4	3	3	3	3	3	2	2
MW360-12MH	113.1	7	7	7	6	5	5	5	5	4	4	4	3

Note: Vault models are designated by length and width i.e. MW360-4-8 is a vault configuration while MW360-5MH is a 5-ft manhole configuration.

Table A-3 Modular Wetlands® 360 Standard Model Maximum MTFR

Standard Models	Maximum MTFR by Cartridge Height (cfs) (active water level)											
	26”	32”	40”	44”	52”	56”	58”	60”	68”	70”	76”	80”
MW360-4-4	0.090	0.111	0.138									
MW360-4-8	0.180	0.221	0.276	0.152	0.180	0.193	0.200	0.207	0.235	0.242	0.262	0.276
MW360-4-12	0.269	0.332	0.414	0.304	0.359	0.387	0.401	0.414	0.235	0.242	0.262	0.276
MW360-4-16	0.359	0.442	0.553	0.456	0.539	0.580	0.601	0.622	0.470	0.483	0.525	0.553
MW360-4-20	0.449	0.553	0.691	0.608	0.718	0.580	0.601	0.622	0.704	0.725	0.525	0.553
MW360-8-8	0.359	0.442	0.553	0.456	0.539	0.580	0.601	0.414	0.470	0.483	0.525	0.553
MW360-8-12	0.539	0.663	0.829	0.760	0.898	0.774	0.801	0.829	0.704	0.725	0.787	0.829
MW360-8-16	0.718	0.884	1.105	1.064	1.077	1.160	1.202	1.036	1.174	0.967	1.050	1.105
MW360-8-20	0.898	1.105	1.381	1.368	1.437	1.354	1.402	1.450	1.409	1.450	1.312	1.381
MW360-5MH	0.090	0.111	0.138	0.152	0.180							
MW360-6MH	0.090	0.111	0.138	0.152	0.180	0.193	0.200	0.207	0.235	0.242	0.262	
MW360-8MH	0.180	0.221	0.276	0.304	0.359	0.387	0.401	0.414	0.470	0.242	0.262	0.276
MW360-10MH	0.359	0.442	0.553	0.608	0.718	0.580	0.601	0.622	0.704	0.725	0.525	0.553
MW360-12MH	0.629	0.774	0.967	0.912	0.898	0.967	1.001	1.036	0.939	0.967	1.050	0.829

Table A-4 Modular Wetlands® 360 Standard Model Maximum Treatment Area

Standard Models	Maximum Treatment Area by Cartridge Height (ac)											
	26”	32”	40”	44”	52”	56”	58”	60”	68”	70”	76”	80”
MW360-4-4	0.90	1.11	1.38									
MW360-4-8	1.80	2.21	2.76	1.52	1.80	1.93	2.00	2.07	2.35	2.42	2.62	2.76
MW360-4-12	2.69	3.32	4.14	3.04	3.59	3.87	4.01	4.14	2.35	2.42	2.62	2.76
MW360-4-16	3.59	4.42	5.53	4.56	5.39	5.80	6.01	6.22	4.70	4.83	5.25	5.53
MW360-4-20	4.49	5.53	6.91	6.08	7.18	5.80	6.01	6.22	7.04	7.25	5.25	5.53
MW360-8-8	3.59	4.42	5.53	4.56	5.39	5.80	6.01	4.14	4.70	4.83	5.25	5.53
MW360-8-12	5.39	6.63	8.29	7.60	8.98	7.74	8.01	8.29	7.04	7.25	7.87	8.29
MW360-8-16	7.18	8.84	11.05	10.64	10.77	11.60	12.02	10.36	11.74	9.67	10.50	11.05
MW360-8-20	8.98	11.05	13.81	13.68	14.37	13.54	14.02	14.50	14.09	14.50	13.12	13.81
MW360-5MH	0.90	1.11	1.38	1.52	1.80							
MW360-6MH	0.90	1.11	1.38	1.52	1.80	1.93	2.00	2.07	2.35	2.42	2.62	
MW360-8MH	1.80	2.21	2.76	3.04	3.59	3.87	4.01	4.14	4.70	2.42	2.62	2.76
MW360-10MH	3.59	4.42	5.53	6.08	7.18	5.80	6.01	6.22	7.04	7.25	5.25	5.53
MW360-12MH	6.29	7.74	9.67	9.12	8.98	9.67	10.01	10.36	9.39	9.67	10.50	8.29

Table A-5 Modular Wetlands® 360 NJDEP Scaling

Standard Models	Ratio ESTA/EFTA – Must Be Greater or Equal to Model Tested[1]											
	26”	32”	40”	44”	52”	56”	58”	60”	68”	70”	76”	80”
MW360-4-4	0.268	0.218	0.174									
MW360-4-8	0.268	0.218	0.174	0.555	0.470	0.436	0.421	0.407	0.359	0.349	0.321	0.305
MW360-4-12	0.268	0.218	0.174	0.357	0.302	0.280	0.271	0.262	0.616	0.598	0.551	0.524
MW360-4-16	0.268	0.218	0.174	0.291	0.246	0.228	0.220	0.213	0.359	0.349	0.321	0.305
MW360-4-20	0.268	0.218	0.174	0.257	0.218	0.332	0.321	0.310	0.274	0.266	0.436	0.414
MW360-8-8	0.268	0.218	0.174	0.291	0.246	0.228	0.220	0.407	0.359	0.349	0.321	0.305
MW360-8-12	0.268	0.218	0.174	0.238	0.201	0.280	0.271	0.262	0.359	0.349	0.321	0.305
MW360-8-16	0.268	0.218	0.174	0.215	0.246	0.228	0.220	0.291	0.256	0.349	0.321	0.305
MW360-8-20	0.268	0.218	0.174	0.202	0.218	0.258	0.249	0.241	0.274	0.266	0.321	0.305
MW360-5MH	0.420	0.342	0.273	0.248	0.210							
MW360-6MH	0.783	0.636	0.509	0.463	0.391	0.364	0.351	0.339	0.299	0.291	0.268	
MW360-8MH	0.651	0.529	0.423	0.385	0.326	0.302	0.292	0.282	0.249	0.634	0.584	0.554
MW360-10MH	0.420	0.342	0.273	0.248	0.210	0.323	0.312	0.301	0.266	0.258	0.426	0.404
MW360-12MH	0.274	0.223	0.178	0.229	0.273	0.253	0.245	0.236	0.299	0.291	0.268	0.383

1. The test unit had an ESTA/EFTA = 0.169