# Attachment 1

## Manufactured Treatment Device (MTD) Registration

1. **Manufactured Treatment Device Name:**

   StormGarden Biofiltration System

2. **Company Name:** Rotondo Environmental Solutions, LLC
   Mailing Address: 2560 Huntington Ave., Suite 303
   City: Alexandria
   State: VA Zip: 22303

3. **Contact Name** (to whom questions should be addressed): John Rotondo
   Mailing Address: 2560 Huntington Ave., Suite 303
   City: Alexandria
   State: VA Zip: 22303
   Phone number: 703-212-4830
   Fax number: N/A
   E-mail address: john@rotondo-es.com
   Web address: Rotondo-es.com

4. **Technology**
   Specific size/capacity of MTD assessed (include units):

   A 4'x6' StormGarden unit was tested at a design hydraulic load rating of 140 in/hr (1.45 gpm/sf). See the attached Washington Ecology GULD report, the field test Technology Evaluation Report, and the attached Technical Memorandum StormGarden Infiltration Test.

   Range of drainage areas served by MTD (acres):

   The system is scalable to drainage areas ranging from 0 acres to greater than 1.0 acres based on the runoff curve number of the specified drainage area shown below. Large drainage areas can be accommodated with custom size units. See the attached sizing methodology.

   Include sizing chart or describe sizing criteria:

| Filter Size | Maximum Drainage Area Treated (acres) | | |
|---|---|---|---|
| | RCN=98 | RCN=95 | RCN=89 |
| 4'x4' | 0.067 | 0.089 | 0.183 |
| **4'x6'** | **0.100** | **0.133** | **0.275** |
| 4'x8' | 0.133 | 0.177 | 0.367 |
| 4'x12' | 0.200 | 0.266 | 0.550 |
| 6'x6' | 0.150 | 0.200 | 0.413 |
| 6'x8' | 0.200 | 0.266 | 0.550 |
| 6'x10' | 0.250 | 0.333 | 0.688 |
| 6'x12' | 0.300 | 0.399 | 0.825 |
| 7'x13' | 0.379 | 0.504 | 1.043 |

The above sizing chart identifies the maximum drainage areas that can be treated by each StormGarden filter based on the following parameters:

- SCS Design Methodology
- Storm Type = Type II 24-hr
- Design Storm = 1.0" Rainfall Depth
- StormGarden Media Flow Rate = 140 in/hr
- Runoff Curve Number (RCN) = As Shown
- Time of Concentration = 6 min
- Allowable Ponding in StormGarden Unit = 9"

This design methodology is consistent with Virginia Stormwater Management Regulations. Additionally, StormGarden can be sized for larger drainage areas with different drainage characteristics or using the Rational Method. See the attached sizing calculations used to formulate the above chart.

It is important to note that the sizing methodology of the test unit as shown in the TER was done in accordance to western Washington state requirements. The sizing methodology that will be used for Virginia is shown above.

Intended application: on-line or offline:

StormGarden can be designed for both on-line and off-line systems.

Media used (if applicable):

StormGarden uses a high flow rate biofiltration media as developed by Rotondo Environmental Solutions. The advanced high-flow rate engineered media utilizes physical, chemical and biological mechanisms of the soil complex to remove pollutants found in stormwater runoff. A hydraulic load rate of 140 inches per hour helps overcome the challenges of clogging and flooding while minimizing space requirements.

It is important to note that the media design hydraulic load rate of 140 in/hr is 44% less than the medias maximum allowable hydraulic load rate with the filter panel (249 in/hr) as shown in the attached StormGarden infiltration Test Report. This yields a factor of safety of 1.78 against potential clogging.

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

Rotondo Environmental Solutions (RES) warrants StormGarden against defects in materials and workmanship only, for a period of 1-year from date RES activates the system into service. RES makes no other warranties, express or implied. RES's liability hereunder shall be conditioned upon the Buyer's installation, maintenance, and service of the goods in strict compliance with the written instructions and specifications provided by RES. Any deviation from RES's instructions and specifications or any abuse or neglect shall void warranties. In the event of any claim upon RES's warranty, the burden shall be upon the Buyer to prove strict compliance with all instructions and specifications provided by RES. RES's liability hereunder shall be limited only to the cost or replacement of the goods. Buyer agrees that RES shall not be liable for any consequential losses arising from the purchase, installation, and/or use of the goods.

6. **Treatment Type**

☐ Hydrodynamic Structure
☒ Filtering Structure

☒ Manufactured Bioretention System
Provide Infiltration Rate (in/hr): 140 in/hr (1.45 gpm/sf) (See attached GULD report)
☐ Other (describe):

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

☒ Sedimentation/settling
☒ Infiltration
☒ Filtration (specify filter media)
☒ Adsorption/cation exchange
☐ 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):

- The StormGarden filter achieved a TSS removal efficiency of 85.1% at a design flow rate of 140 in/hr (1.45 gpm/sf). This removal efficiency was evaluated over 15 qualifying storm events. The influent TSS concentrations during these events ranged from 20 mg/L to 289 mg/L with a mean concentration of 55 mg/L.

- The StormGarden filter achieved a total phosphorous (TP) removal efficiency of 53.4% at a design flow rate of 140 in/hr (1.45 gpm/sf). This removal efficiency was evaluated over 19 qualifying storm events. The influent TP concentrations during these events ranged from 0.03 mg/L to 0.346 mg/L with a mean concentration of 0.099 mg/L.

- The StormGarden system comes with a filter panel located at the base of the sidewall that allows a portion of the treated water to exfiltrate the system through the panel to the exterior sub-grade after being filtered through the media. This exfiltration volume results in a reduced runoff volume leaving the system through the underdrain pipe entering the storm drain system. It is important to note that the pollutant removal efficiencies detailed above do not take into consideration the additional pollutant reduction associated with reducing the runoff volume. Therefore, under normal operations, the mass load of pollutants entering the storm drain system is reduced by the exfiltration volume leaving the StormGarden through the filter panel, thus increasing the pollutant removal efficiencies above what is shown above.

Specific size/Capacity of MTD assessed:

The 4'x6' StormGarden unit that was field tested has a design hydraulic capacity of 35 gpm (1.45 gpm/sf or 140 in/hr) (see attached Washington Ecology GULD report).

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.
☐ **No**

☒ **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.

The StormGarden has been approved by Washington State Department of Ecology for "General Use Level Designation" (GULD) for both Basic (TSS) and Phosphorous in accordance with the TAPE testing protocol in July 2019. See attached GULD approval.

Was an established testing protocol followed?
☐ **No**
☒ **Yes**, (1) Provide name of testing protocol followed, (2) list any protocol deviations:

1. Technology Assessment Protocol – Ecology (TAPE) followed for field test.
2. Protocol was followed without deviation.

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

Attached – Technical Evaluation Report for the StormGarden TAPE Field Test
Attached – Pollutant Removal Efficiency Test Report for the StormGarden Media Lab Test

For lab tests:

i. Summarize the specific settings for each test run (flow rates, run times, loading rates) and performance for each run:

- TSS – The mean flow rate was 0.50 gpm/sf of filter area. The mean run time for each sample was 48 minutes. The TSS loading rates were 20, 100 and 200 mg/L of Sil-co-sil 106, and the removal efficiencies were 92.75%, 93.86% and 98.31% respectively.

- TP – Like the tests for TSS removal, the mean flow rate was 0.50 gpm/sf of filter area, and the mean run time for each sample was 48 minutes. However, the mean loading rate of liquid phosphorous (ammonium dihydrogen phosphate $NH_4H_2PO_4$) was 0.50 mg/L. The removal efficiency of liquid phosphorous was 17.6%. However, it is important to note that the phosphorous used in the test was entirely dissolved phosphorous. Assuming dissolved phosphorous comprises about 50% of the total phosphorous in stormwater runoff which is considered conservative, that leaves about 50% of total phosphorous being attached to particulate matter or sediment. Therefore, it is reasonable to assume that that the TP removal efficiencies would range from approximately 64% (TSS=20 mg/L) to 67% (TSS=200 mg/L).

ii. If a synthetic sediment product was used, include information about the particle size distribution of the test material:

Sil-co-sil 106 (Attachment #8)

iii. If less than full-scale setup was tested, describe the ratio of that tested to the full-scale MTD:

The lab test was performed using 6-inch diameter PVC columns, which has a filter area of 0.20 sf. Comparing this to the 4'x6' field test unit, which has a filter area of 24 sf, the ratio is 0.83%.

For field tests:

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

The StormGarden field study is being conducted at the Ship Canal Testing Facility (SCTF) located in Seattle, WA in the Interstate 5 right-of-way beneath the north side of the Lake Union Ship Canal Bridge. The average annual rainfall for Seattle is approximately 37 inches, with the majority occurring primarily during the "wet season" between October and May of each year. The rainfall pattern is a Type IA according to the USDA-NRCS rainfall distributions for the United States.

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 drainage area contributing to the SCTF site is approximately 31.6 acres, with 22.7 acres of pavement, and 8.9 acres of roadside landscaping. The site allows for the simultaneous testing of up to four treatment systems. Through a series of diversion structures, the runoff from the drainage area is split to the four treatment systems. To fine tune the flow into the test bay even further, a bypass valve was installed immediately upstream of the influent pipe to the StormGarden test unit that can divert water around the structure without changing the flow rate to the neighboring test bay.

Because influent flow rates can be fine-tuned with the upstream valves and flow splitters, the peak influent flow rate was set to range between 50 and 125 percent of the design flow rate, for a 4-foot by 6-foot unit; this equates to between 17.5 and 43.75 gpm (design flow rate = 35 gpm).

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

The system is an off-line system with an external bypass. The bypass consists of an 8" diameter PVC pipe at the downstream end of the curb tray. The invert elevation of the bypass pipe is at the same elevation as the inside roof slab which is the maximum ponding depth of the WQv. There is no pre-treatment prior to the StormGarden test unit, the 3-inch deep mulch layer over the top of the filter media acts as the pre-treatment mechanism for the filter.

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

The test unit was activated the last week of April 2017 and the last monitored storm was taken on 11/22/2018, which is a duration of 19 months. In that time we monitored (22) storm events. The amount of precipitation and duration of each qualifying event is provided in the TER.

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

Yes, the monitoring extended over a period of 19 months, and experienced seasonal variations. The monitoring period started in mid-spring (April 2017) and extended through to the fall of the following year (November 2018).

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

The PSD was monitored and the particles are mostly comprised of silt sized particles with an average $D_{50}$ of 33 microns. More detailed information regarding the PSD is contained in the attached TER.

**9. MTD History:**

How long has this specific model/design been on the market? 4 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:

1. McDonald's Restaurant, 91 Reliance Rd., Middletown, VA ((7) 4'x6' & (1) 4'x8' Units)
2. Central Virginia Regional Jail, 13021 James Madison Hwy, Orange, VA ((3) 4'x6', (3) 6'x10', (1) 6'x12' Units)
3. Madison Village Subdivision, US Route 522 Front Royal Pike, Frederick County, VA ((2) 4'x8', (2) 6'x6', (3) 6'x8', (17) 6'x10', (5) 6'x12' & (12) 7'x13' Units)

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:

1. Waverley Dr. Water Quality Inlet Project, Waverley Dr., Salisbury, MD ((2) 4'x8', (1) 6'x8', (1) 6'x10' & (4) 8'x10' Units)
2. Brookside Square, 352 Turnpike Rd., Southborough, MA ((4) 4'x4' Units)
3. Saint Ambrose Church, 6310 Jason St., Cheverly, MD ((1) 8'x10' & (1) 8'x11' Units)

**10. Maintenance:**

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

See attached maintenance procedures

Is there a maintenance track record/history that can be documented?
☐ No, no track record.
☒ Yes, track record exists; (provide maintenance track record, location, and sizing of three to five MTDs installed in Virginia [preferred] or elsewhere):

See attached maintenance log

Brookside Square, 352 Turnpike Rd., Southborough, MA ((4) 4'x4' Units)

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?

Maintenance requirements for the StormGarden units are a direct function of pollutant load in the runoff treated by the device. Typically, the StormGarden is maintained once in the spring after the winter

loads which include salts and sands, and once in the fall to remove excessive leaves and debris. Typically, maintenance is performed by landscape companies that are responsible for mowing the grass on the property.

The quality of the discharge will be consistent with the effluent observed in our TAPE field study.

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

StormGarden is a biofiltration system. These living systems can last indefinitely unless they become contaminated or are neglected from an operation and maintenance standpoint. Contamination can come from things like chemical or fuel spills, or excessive sedimentation occurring from unstabilized areas.

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?

StormGarden biofilters are living systems. The media incorporates no specialized components or amendments which have a finite lifespan. It utilizes physical, chemical and biological mechanisms of a soil complex, involving numerous unit processes including cation exchange and adsorption among others, to remove pollutants typically found in urban stormwater runoff. No "breakthrough" is expected as long as the system and plants remain healthy.

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)?

No breakthrough is expected. See explanation to previous question.

Is the maintenance procedure and/or are materials/components proprietary?
☐ Yes, proprietary
☒ No, not proprietary

Maintenance complexity (check all that apply):
☐ Confined space training required for maintenance
☐ Liquid pumping and transportation
Specify method:
☒ Solids removal and disposal
Specify method: Remove mulch and debris by using a hand-held rake.
Other noteworthy maintenance parameter (describe):

Remove mulch, sediment, trash and debris and replace with clean mulch. Evaluate and prune plant or replace if necessary.

## 11. Comments

Include any additional explanations or comments:

The StormGarden system comes with a filter panel located at the base of the sidewall that allows a portion of the treated water to exfiltrate the system through the panel to the exterior sub-grade after being filtered through the media. This exfiltration volume results in a reduced

runoff volume leaving the system through the underdrain pipe entering the storm drain system. It is important to note that the pollutant removal efficiencies detailed in the attached TER do not take into consideration this runoff volume reduction. Therefore, under normal operations, the mass load of pollutants entering the storm drain system is reduced by the exfiltration volume leaving the StormGarden filter, and the pollutant removal efficiencies will be higher than what is shown in the TER results.

It is also important to note that because StormGarden units are often distributed about a site, it allows for recharge volume (REv) to be distributed across a site as much as practical to mimic natural conditions.

**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 Rotondo

Title: Manager

Date: 7/12/19

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