Attachment 1

Manufactured Treatment Device (MTD) Registration

1. **Manufactured Treatment Device Name: CrystalStream Water Quality Vault**

2. **Company Name: CrystalStream Technologies**
   Mailing Address: 2090 Sugarloaf Parkway Suite 245
   City: Lawrenceville
   State: GA Zip: 30045

3. **Contact Name (**to whom questions should be addressed)**: John Moll**
   Mailing Address: 2090 Sugarloaf Parkway Suite 245
   City: Lawrenceville
   State: GA Zip: 30045
   Phone number: 800-748-6945
   Fax number: 770-979-6954
   E-mail address: johnmoll@crystalstream.com
   Web address: www.crystalstream.com

4. **Technology – Note: Two Field Tests are included, ETV and CWMTF**
   Specific size/capacity of MTD assessed (include units):

   Model 1056 (ETV) -- Maximum flow is 15 cfs, water quality flow is 2.90 cfs; Model 2056 (CWMTF) – Maximum flow is 25 cfs, water quality flow is 5.79 cfs.

   Range of drainage areas served by MTD (acres):

   For the ETV test, the area served by the Model 1056 was 4.047 ac. and for the CWMTF test the area served was 14.6 acres. The product line is designed to serve from 0.25 ac. – 8.00 acres.

   Include sizing chart or describe sizing criteria:

   Our standard design specification is that the maximum treatment flow will not exceed 26 gpm/sf (This is the Hydraulic Loading Rate, or HLR). Not all models are available in a specific area. The chart below this section shows all available models and the maximum water quality treatment flow based on 26 gpm/sf. Both field tests cited here had devices that were loaded in excess of 30 gpm/sf, so our policy of limiting flows is a conservative approach. Every model specified for use includes a full explanation of testing support and the standard sizing chart.

   Intended application: on-line or offline:

   On-line w/ optional internal bypass.

Media used (if applicable):

Coir (coconut fiber filter), X-Tex ™ cloth filters are occasionally added to improve hydrocarbon removal rates. Neither of the tested devices had X-Tex cloth filters installed.

Standard Model Sizing Chart based on HLR

Model	Width	Length	Sqft	Target WQ flow	Target HLR ft/sec	Target HLR gpm/sf	Total Flow
646	4	6	24	1.4	0.058	26.00	6.0
846	4	8	32	1.9	0.058	26.00	8.0
856	5	8	40	2.3	0.058	26.00	10.0
866	6	8	48	2.8	0.058	26.00	12.5
956	5	9	45	2.6	0.058	26.00	12.5
1056	5	10	50	2.9	0.058	26.00	15.0
1266	6	12	72	4.2	0.058	26.00	24.0
1246	4	12	48	2.8	0.058	26.00	12.0
1856	5	18	90	5.2	0.058	26.00	23.0
2056	5	20	100	5.8	0.058	26.00	25.0
2466	6	24	144	8.3	0.058	26.00	36.0
CrystalStream Model 1056 Hydraulic Loading "As Tested"*							
1056	5	10	50	3.5	0.070	**31.42**	17.5

Media used (if applicable):

Coir (coconut fiber filter) is used in all devices. X-Tex ™ cloth filters are occasionally added to improve hydrocarbon removal rates. Neither tested device had X-Tex cloth filters installed.

5. Warranty Information (describe, or provide web address)**:**

5 year warranty on parts and labor if periodic maintenance is performed.

6. Treatment Type

X Hydrodynamic Structure
X Filtering Structure
X Other (describe): Hydrodynamic with vegetation screening and coconut fiber filter

7. Water Quality Treatment Mechanisms (check all that apply)

X Sedimentation/settling
☐ Infiltration
X Filtration (specify filter media)
X Adsorption/cation exchange Field analysis shows some adsorption by fiber filter.
☐ Chelating/precipitation
☐ Chemical treatment
☐ Biological uptake
☐ Other (describe):

8. Performance Testing and Certification (check all that apply):

Performance Claim (include removal efficiencies for treated pollutants, flow criteria, drainage area):

80+% Suspended Solids, 40% Total Phosphorus at 26 gpm/sf.

Specific size/Capacity of MTD assessed:

5' x 10' (Model 1056 – ETV field test), 20' x 5' (Model 2056 – CWMTF field test)

Has the MTD been "approved" by an established granting agency, e.g. New Jersey Department of Environmental Protection (NJDEP) , Washington State Department of Ecology, etc.

X **Yes**

For each approval, indicate (1) the granting agency, (2) use level if awarded (3) the protocol version under which performance testing occurred (if applicable), and (4) the date of award, and attach award letter. 1. Granting Agency: USEPA, 2. On-line field use, 3. ETV Verification Protocol Stormwater Source Area Treatment Technologies, Draft 4.1, 2002, 4. June, 2005. Verification Statement and Full Test Report attached.

Was an established testing protocol followed?

X **Yes**, (1) Provide name of testing protocol followed, (2) list any protocol deviations:

Provide the information below and provide a performance report (attach report):

"Environmental Technology Verification Report, Stormwater Source Area Treatment Device, Practical Best Management of Georgia, Inc., CrystalStream ™ Water Quality Vault, Model 1056", June 2005, 05/21/WQPC-WWF, EPA 600/R-05/085 is attached.

For field tests: (EPA sponsored ETV verification Test)

i. Provide the address, average annual rainfall and characterized rainfall pattern, and the average annual number of storms for the field-test location:

Device is on US Hwy 16 at Grape Creek, Griffin, GA, coordinates are 84˚ 15' 16.8480" latitude, 33˚ 14' 47.4360 longitude. Average annual rainfall is 52 inches, monthly totals range from an average high of 5.58 inches in July to a low of 2.80 inches in October, and there are 120 days with measurable rainfall. Five minute intensities in the area are: 1-year storm 5.40 in./hr., 2-year storm 5.76 in./hr., 5-year storm 6.63 in./hr., 10-year storm 7.30 in./hr., 25-year storm 8.28 in./hr., 50-year storm 9.08 in./hr., 100-year storm 9.87 in./hr.

ii. Provide the total contributing drainage area for the test site, percent of impervious area in the drainage area, and percentages of land uses within the drainage area (acres):

4.047 ac. total. Lawn (cemetery) = 2.836 ac., Roadway = 1.145 ac., Sidewalks = 0.066 ac.

iii. Describe pretreatment, bypass conditions, or other special circumstances at the test site:

There was no pretreatment or bypass condition upstream of the test device. Mapping indicates an improper drainage area calculation, with an additional (approximate) three acres tributary to the west and south.

iv. Provide the number of storms monitored and describe the monitored storm events (amount of precipitation, duration, etc.): See Chart immediately below.

Event No.	Start Date	Start Time	End Date	End Time	Rainfall Amount (inches)	Rainfall Duration (hr)	Average Rainfall Intensity (in/hr)	Inlet Runoff Volume (gal)	Peak Rainfall Intensity (in/hr)	Inlet Peak Discharge Rate (gpm)	Outlet Runoff Volume (gal)	Outlet Peak Discharge Rate (gpm)
1	3/26/03	19:55	3/26/03	22:35	0.36	2.67	0.13	22,700	0.48	409	13,800	227
2	5/5/03	0:45	5/5/03	2:00	0.49	1.25	0.39	39,000	1.80	1,750	32,900	1,313
3	1/25/04	1:25	1/25/04	5:40	0.25	4.25	0.06	8,120	0.24	126	2,890	40
4	4/13/04	19:25	4/14/04	4:50	0.89	9.42	0.09	15,900	1.20	700	20,240	950
5	4/26/04	11:15	4/26/04	15:05	0.21	3.83	0.05	9,330	0.12	319	10,600	360
6	4/30/04	21:05	5/1/04	5:20	0.78	8.25	0.09	9,630	0.48	341	16,600	417
7	6/25/04	13:25	6/25/04	19:45	0.27	6.33	0.04	20,600	0.36	1,720	4,265	311
8	6/28/04	22:40	6/29/04	1:05	0.45	2.42	0.19	26,600	1.56	2,100	9,730	866
9	6/30/04	19:25	6/30/04	22:30	1.12	3.08	0.36	68,500	2.28	1,900	44,800	1,530
10	7/12/04	14:45	7/12/04	15:15	0.34	0.50	0.68	17,500	1.44	1,080	9,040	534
11	7/17/04	15:00	7/17/04	15:20	0.27	0.33	0.82	14,190	2.40	1,110	9,700	1,040
12	7/25/04	21:40	7/26/04	2:05	0.77	4.42	0.17	34,900	1.08	1,220	22,400	729
13	8/5/04	18:55	8/5/04	19:45	0.63	0.83	0.76	33,900	2.76	1,270	15,400	790
14	8/12/04	1:20	8/12/04	4:10	0.49	2.83	0.17	37,400	1.68	2,600	17,100	1,000
15	8/21/04	15:40	8/21/04	16:55	0.23	1.25	0.18	20,200	1.92	1,770	5,870	571

v. Describe whether or not monitoring examined seasonal variation in MTD performance:

Testing spanned approximately 18 months, but no specific reference to seasonal variations was included in the study.

vi. If particle size distribution was determined for monitored runoff and/or sediment collected by the MTD, provide this information: See chart below.

		Sands (>62 µm)		Fines (<62 µm)	
Event No.	Date	Inlet (percent)	Outlet (percent)	Inlet (percent)	Outlet (percent)
1	3/26/2003	47.7	6.8	52.3	93.2
2	5/5/2003	6.1	33.1	93.9	66.9
3	1/25/2004	32.9	NA	67.1	NA
4	4/13/2004	17.8	7.1	82.2	92.9
5	4/26/2004	22.3	10.7	77.7	89.3
6	4/30/2004	39.1	9.5	60.9	90.5
7	6/25/2004	28	6.2	72	93.8
8	6/28/2004	60.8	6.8	39.2	93.2
9	6/30/2004	38.5	21.9	61.5	78.1
10	7/12/2004	68.6	19.7	31.4	80.3
11	7/17/2004	33.7	11	66.3	89
12	7/25/2004	74.1	23.8	25.9	76.2
13	8/5/2004	90.7	9.1	9.3	90.9
14	8/12/2004	77.6	9.2	22.4	90.8
15	8/21/2004	72.6	7.4	27.4	92.6
	Mean	47.37	13.02	52.63	86.98

The material coming to the device averaged about 47% sand sized particles and 53% silt and clay sized particles. The device removed 98% of the sand and 34% of the fines. This resulted in effluent that consisted of about 13% sand and 87% fines. See full report attached.

NOTE: This section pertains to a second field test in Highlands, NC. This test was also conducted and paid for by others, so that it is a true third party test.

Provide the information below and provide a performance report (attach report):
"Pine Street Stormwater Management Facilities Study (Innovative Stormwater Project Implementation), Town of Highlands, Macon County, North Carolina, McGill Associates,

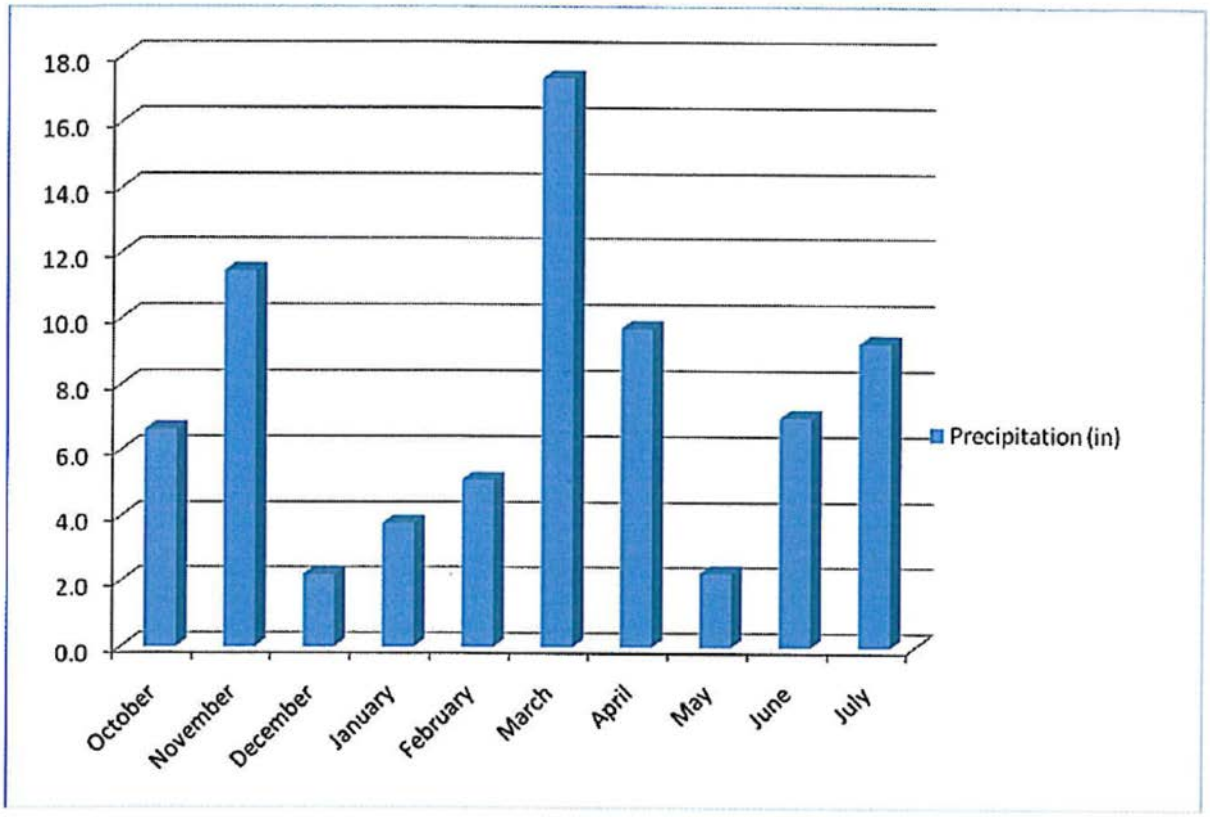
Forrest Westall, PE and Joseph C. Williams, PE, September, 2011, 10.00336" is attached.

For field tests: (Clean Water Management Trust Fund, Highlands, NC field test)

i. Provide the address, average annual rainfall and characterized rainfall pattern, and the average annual number of storms for the field-test location:

Device is located in a park on Pine Street in Highlands, NC near the end of the park adjacent to 5th Avenue: coordinates are 83.195268˚ W longitude, 35.052936˚ N latitude. Average annual rainfall is 84.6 inches, monthly totals range from an average high of 8.19 inches in November to a low of 5.94 inches in October, and there are over 150 days with measurable rainfall. There was a total of 74.7 inches of rain recorded during the study period. The precipitation occurs partly because of orographic lifting due to the high relative elevation of Highlands at 4,118 MSL which makes it the highest crest on the Western North Carolina Plain. The lifting raises the relative humidity to 100% and creates clouds and fog. Many days could be added to the measurable rainfall days as the fog and mist contribute to trace amounts of precipitation. During the winter months average snowfall amounts are: December - 2 inches, January – 4 inches, February – 3 inches, March – 2 inches, April – 1 inch. Five minute intensities in the area are: 1-year storm 5.18 in./hr., 2-year storm 6.16 in./hr., 5-year storm 7.21 in./hr., 10-year storm 8.17 in./hr., 25-year storm 9.32 in./hr., 50-year storm 10.30 in./hr., 100-year storm 11.20 in./hr. Actual rainfall during the study period is depicted in the following chart from Page 21 of the main report:

Figure 8: Study Period Precipitation



ii. Provide the total contributing drainage area for the test site, percent of impervious area in the drainage area, and percentages of land uses within the drainage area (acres):

The total drainage basin is 14.6 acres: Impervious area (downtown business district) = 5.84 ac., Pervious (mostly wooded and some lawns) = 8.76 acres. A site map detailing three distinct drainage areas along with curve numbers and times of concentration is shown on Page 10 of the full study (attached). The site analysis was taken from a 2007 Stormwater Master Plan study to delineate the basins and downtown flooding issues. This site discharges into the Big Creek basin, which is classified as WS-III (water supply Class II) and as trout waters by the State of North Carolina.

iii. Describe pretreatment, bypass conditions, or other special circumstances at the test site:

The device proposed was designed to accept a peak flow of 25 cfs. The peak flow for the basis was calculated to 69.7 cfs for the 25-year storm, so the system was designed to bypass the device (and an underground storage facility downstream) during flows that exceeded 25 cfs. This was

accomplished by a diversion plate located in and manhole just upstream of the device. Up until 25 cfs, water flowed through the device and then into the underground storage facility. Thereafter, flows above 25 cfs passed over the weir plate in a bypass pipe. Depending on the depth of the hydraulic gradient downstream, some flows continued through the system at all times. The full report includes a complete description of the system, including a schematic drawing of the bypass arrangement. Current aerial mapping (such as “Google Earth) clearly shows the system lid tops at the coordinates listed above. The rectangular concrete lids on the device are easily identifiable on the overhead view, as is the nature of the drainage basin.

iv. Provide the number of storms monitored and describe the monitored storm events (amount of precipitation, duration, etc.):

There were 20 events monitored during the study. In addition to the monitored storm data, the study recorded all rainfall during the study and it is available in tabular form upon request. The data set is very large due to the fact that the rainfall amounts were measured at 15 minute intervals for a year, and most of the amounts are simply zeros during periods when there was no rainfall. Nevertheless, the data is useful for establishing the antecedent conditions for each monitored event. The chart below lists the storms by date:

Table 1: Study Period Sampling Storm Events

Event Date	Total Rain (in)	Duration (hrs)	*Storm Event
October 25, 2010	1.10	6.00	-
November 4, 2010	0.35	13.00	-
November 16, 2010	0.28	9.00	-
November 30, 2010	4.59	21.00	1-Year
December 21, 2010	0.08	2.50	-
January 18, 2011	0.07	6.75	-
January 26, 2011	0.51	9.50	-
February 1, 2011	0.14	4.25	-
February 28, 2011	0.98	2.25	-
March 9, 2011	1.65	9.00	-
March 26, 2011	0.73	4.00	-
April 12, 2011	0.26	3.75	-
April 21, 2011	0.16	1.50	-
April 26, 2011	0.16	6.75	-
May 4, 2011	0.81	8.75	-
May 27, 2011	1.12	12.00	-
June 16, 2011	1.76	5.50	1-Year
June 23, 2011	0.75	5.25	-
July 21, 2011	0.30	1.00	-
July 26, 2011	0.90	3.00	-

**Note: Storm Event reflects greatest precipitation intensity and not Total Rain/Total Duration*

v. Describe whether or not monitoring examined seasonal variation in MTD performance:

Although the date was recorded for all data, the report did not draw any seasonal conclusions regarding MTD performance. The TSS data that demonstrated 96% removal overall is listed in the chart below that shows all the storm events, and the results of the laboratory analysis for TSS using SM-2540-D. There is a general seasonal relationship of lower intensity storms that had lower effluent concentrations of TSS, and by inference, lower concentrations of particulate organics and other gross materials.

Date	Duration (hrs)	Total (in)		Concentrations (mg/L) Site A	Site B	Site C
25-Oct-10	6.00	1.10		364.0	20.0	20.0
4-Nov-10	13.00	0.35		4.0	4.0	4.0
16-Nov-10	9.00	0.28		20.8	27.3	2.0
30-Nov-10	21.00	4.59		10.6	6.9	2.0
21-Dec-10	2.50	0.08		40.7	2.0	2.0
18-Jan-11	6.75	0.07		18.8	9.2	2.0
26-Jan-11	9.50	0.51		42.0	27.2	10.8
1-Feb-11	4.25	0.14		77.3	25.0	3.4
28-Feb-11	2.25	0.98		2150.0	4.7	5.5
9-Mar-11	9.00	1.65		18.7	16.7	2.0
26-Mar-11	4.00	0.73		24.4	29.3	2.0
12-Apr-11	3.75	0.26		1010.0	3.3	2.0
21-Apr-11	1.50	0.16		265.0	4.7	4.8
26-Apr-11	6.75	0.16		537.0	7.0	4.5
4-May-11	8.75	0.81		164.0	7.7	7.3
27-May-11	12.00	1.12		112.0	11.0	16.7
16-Jun-11	5.50	1.76		116.0	5.6	5.6
23-Jun-11	5.25	0.75		13.7	6.7	6.7
21-Jul-11	1.00	0.30		565	3.3	3.3
26-Jul-11	3.00	0.90		123	9.2	3.3
Rain Totals	134.75	16.70	**Raw Average**	283.9	11.5	5.5
Rain Average	6.74	0.84				
	Sum of Loads	**(SOL)**		5960.9	242.3	115.4
	Average Intensity (in/hr)		**0.124**		**96% Eff.**	

vi. If particle size distribution was determined for monitored runoff and/or sediment collected by the MTD, provide this information:

Particle size distribution was recorded by studying the contents of the MTD. The laboratory results are contained in the appendices of the main report, and are summarized in the report by the following excerpt from the report:

4.3 Sediment Evaluation

Composite sediment samples were taken from the floors of the hydrodynamic separator units # 1 & #2. The analysis found that the sediment retained was generally comprised of the following: 57% sand, 35.5% silt and 7.5% clay. Table 5 below presents the average particle size distribution based on the sieve analysis of the composite sediment samples. The particle size distribution shows that the majority of particles retained were less than 0.25-millimeters in size. This is consistent with expectations given that flows to the hydrodynamic separator must first flow over a weir wall, which should typically exclude larger size particles from the separator.

Table 5: Average Sieve Analysis Results

Coarse Fragments (Gravel > 2mm) %	Very Coarse Particle (1-2 mm) %	Coarse Sand (0.5-1 mm) %	Medium Particle (0.25-0.5 mm) %	Fine Particle (0.1-0.25 mm) %	Very Fine Particle (0.05-0.10 mm) %
3.12	2.19	5.29	8.35	31.23	22.82

**Note: Remaining percentage is finer than 0.05 mm*

NOTE: Additional data pertinent to nutrient removal and other performance parameters were gathered in this study, and are summarized below.

In Table 3 on Page 25 of the Highlands Report the overall results of the field test were detailed as follows:

Table 3: Hydrodynamic Separator Performance

		Hydrodynamic Separator Influent (A)	**Hydrodynamic Separator Effluent (B)**	
Parameter	**Units**	**Average**	**Average**	**Removal % [Increase %]**
Total Suspended Solids	mg/L	283.8	11.9	96%
BOD, 5 day	mg/L	7.1	7.9	[11%]
Fecal Coli form	CFU/100mL	1443.3	1127.0	22%
Specific Conductance	µmhos	98.1	122.0	[24%]
Ammonia, Nitrogen	mg/L	0.2	0.1	50%
Total Nitrogen	mg/L	1.66	0.43	74%
Total Kjeldahl Nitrogen	mg/L	1.36	0.34	75%
Nitrogen, NO2 plus NO3	mg/L	0.29	0.27	7%
Total Phosphorous	mg/L	0.19	0.05	74%
Orthophosphate as P	mg/L	Non-Detectable Level		-

It is important to note that the average effluent concentration for TSS was under 20 mg/L at 11.9 mg/L and that there were significant reductions in nutrients. "Appendix A" of the report contains the full sampling protocol and sampling schedule. All analysis results for each sampling event are contained in "Appendix B" showing the constituents that were analyzed, the methodology including RL (Reporting Limit) and MDL (Method Detection Limit). In addition, the Certificates of Analysis and the analysis results sheets are included as signed and verified by the laboratory. This material provides the basis for Table 3 as shown above.

In addition to water testing, the study gathered sediments from the device on four occasions when the device was cleaned. Those sediments were used to define the particle size distribution as detailed above in Section 8, "Field Tests", item "vi." There was further analysis of the sediments for nutrients and heavy metals as shown in Table 7, Page 28, below:

Table 7: Sediment Pollutants Retained by Hydrodynamic Separator

Parameter	Units	Sediment Result	Total Quantity Removed (lb)
Mercury	mg/kg	0.081	0.0008
Arsenic	mg/kg	4.1	0.04
Barium	mg/kg	170.0	1.7
Cadmium	mg/kg	1.10	0.01
Chromium	mg/kg	30.00	0.31
Copper	mg/kg	170.0	1.7
Lead	mg/kg	35.00	0.36
Selenium	mg/kg	3.8	0.04
Silver	mg/kg	1.10	0.01
Zinc	mg/kg	400.0	4.1
Total Kjeldahl Nitrogen	mg/kg	2,650	27
Nitrate + Nitrite	mg/kg	24	0.2
Total Nitrogen	mg/kg	2,650	27
Total Phosphorus	mg/kg	935	10

The sediment analysis results including the Certificates of Analysis are detailed in "Appendix C" of the Highlands field study report.

Every CrystalStream device has a ¾ inch thick coconut fiber filter in the rear chamber that is designed to stay in place up to the water quality flow (and above in most cases), but that can tilt up and out of the way at high flows to provide pressure relief. This filter is changed at every cleaning (at least every six months), and is effective at capturing materials that are too small to be trapped in the trash basket, materials that are neutrally buoyant (like decomposed organic matter), and emulsified or free oils and hydrocarbons. As the filter traps organic debris, that trapped material serves to expand the amount of material available to adsorb dissolved or emulsified materials. A unique

aspect of the Highlands field study was that fresh (unused) samples of this fiber filter were analyzed to see what they contained, and used samples of the filter were also analyzed to see what materials had been trapped or adsorbed during the life of the filter. The results of those analyses are summarized below in Table 8, Page 29:

Table 8: Filter Fabric Performance

Parameter	Units	Clean Fabric Filter Test Result	Used Fabric Filter Test Result	Total Quantity Retained (mg)
Mercury	mg/kg	0.023	0.058	0.324
Arsenic	mg/kg	0.6	1.4	7.4
Barium	mg/kg	5.2	78.0	673.9
Cadmium	mg/kg	0.28	0.66	3.47
Chromium	mg/kg	0.36	13.50	121.59
Copper	mg/kg	3.8	191.0	1,731.6
Lead	mg/kg	0.38	18.00	162.99
Selenium	mg/kg	0.6	2.3	15.4
Silver	mg/kg	0.28	0.66	3.47
Zinc	mg/kg	8.3	660.0	6,029
Total Kjeldahl Nitrogen	mg/kg	155	1767	14,908
Nitrate + Nitrite	mg/kg	8	13	40
Total Nitrogen	mg/kg	160	1767	14,862
Total Phosphorus	mg/kg	77	447	3,419

The table shows impressive increases in the amounts of barium, chromium, copper, lead, and zinc captured by the filter, with other metals having less impressive but still significant increases. In addition, there were large increases in TKN, total nitrogen, and total phosphorus shown by the analysis. The data used to develop this table, along with the laboratory results and Certificates of Analysis are contained in “Appendix D” of the report.

9. MTD History:

How long has this specific model/design been on the market?

15 years

List no more than three locations where the assessed model size(s) has/have been installed in Virginia. If applicable, provide permitting authority. If known, provide latitude & longitude:

Please note that although we offer cleaning and maintenance service on our devices, none of the devices located in Virginia have elected to use our service.

Model 1056 (Matches ETV test device) , Installed 7/10/2007, Aluminum hatch and manhole access, College of William and Mary Business School, Jamestown road at Campus Dr., Williamsburg, VA, Jurisdiction was Williamsburg, VA, Engineer was Clough, Harbour and Associates of Richmond, VA, Latitude 37.26692 N, Longitude 76.718522 W

Model 856 (Most recent Virginia install), Installed 6/2/2014, Traffic grate and manhole access, Murphy Express at 450 Kings Highway, Fredericksburg, VA, Jurisdiction was Fredericksburg, VA, Engineer was Greenberg-Farrow of Atlanta, GA, Latitude 38.2874821 N, Longitude 77.4381128 W

Model 2466 (Slightly larger than CWMTF-Highlands test device), Installed 8/21/2008, Traffic grate and manhole access, Lowes Home Improvement, 2085 Waterside Road, Prince George, VA, Jurisdiction was Prince George, VA, Engineer was Clough, Harbour and Associates of Richmond, VA, Latitude 37.247023 N, Longitude 77.363697 W

List no more than three locations where the assessed model size(s) has/have been installed outside of Virginia. If applicable, provide permitting authority. If known, provide latitude & longitude:

Please note that we have installed 1,970 devices in 26 states. Of those devices, we have performed maintenance on 598 devices. The devices listed here were selected because of their proximity to Virginia. We have records on all devices including engineering data, field report sheets, manifests, and removal weights. Other devices can be provided if necessary.

Model 1056 (as tested, ETV), Installed 9/15/2008, Aluminum hatch and manhole access, Olive Garden Restaurant Salisbury, 1425 Klumac Road, Salisbury, NC, Jurisdiction was Salisbury, NC, Engineer was Hussey, Bell, Gay and DeYoung, Inc. of Mt. Pleasant, SC, Latitude 35.637981 N, Longitude 80.486715 W.

Model 846 (Municipal Installation), Installed 4/9/2008, Traffic grate and manhole access, Elizabethton City Garage, 729 Sycamore Shoals Drive, Elizabethton, TN, Jurisdiction was Elizabethton, TN, Engineer was Elizabethton Public Works City Engineer, Johann Coetzee, Latitude 36.340618 N, Longitude 82.208391 W.

Model 956, Installed 9/15/2008, Traffic grate and manhole access, Longhorn's Steakhouse Restaurant, 1371 Klumac Road, Salisbury, NC, Jurisdiction was Salisbury, NC, Engineer was Hussey, Bell, Gay and DeYoung, Inc. of Mt. Pleasant, SC, Latitude 35.639001 N, Longitude 80.487948

10. Maintenance:

What is the generic inspection and maintenance plan/procedure? (attach necessary documents):

Current O & M Manual Attached.

Is there a maintenance track record/history that can be documented?

X Yes, track record exists; (provide maintenance track record, location, and sizing of three to five MTDs installed in Virginia [preferred] or elsewhere):

Although there are records on hundreds of CST devices, we felt that it would be informative for the installation sites listed above to be used to show maintenance track records. In addition, we are including the maintenance records for the device tested in Highlands, NC and the maintenance records for the first device we installed at a Costco store in Atlanta. The Costco store has been under continual maintenance for 15 years with 30 cleanings performed to date. These records are attached in Appendix "A" at the end of this document.

Recognizing that maintenance is an integral function of the MTD, provide the following: amount of runoff treated, the water quality of the runoff, and what is the expected maintenance frequency for this MTD in Virginia, per year?

This MTD has been in service at some locations for 15 years. Over 10,000 maintenance and cleaning operations have been performed and shown that typical sites require two cleanings per year. On specific sites, such as maintenance yards where hydrocarbon releases are prevalent, cleanings should be done quarterly to prevent inadvertent wash out. On other sites where decomposed vegetation matter is commonly found in stormwater, cleanings can still be scheduled twice yearly, but the trash basket may need to be emptied and the coconut fiber filter replaced quarterly. In a population of 600 devices currently under maintenance by our service company, the average frequency of cleaning is 2.1 cleanings per year.

Total life expectancy of MTD when properly operated in Virginia and, if relevant, life expectancy of media:

All devices installed and inspected are still functional. The theoretical life of concrete structure is 50 to 100 years. Aluminum parts have shown no significant deterioration over the life of devices installed up to 15 years. Note that the aluminum wire mesh in the trash basket (1/4 inch mesh is typical) should be inspected and replaced as necessary. Typical life span is 10 years. The coconut fiber filter should be replaced twice yearly, and has a wet life expectancy of three years before decomposition.

For media or amendments functioning based on cation exchange or adsorption, how long will the media last before breakthrough (indicator capacity is nearly reached) occurs?

See above. Some adsorption occurs but much of the effectiveness is physical trapping. Exhaustion of media (fiber) is closely related to clogging, which is managed initially by inspection to establish the replacement regimen, and thereafter is typically stable in replacement intervals.

For media or amendments functioning based on cation exchange or adsorption, how has the longevity of the media or amendments been quantified prior to breakthrough (attach necessary performance data or documents)?

Through performing over 10,000 maintenance and cleaning procedures on our devices, we have learned that most sites work well with a twice yearly fiber filter replacement. Those sites which are atypical are identified by inspection after the fact, but are predictable in advance, based on experience. To date, over 20,000,000 pounds of material has been cleaned out of our devices under in-house maintenance and disposed of properly.

Is the maintenance procedure and/or are materials/components proprietary?

X No, not proprietary

Maintenance complexity (check all that apply):

X (Qualified): Confined space training required for maintenance. Note that confined space training is in place for all of our crews, and is highly recommended for anyone servicing our products. Entering the device improves the effectiveness of the cleaning and lowers the time needed to accomplish the task.

X Liquid pumping and transportation
Specify method:

We recommend vacuum trailers to be towed behind “F-250 or F-350” class trucks equipped for towing. This method improves the ability to access MTDs that tend to be at the end of drainage systems or off-road below ponds. Standard vacuum trucks can be used effectively in most cases.

X Solids removal and disposal
Specify method:

Sediments found in these devices typically are not hazardous waste. Of course, this can depend on the site and source materials. We dispose of the materials we vacuum out of the devices at licensed “decanting” or disposal centers that can provide a manifest that specifies the generator, transporter and disposal facility. This protects our customers, and provides jurisdictions with credentials that verify proper disposal. Local rules dictate how and where we dispose of the materials we remove.

Other noteworthy maintenance parameter (describe):

Because of the varying nature of site usage and the materials that may be entrained in stormwater, we provide enhancements to our standard MTD as described here to address specific pollutants. We also provide a modification for

jurisdictions that wish to completely eliminate any need for confined space entry, so that all cleaning and maintenance can be done from ground level. We also offer to service every device we install and provide a five year warranty if the device is maintained and cleaned twice yearly.

11. Comments

Include any additional explanations or comments:

Storm Systems Services, LLC, a subsidiary of CrystalStream Technologies will offer maintenance and cleaning services for all devices installed in Virginia. Typically, this service is paid for by the device owner.

12. Certification

Signed by the company president or responsible officer of the organization:

"I certify that all information submitted is to the best of my knowledge and belief true, accurate, and complete."

Signature: 

Name: John Moll

Title: CEO

Date: February 3, 2015

NOTE: All information submitted to the department will be made publically accessible to all interested parties. This MTD registration form will be posted on the Virginia Stormwater BMP Clearinghouse website.

Appendix “A”

Maintenance Records

Maintenance Detail Report

2/2/2015 NC0-001-052908

Longhorn's **Model** 956 **Start Date:** 3/1/2009 **Jurisdiction** Salisbury

Acres: 1.45 **Peak Flow:** 9.57 cfs **WQ Flow:** 1.66 cfs **Pipe Size** 15 In ☐ **Bypass** Type:

Total Days 1,976 **Pounds:** 22,850 **Pounds/Acre/ Year:** 2,911 ☐ Below Detention

☐ Flow Restriction ☐ Other Impairment

Service Date	Service Type	Sediment Inches	Trash (30 gal.)	Time on Unit (H:MM)
9/1/2009	CST Planned Maintenance	6.0	1	2:30
3/24/2010	CST Planned Maintenance	5.0	1	2:00
10/8/2010	CST Planned Maintenance	8.0	2	2:00
4/25/2011	CST Planned Maintenance	5.0	1	2:00
10/25/2011	CST Planned Maintenance	3.0	1	2:00
5/9/2012	CST Planned Maintenance	7.0	2	3:00
11/30/2012	CST Planned Maintenance	6.0	2	2:30
6/5/2013	CST Planned Maintenance	5.0	2	2:30
1/22/2014	CST Planned Maintenance	6.0	2	2:30
7/29/2014	CST Planned Maintenance	5.0	2	2:30

Records = **10**

Maintenance Detail Report

2/2/2015 NC0-002-052908

Olive Garden - Salisbury **Model** 1056 **Start Date:** 9/15/2008 **Jurisdiction** Salisbury

Acres: 2.32 **Peak Flow:** 14.04 cfs **WQ Flow:** 2.21 cfs **Pipe Size** 30 In ☐ **Bypass** Type:

Total Days 2,144 **Pounds:** 41,975 **Pounds/Acre/ Year:** 3,080 ☐ Below Detention

☐ Flow Restriction ☐ Other Impairment

Service Date	Service Type	Sediment Inches	Trash (30 gal.)	Time on Unit (H:MM)
9/1/2009	CST Planned Maintenance	26.0	1	6:00
3/22/2010	CST Planned Maintenance	19.0	1	4:30
10/8/2010	CST Planned Maintenance	7.0	2	2:30
4/25/2011	CST Planned Maintenance	5.0	1	4:00
10/25/2011	CST Planned Maintenance	5.0	2	2:00
5/9/2012	CST Planned Maintenance	6.0	2	3:00
11/30/2012	CST Planned Maintenance	7.0	2	2:30
6/8/2013	CST Planned Maintenance	7.0	2	2:30
1/22/2014	CST Planned Maintenance	7.0	2	2:30
7/30/2014	CST Planned Maintenance	5.0	2	2:30

Records = **10**

Maintenance Detail Report

2/2/2015 NC0-002-052809

Highlands Stormwater **Model** 2056 **Start Date:** 6/8/2010 **Jurisdiction** Highlands, NC

Acres: 9.26 **Peak Flow:** 25.00 cfs **WQ Flow:** 4.29 cfs **Pipe Size** 30 In ☑ **Bypass** Type: Weir Plate

Total Days 1,512 **Pounds:** 64,625 **Pounds/Acre/ Year:** 1,685 ☐ Below Detention

☑ Flow Restriction Diversion weir limits flow ☑ Other Impairment Upstream splitter allows flow to swale

Service Date	Service Type	Sediment Inches	Trash (30 gal.)	Time on Unit (H:MM)
9/1/2010	CST Planned Maintenance	8.0	2	6:00
12/8/2010	CST Planned Maintenance	10.0	2	6:00
3/8/2011	CST Planned Maintenance	7.0	1	6:00
6/8/2011	Cleaning	5.0	1	6:00
8/11/2011	CST Planned Maintenance	4.0	1	2:30
2/22/2012	CST Planned Maintenance	7.0	1	3:00
6/29/2012	CST Planned Maintenance	6.0	1	3:00
10/9/2012	CST Planned Maintenance	6.0	1	3:00
2/21/2013	CST Planned Maintenance	6.0	1	3:30
8/27/2013	CST Planned Maintenance	7.0	2	3:30
7/29/2014	CST Planned Maintenance	7.0	2	3:30
12/4/2014	CST Planned Maintenance	6.0	2	3:30

Records = 12

Maintenance Detail Report

2/2/2015 TN0-025-030508

Elizabethton City Garage **Model** 846 **Start Date:** 2/29/2008 **Jurisdiction** Elizabethton

Acres: 1.33 **Peak Flow:** 7.20 cfs **WQ Flow:** 1.54 cfs **Pipe Size** 12 In ☐ **Bypass** Type:

Total Days 2,372 **Pounds:** 25,920 **Pounds/Acre/ Year:** 2,999 ☐ Below Detention

☐ Flow Restriction ☐ Other Impairment

Service Date	Service Type	Sediment Inches	Trash (30 gal.)	Time on Unit (H:MM)
8/29/2008	CST Planned Maintenance	4.0	1	2:00
2/26/2009	CST Planned Maintenance	4.0	1	1:30
8/25/2009	CST Planned Maintenance	8.0	1	2:00
2/18/2010	CST Planned Maintenance	5.0	2	2:00
8/18/2010	CST Planned Maintenance	6.0	2	4:00
2/22/2011	CST Planned Maintenance	8.0	1	4:00
8/18/2011	CST Planned Maintenance	9.0	1	2:30
2/23/2012	CST Planned Maintenance	5.0	2	2:30
8/23/2012	CST Planned Maintenance	11.0	2	3:30
2/21/2013	CST Planned Maintenance	11.0	2	2:30
8/22/2013	CST Planned Maintenance	8.0	2	2:30
2/27/2014	CST Planned Maintenance	5.0	1	2:30
8/28/2014	CST Planned Maintenance	5.0	2	2:30

Records = 13

Maintenance Detail Report

2/2/2015 GA0-003-110199

COSTCO **Model** 945 **Start Date:** 2/10/2000 **Jurisdiction** Gwinnett

Acres: 0.25 **Peak Flow:** 2.15 cfs **WQ Flow:** 0.37 cfs **Pipe Size** 12 In ☐ **Bypass** Type:

Total Days 5,318 **Pounds:** 42,734 **Pounds/Acre/ Year:** 11,732 ☐ Below Detention

☐ Flow Restriction ☐ Other Impairment

Service Date	Service Type	Sediment Inches	Trash (30 gal.)	Time on Unit (H:MM)
3/31/2000	Inspection	1.0	1	0:30
5/9/2000	Inspection	2.0	1	0:30
8/5/2000	Cleaning	2.3	2	1:30
12/13/2000	Inspection	1.3	2	0:30
3/10/2001	Cleaning	2.8	2	1:30
8/25/2001	Inspection	1.5	1	0:30
12/21/2001	Construction Cleaning	4.0	2	1:30
2/7/2002	Inspection	2.0	2	0:30
6/30/2002	Cleaning	7.0	2	1:30
12/5/2002	Inspection	1.5	1	0:30
5/18/2003	Inspection	2.0	2	0:30
6/23/2003	Cleaning	3.0	2	1:30
9/17/2003	Inspection	1.0	1	0:30
12/16/2003	Cleaning	2.5	2	1:30
6/15/2004	Cleaning	4.0	1	2:00
9/21/2004	Inspection	1.5	1	0:15
12/8/2004	Cleaning	4.0	1	2:00
3/7/2005	Inspection	2.0	1	0:15
6/7/2005	Cleaning	4.3	1	1:30
5/9/2006	Cleaning	4.5	1	1:00
10/31/2006	Cleaning	4.5	1	1:30
4/10/2007	CST Planned Maintenance	5.0	1	1:30

Service Date	Service Type	Sediment Inches	Trash (30 gal.)	Time on Unit (H:MM)
10/1/2007	CST Planned Maintenance	4.5	1	2:30
4/8/2008	CST Planned Maintenance	5.0	1	2:00
10/17/2008	CST Planned Maintenance	5.0	1	1:30
4/10/2009	CST Planned Maintenance	4.0	1	2:00
9/22/2009	CST Planned Maintenance	6.0	1	2:30
3/16/2010	CST Planned Maintenance	5.0	1	2:00
9/23/2010	CST Planned Maintenance	6.0	2	2:00
3/10/2011	CST Planned Maintenance	10.0	1	4:00
9/7/2011	CST Planned Maintenance	7.0	1	2:30
3/7/2012	CST Planned Maintenance	6.0	2	2:30
9/7/2012	CST Planned Maintenance	5.0	2	2:00
3/4/2013	CST Planned Maintenance	5.0	2	2:30
9/3/2013	CST Planned Maintenance	5.0	2	2:30
3/3/2014	CST Planned Maintenance	5.0	2	2:30
9/2/2014	CST Planned Maintenance	5.0	2	2:30
Records =	**37**			