Technology Assessment Report

StormTreat System™
StormTreat Systems, Inc.

Prepared for
The Massachusetts Strategic
Envirotechnology Partnership
STEP

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Prepared by

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PREFACE

The STEP technology assessment process is designed to identify those technologies that will support the economic and environmental/energy goals of the Commonwealth of Massachusetts and may benefit from STEP assistance. The process is meant to be one of screening, in which technologies are evaluated by independent technical specialists. Recommendation from this process does not constitute an endorsement of the technology or of the absolute validity of the technology. Rather, STEP technical assessments attest only that, through the screening process, the reviewers feel there may be benefit to the Commonwealth of Massachusetts.

EXECUTIVE SUMMARY

The technology described in this document is StormTreat System™ and is currently owned by StormTreat Systems Inc. (STS) of Sandwich, MA. The parent company is Horsley and Witten, Inc. of Sandwich, MA, an engineering and design consultancy, specializing in hydrological engineering and wetlands. STS has asked that STEP provide third party verification of the performance of the StormTreat system as it relates to the Commonwealth of Massachusetts Stormwater Management Standards. No request for business assistance was made by STS at this time but may be pursued at a later date.

The StormTreat system is a unique stormwater treatment technology that combines several treatment processes into a unitary system. The system includes sedimentation chambers and a biological filter capable of sustaining wetland plants. The system is installed at a depth of approximately 4 feet on a bed of washed stone. The system can be configured for recharge into the subsurface soils below the excavation required for installation or can also be configured for discharge to surface water or to a stormwater conveyance system. The system requires a pretreatment unit, such as a catch basin. There are several competing technologies with varying degrees of similarity. Few technologies exist, which combine the treatment process offered by the StormTreat system. The StormTreat system has the potential to provide enhanced treatment of stormwater compared to conventional stormwater BMPs such as sand filters and infiltration basins. The system requires no energy inputs and may be constructed out of recycled plastic materials.

An assessment of the performance capabilities was prepared based on data submitted by the proponent from two installation in Massachusetts. Performance verification beyond the scope of available test data was made from comparable conventional BMPs described within the DEP Stormwater Management Handbooks. It is the conclusion of this assessment that the system, when sized according to recommended criteria, with proper operation and maintenance, can provide levels of treatment required under Standards 4 and 6, as specified by the DEP Stormwater Management Handbook. Under special circumstances, the system may provide as much as 98% removal of TSS when sized according to design criteria. The system, when configured for recharge can meet Standard 3. The closed mode system is also likely to meet Standard 5, for land uses with higher potential pollutant loads, when sized according to design criteria. Higher performance capabilities may be possible, but are currently undocumented. It is the recommendation of this assessment that when additional data becomes available, that the performance ratings be amended accordingly. STEP will provide additional assistance at the request of STS and the STEP partners.

HIGHLIGHTS

- Performance data available to this reviewer suggest that the StormTreat system can provide removal rates for TSS at least equivalent to sand filters at 80% removal (Standard 4 and 6) when sized accordingly.

" The StormTreat system may be capable of achieving TSS removal rates up to 98% under conditions similar to those reported in the Kingston site, including: climate, land use intensity, and soil type.

- The StormTreat system can potentially meet Standard 3 when configured as a recharge system.

- The StormTreat system may conditionally meet treatment requirements for land uses with higher potential pollutant levels (Standard 5) provided it is not installed as a recharge unit.

- The StormTreat system is likely to remove grease and oils with its unique skimmer mechanism.

" The StormTreat system is useful for new and retrofit installations, especially where space is limited.

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TECHNOLOGY PROPONENT

The technology described in this document is StormTreat System™ (hereafter referred to as the StormTreat system) and is currently owned by StormTreat Systems Inc. (STS) of Sandwich, MA. The system is being commercialized by STS. STS was established in 1994 and has sold 52 units between 1994 through 1996. An additional 89 units have been quoted for sale in the first four months of 1997. The average number of units per location is approximately 4 at 34 installations in California, Florida, Maine, Massachusetts, Mississippi, New Hampshire, New York, Oregon, South Carolina, and Virginia.

TECHNOLOGY DESCRIPTION

The StormTreat system technology addresses treatment of stormwater runoff. It is proposed as an effective first flush collection and "cleansing" system, capable of retaining grit, suspended solids, BOD_5, petroleum hydrocarbons, metals, nitrogen, phosphorus, and bacteria. It is proposed as a cost effective technology for a high level of stormwater treatment. It is proposed that the system has an added value in its small size and minimal impact as compared to detention ponds. Used in combination with other structural BMPs, it has the potential for reducing overall size of detention ponds or basins. The system is currently protected by a United States Patent issued August 27, 1996 to Scott Horsley and Winfried Platz under patent number 5,549,817.

The system is a prefabricated unitary structure which provides sedimentation, oil and grease separation, sand filtration, and biological filtration. In the system, a chambered sedimentation unit and oil and grease separator is combined with a containerized biofilter. The system is designed as a recharge unit or with controlled discharge to surface water or a stormwater conveyance system (Closed Mode). The system is 9.5 feet in diameter and 4 feet in depth. Depending on the area to be treated, any number of units could be utilized in parallel. The chamber is manufactured using rotational molded recycled polyethylene. Other components are made of PVC, gravel (in the biofilter), native wetland plants (in the biofilter), metal closures, and various fittings constructed of plastic or other durable materials. All installation of the StormTtreat system require basic pretreatment in the form of a separate stormwater inlet or catch basin. The unit, designed for recharge, is installed in a 12' x 12' excavation, with a minimum of 12" below the unit and stone surrounding the unit's sides. The closed mode unit is installed in the same sized excavation with 6" of stone below the unit. Treated stormwater effluent discharges from the closed mode unit through a 1 to 2" PVC pipe to a surface discharge or stormwater conveyance system. The STS unit is shown in Figure 1. Discharge components number 8 and 9 (Figure 1), illustrate closed mode discharge and recharge, respectively. Under typical installations, only one mode would be used per site.

The system is designed to treat the first flush of stormwater events, consistent with Standards 4 and 6, of the Stormwater Management Handbook (DEP and CZM, 1997). In the recharge mode, the system may be designed to meet Standard 3 for recharge. The system operates during the initial flush of storm events. Influent loading above the capacity of the unit is directed to an overflow pipe in the catch basin or other pretreatment device. Stormwater enters at the bottom of the unit through a PVC pipe connected to the central sedimentation chambers, configured like a pie with six sections. Influent first passes through a bag filter (component 2, Figure 1) collecting grit and large debris. The influent is directed around the sedimentation chambers, separated by solid bulkheads, through floating skimmers (component 4, Figure 1). The skimmers retain oil and grease by transferring clarified water from 3-4" below the surface of the water to the next chamber. The final sedimentation chamber effluent outlets to a slotted PVC pipe extending into the biofilter (component 5, Figure 1). The biofilter surrounds the sedimentation chambers on the perimeter of the unit occupying roughly ½ the radius of the unit (component 6, Figure 1). Thebiofilter contains a gravel matrix, with an effective aggregate size diameter between 3 and 5 mm. The biofilter is designed to support facultative wetland plants such as, bullrush. Effluent is directed in a counter clockwise direction through the biofilter to slotted PVC pipe (component 7, Figure 1) to an outlet pipe with an adjustable valve for closed mode discharge (component 8, Figure 1). Lineal distance of the biofilter is approximately 25 feet. The flow rate on the outlet is adjustable. STS recommends the outlet flow rate be set at 0.25 gallons per minute, resulting in a 5 day residency time at full capacity. The outlet valve can be closed for containment purposes in the event of a hazardous waste spill. The unitary system provides an approximate storage capacity of 1400 gallons.

The alternative recharge system design, allows for effluent recharge to permeable soils around and below the unit. The capacity of the recharge design is determined by the soil water permeability of the most limiting soil horizon. Treated effluent discharges from the biofilter via slotted PVC pipe located at the top (component 9, Figure 1) and bottom (not shown) of the unit to slotted PVC pipe located outside the unit in the surrounding gravel. Additional distribution pipe in the gravel below the unit is recommended by this author for uniform distribution to the soils below. The outlet of the biofilter is six inches above the bottom of the unit leaving sufficient water for plant growth between storm events.

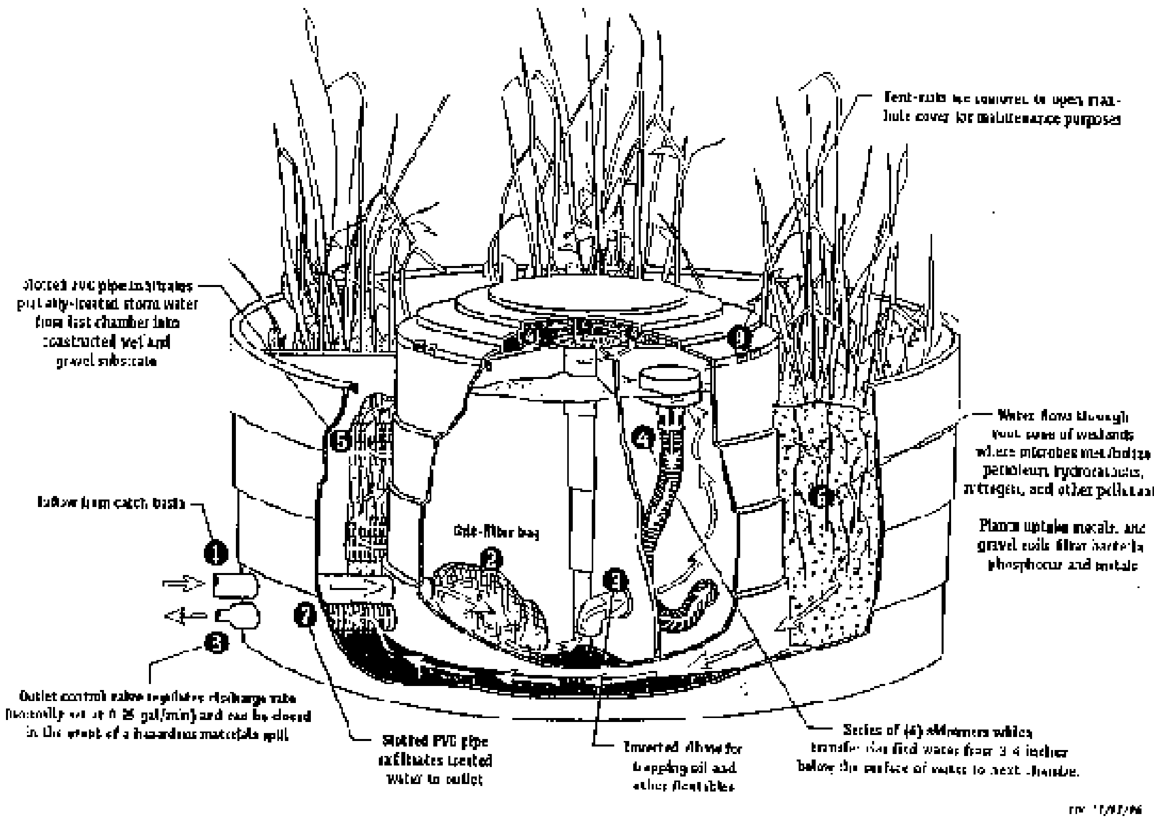

Figure 1. Illustration of the StormTreat unit. (after STS, Boston MA. 1997)

TECHNICAL FEASIBILITY

The StormTreat system is based on reasonable and accepted principles in water treatment technology. The system is designed to provide physical separation/filtration of grit and suspended solids and biological and physical/chemical reduction of pollutant parameters such as: BOD_5, nitrogen (N), phosphorus (P), petroleum hydrocarbons, metals and bacteria. Additional filtration occurs when the system is designed with recharge after the biofilter.

Hydraulic properties of the system suggest that residency time (5 days) within the separation chambers and the biofilter will have a direct relationship on treatment potential. Removal rates of pathogens may be much lower at shorter retention times. The biofilter, like sand filters, should be capable of high bacterial removal based on filtration and retention in small pores. Total N reduction will result from assimilation by microbes and plants and transformations via biochemical oxidation processes. Total N may also be reduced through biochemical reduction (denitrification) of oxidized forms of N. Denitrification will occur if oxidized N and soluble carbon are present in an anoxic environment such as a wetland. Phosphorus can be fixed on soil minerals or precipitated with iron and aluminum oxides. Fixed P will equilibrate with the solution, resulting in a dynamic removal process that has an finite capacity. Phosphorus removal will not be possible once the filter capacity is reached. STS recommends changing the biofilter medium at some interval to assure continued P removal, if P removal is an objective of the project. There is no information regarding performance characteristics as a function of flow rate. Solution equilibration time may be strongly affected by flow rate.

The biological component of the system is based on well documented technologies for reduction of carbon, TSS, and petroleum hydrocarbons. Residency time and operating conditions, such as: moisture, temperature, oxygen, nutrients, and light will most likely affect performance. Seasonal variation of performance is likely in the biofilter, as vegetative growth will be low or dormant for as many as 8 months per year. Additionally, the plants in the filter may not be at their maximum in spring, when runoff is highest, resulting in lower removal rates for biologically controlled processes (nitrogen and bacteria). Seasonal variation of TSS removal is not likely to occur as a result of the biofilter system performance, since removal is primarily based on sedimentation/filtration. TSS removal is more likely to vary as a function of sediment loading.

The system, when designed as a recharge unit should provide equivalent or better treatment to conventional infiltration BMPs when the unit is sized according to standard practices. The water permeability (cm/sec) of the surrounding soils will be the limiting design factor. The StormTreat system is untested as a recharge system. Total flow through the system as a recharge unit is not likely to be limited by the hydraulic properties of the internal structures of the system. Typical flow rates through the system will range from approximately 2 to 50 gallons per minute, based on a 0.5 inch precipitation event over a 5.8 hour duration (Wanielista and Yousef, 1993).

STS suggests that minimal maintenance is required, with major suction or vacuum pumping of solids once every 3 to 5 years. Shorter periods of time between pumping may be required with higher sediment loadings. The sedimentation bulkheads can be removed and washed or repaired through the central access. Sediment should be removed by qualified maintenance personnel, such as a DPW, with a vacuum truck. The biofilter medium should also be inspected as needed to assess solids buildup. Seasonal changes may require plant maintenance which could occur along with normal cleaning of catch basins and connecting pipes.

COMPETING TECHNOLOGIES

Several competing technologies are identified by STS. They include products by Stormceptor, Vortechnics, HIL Downstream Defender, and Compost Stormwater Filter (CSF). None of these competing products are particularly similar and only the CSF product, manufactured by Stormwater Management, has a biological component used for treatment (a compost filter cartridge). Two technologies, Stormceptor and Vortechnics, utilize basin configurations capable of removing grit, oils and grease. STS claims the StormTreat system is cost competitive with the other technologies mentioned. Other competing systems are detention basins and artificial wetland systems. The reported treatment potential of the StormTreat system demonstrates performance advantages over most conventional BMPs when sized accordingly. Cost competitive advantages of the StormTreat system over conventional best management practices (BMPs) have not been developed. Further information is required to clarify typical operation and maintenance costs.

DATA SUPPORTING CLAIMS

Prior to considering performance data from any treatment technology, the following notation is advised. Data collected from isolated stormwater treatment systems may be variable. Some of this variability may be due to differences in land use, climate, and soil type. Additionally, it is possible that storm events may have variable pollutant loads, resulting in varied treatment system performance at an individual site. The combination of these two sources of variability, inherent in all BMP performance verification, presents an unknown level of uncertainty. In order to overcome this uncertainty a larger set of data would be required to predict the performance of the technology under a variety of conditions. The StormTreat system has a limited set of performance data.

The proponents wish to demonstrate that the StormTreat system is capable of achieving Standards 3, 4, 5, and 6 of the Department of Environmental Protection (DEP) Stormwater Management Handbooks (DEP and CZM,1997). In this document, performance is based on available data in the proponent's submission from installations in Kingston, Massachusetts and Greenfield Massachusetts. STS had 52 units installed in 15 locations between 1994 and 1996. In the first 4 months of this year, STS quoted an additional 89 units to be sold. Additional data from other installations, with presumably different conditions, are potentially available or may be utilized for future performance evaluation.

TEST INSTALLATIONS

Kingston

The Kingston demonstration was initiated in October 1994. Performance data were collected over two years between November 1994 and October 1996. The site is located along the Jones River, identified as an environmentally sensitive area by the Jones River Watershed Association. Stormwater was collected from approximately 73,000 ft^2 of impervious area, including: approximately 2,000 ft of road, a 4,500 ft^2 parking area at a municipal building, and 14 private driveways (see Appendix). According to STS, the estimated loading to the StormTreat units from this area is less than the total runoff according to STS. This is due to the fact that 14 of the 15 catchment basins leading to the terminal basin, which feeds the StormTreat units, are recharging basins. It is estimated that roughly 33% of the total runoff from a typical 0.5 inch storm event was treated by the StormTreat systems. This equates to approximately 2,000 gallons per unit. The installation consisted of four units, installed in parallel, and fed centrally by the terminal catch basin with 4" PVC lines feeding each unit. This study site, facilitated by STS, provided essentially 4 replicate treatment units allowing for statistical analysis of performance data. Sampling was conducted when a 0.5 inch rainfall was likely to occur. Sampling was not done unless 3 days of dry weather preceded the storm event. Influent samples were taken from the entry point to the units within the terminal catch basin. Effluent samples were obtained from sampling ports located at the discharge end of each unit. STS provided that standard methods of analysis were used for analysis with quality control samples analyzed at an independent laboratory. These procedures were identified in the STS submission.

TSS performance claims are based on 6 storm events from the Kingston site. Mean reduction of TSS at the Kingston site by storm event was 95% with a 4% coefficient of variation. Raw data, uncorrected for storm event, resulted in a mean removal rate of 98% as shown in Table 1. Mean percent removal rates for Fecal Coliform, total N, P, and TPH were 97%, 77%, 90%, and 90%, respectively. TPH removal was based on one sample and is not statistically significant. The system also showed better than 77% removal of heavy metals.

Table 1. Summary of performance from the Kingston installation.

Pollutant	Influent Concentration		Effluent Concentration		Removal Rate (percent)	Storm Events
	Mean	Range	Mean	Range		
Fecal Coliform (no/100mL)	690	40-6000	20	10-462	97	4
TSS (mg/L)	76.6	4-344	1.75	0.5-12	98	6
COD (mg/L)	95	41-232	17	1-30	82	4
Total N (mg/L)	5.6	2.5-13	1.5	0.7-4.2	77	3
TPH (mg/L)	3.4	-	0.3	0.1-0.6	90	1
Lead (ug/L)	6.5	4-115	1.5	1-2	77	5
Chromium (ug/L)	18	16-60	1	0.5-1	98	3
Phosphorus (ug/L)	300	121-590	26	22-60	90	3
Zinc (ug/L)	184	70-590	28	2.5-84	90	3

Greenfield

Limited information is available on the StormTreat system installation in Greenfield. The site receives stormwater from a parking area and roadway associated with a municipal sewage treatment plant. Higher pollutant loadings may have occurred on this system due to periodic contamination from septage haulers, although this is unconfirmed. Data from a single storm event at the Greenfield site had a TSS removal rate of 85% with influent and effluent concentrations at 6.0 and 0.4 mg/L, respectively. Additional data from this installation may become available.

PERFORMANCE SUMMARY

These data suggest that the StormTreat system, designed for closed mode, can meet Standard 4 treatment (80% TSS removal, 0.5 inch storm event) and Standard 6 treatment (80% TSS removal, 1.0 inch storm event) if sized accordingly. Higher levels of treatment, up to 98% removal, have been demonstrated at the Kingston site and may be expected at sites with similar environmental conditions, including: climate, land use intensity, and soil type.

Predicted performance capability of the unit, designed with recharge, is based on performance characteristics of conventional infiltration BMPs. Conventional infiltration BMPs are reportedly capable of reducing TSS by 80%, if designed in accordance with the Stormwater Management Handbook (DEP and CZM, 1997). This suggests that the StormTreat system, as a recharge system, will be capable of removing at least 80% of the TSS and is likely to be capable of removing up to 96% of the TSS, when sized on the water permeability of the surrounding soils. Massachusetts Stormwater Policy prohibits recharge BMPs for land uses with higher pollution potential (Standard 5). Therefore the StormTreat unit must be used without recharge in these locations.

Removal rates of other standard parameters not specified in the Stormwater Management Handbooks (DEP and CZM, 1997) were obtained from the system installed at the Kingston site. The system has demonstrated relatively high removal rates for fecal coliform, petroleum hydrocarbons, nitrogen, phosphorus, and some heavy metals (Table 1). While these removal rates are not required for meeting Standards 4, 5, and 6, they demonstrate innovative and effective treatment potential compared to conventional BMPs, especially for Standard 5. Under conditions similar to the Kingston Site and in environmentally sensitive areas, such as coastal shellfish areas, the StormTreat system may provide superior treatment over conventional BMPs.

SITE SUITABILITY AND MAINTENANCE RECOMMENDATIONS

The applicability of this technology is similar to that of several other BMPs, including: sand filters, constructed wetlands, organic filters, and infiltration systems, all described in the Stormwater Management Handbooks (DEP and CZM, 1997). The system is suitable for new and retrofit situations. The system is particularly well suited for constricted areas and areas requiring recharge under Standard 3. Site requirements are minimal. The system can be used on sites with drainage areas from 0.5 to 10 acres. For larger installations, units may be located throughout the drainage area rather than in a central location and provide treatment of runoff closer to its source. Unlike constructed wetlands which require drainage areas greater than 10 acres, the StormTreat system can be used on small drainage areas or on individual inlets.

In high ground water conditions or flood plains, the system is designed to withstand the hydrostatic pressures created by the saturated soil conditions around the unit. Buoyancy control of the unit has been engineered into the system design. Installations that have a discharge to tidally influenced areas include a check valve on the outlet to allow discharge during low and mid tide conditions.

Sizing

System sizing will depend on the application of the system (closed or recharge mode), the stormwater treatment standards that must be met (3, 4, 5, or 6), soil permeability, soil hydrologic group (soil infiltration), level of pre- and post treatment, storm duration, and storm intensity, among other factors.[1] The sizing information below is provided for guidance only.

The closed mode system, with a surface discharge, was shown to be capable of removing as much as 98% TSS from an area of 6050 ft^2 of impervious surface per unit, calculated as the area receiving 0.5 inches of rainfall totaling 1885 gallons (see Appendix for explanation of sizing). When the system is installed with a catch basin, capable of 25% TSS removal, the StormTreat system must be capable of removing 73.3% of the influent TSS to meet Standard 4. (This is the difference between the 75% remaining and the goal of 80% total removal). Since the system has been demonstrated to provide 98% TSS removal, the area for Standard 4 can be calculated as the measured removal rate (98%) divided by the required removal rate (73.3%) multiplied by the known area of treatment (6050 ft^2). This calculation results in 8,080 ft^2 of impervious surface per unit, assuming pretreatment of 25%.

System sizing for the recharge design is based on soil water permeability. An example of the sizing requirements using soil water permeability is presented in Table 2. Calculations used to establish the number of units per area of impervious surface is based on Standards 4 and 6 (0.5 and 1.0 inch of rainfall), mean storm duration of 5.8 hours (Wanielista and Yousef, 1993), and an infiltrative surface area of 144 ft^2/unit. No credit for sidewall area of the excavation is given, due the fact that a restrictive mat is not likely to form under normal operating conditions. All flow is assumed to be vertical. Sizing, based on soil water permeability does not account for reduced permeability as a function of solids loading. The long term acceptance rate of soils receiving solids is known to decrease with time. The sizing data presented below do not include pretreatment removal efficiency or reduced loading due to rainfall intensity. Therefore, impervious area treated per unit will be slightly higher depending on the level of pretreatment

[1]1- The sizing information presented by STS in the initial submmition lacked adequate justification based on existing experimental data. In particular, the sizing data for 80% and 90% removal efficiency, based on soil type, did not consider details such as: storm duration, soil water permeability, and potential for reduced efficiency of the StormTreat system at higher flow rates. STS claimed that the closed mode installation should be capable of treating the first 0.5 inch of stormwater from 8,920 ft^2 of impervious surface. Our analysis, of the treatment potential for a given drainage area suggests that the sizing should be based on the holding capacity of the unit and any conveyance pipes that are full at the end of the storm event. It is important to note that the mean interval between storm events in the Northeast is 73 hours (Wanielista and Yousef, 1993). This period is shorter than the claimed system process time of 120 hours, and only 40% of the process time for the volume of runoff from 8,080 ft^2. This suggests that the total volume treated by the system, on an annual basis, may be lower than predicted. Shorter process times may be achieved by adjusting the outflow rate. However, shortening the process time may potentially reduce performance. Without additional field data, the performance capability at higher flow rates cannot be verified.

and rainfall intensity.

Table 2. System sizing based on $144 ft^2$ of soil surface interface area.

Soil Water Permeability (in/min)	Impervious Area Treated per Unit	
	Standard 4 80% TSS Removal (0.5 inch event)	Standard 6 80% TSS Removal (1.0 inch event)
0.50	50,000 ft^2	25,000 ft^2
0.25	20,000 ft^2	10,000 ft^2
0.13	12,000 ft^2	6,000 ft^2
0.06	6,000 ft^2	3,000 ft^2

Inspection and Maintenance

All BMPs require periodic maintenance. Inspection of the system after major storm events is recommended by this reviewer during the initial period of operation. Inspection of internal structures, including, baffles, skimmers, and control valves should be part of an annual inspection plan. STS recommends replacement of the grit bag filter and sediment removal every 3 to 5 years by suction pump. Typical removal of sediment and biofilter material can be performed with a vacuum truck and disposed of in accordance to DEP written policy. Shorter periods of time between pumping may be required with higher sediment loadings. Maintenance of the wetland system should include plant viability observations during growing and non-growing season. Replacement of sand media may be required at once every 10 - 20 years, which also requires reestablishment of the wetland plants. Without further field data, it is unknown how long the media will last. However, based on sand filter technology for domestic wastewater treatment, expected life may exceed 10 years.

REGULATORY ISSUES

The performance requirements for stormwater treatment systems are established by the DEP Stormwater Management Standards listed in the Stormwater Management Handbooks (DEP and CZM, 1997). Projects subject to the standards may be required to file a Notice of Intent when the site is in wetlands jurisdictional areas. Under the Wetlands Protection Act, conservation commissions, must apply the standards to new or modified discharges. Permits for surface water discharges under the National Pollutant Discharge Elimination System (NPDES), issued by the Massachusetts DEP Bureau of Resource Protection Division of Watershed Management, are not required if the discharge is tied to a conveyance or system of conveyances operated primarily for the purpose of collecting and conveying uncontaminated stormwater runoff.

Cross Media Impacts

Disposal of sediment from stormwater treatment systems is allowed in lined or unlined permitted solid waste landfills. In the absence of written approval from DEP, sediments are considered non-hazardous solid waste and may be treated in accordance the DEP written policy regarding disposal of catch basin waste. Grease and oils may accumulate in the sedimentation chambers and can be removed and disposed as non-hazardous solid waste. If the system has received influent from a hazardous materials spill, the system should be managed in accordance with an approved emergency response plan and appropriate state requirements. The StormTreat system does not present more restrictions for removal of wastes than would be associated with any other BMP.

Energy Issues

There are no specific energy issues related to this technology as it is not an energy consumer. There may be energy benefits when this "passive" system is compared to other technologies that may consume energy resources.

Need for Additional Research, Demonstration, and STEP Support

To establish removal rates in excess of those reported herein, further research on the StormTreat sysTem should include: i) evaluation of seasonal variation in performance, ii) variation due to climatic and soil conditions, iii) vegetation establishment and viability, iv) system performance as a function of wetland plants and type, and v) impact of freeze/thaw cycles and road salt on performance, vi) bacteria and pathogen removal efficiency in dry weather periods, vii) performance as a function of flow rate. The STEP program will be able to assist in commercialization issues concentrating on marketing, finance, business structure and other performance characteristics. Technical demonstrations already under way may be augmented with STEP support through STEP oversight and reporting.

Summary Recommendation

The StormTreat system is based on reasonable and accepted principles in water treatment technology and is likely to perform as an effective stormwater treatment system. The StormTreat system compares favorably to other conventional BMP technologies, offering enhanced treatment and application.

- Performance data available to this reviewer suggest that the StormTreat system can provide removal rates for TSS at least equivalent to sand filters at 80% removal (Standard 4 and 6) when sized accordingly.

- The StormTreat system can potentially meet Standard 3 when configured as a recharge system.

- The StormTreat system may be capable of achieving TSS removal rates up to 98% under conditions similar to those reported in the Kingston site, including: climate, land use intensity, and soil type.

- The StormTreat system may conditionally meet treatment requirements for land uses with higher potential pollutant levels (Standard 5) provided it is not installed as a recharge unit.

- The StormTreat system is likely to remove grease and oils with its unique skimmer mechanism.

" The StormTreat system is useful for new and retrofit installations, especially where space is limited.

Additional data representing a varied set of operating conditions over a realistic maintenance cycle are needed to establish rates in excess of 80% other than for sites similar to the Kingston site. These data may be forthcoming, since several installations have occurred with support from Section 319 Nonpoint Source Program grants under the Bureau of Resource Protection Division of Municipal Services and funding through CZM in its Coastal Remediation Program.

REFERENCES

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APPENDIX

Elm Street - Kingston, MA Impervious Drainage Area Calculation:

	length (ft)	width (ft)	area (ft^2)
Elm Street	900	24	21600
Water Dept lot	90	50	4500
6 driveways @ 500 sq ft			3000
Rte 106	1050	38	39900
8 driveways @ 500 sq ft			4000
		TOTAL AREA	73000

SIZING CALCULATIONS FOR CLOSED MODE OPERATION

Volume calcs based on storage in conducting pipes and sts units and catch basins at the Kingston installation.

	Quantity	Unit Volume or Flow Rate	Volume (gal)	
STS units	4	1400	5600	
feed pipes 6" and 4"	varied		1217	
STS discharge	348 min	1gpm	348	
catch basins	1	376	376	
free draining catch basins	14	376	5264	
			12805	**Total Volume**

The free draining sumps do not contribute to storage, so the real treated volume is the total minus the free draining sumps.

Unit	Volume (gal)	
old total	12805	
catch basins	5264	
new total	7541	
divide by 4 units	1885	**Volume per unit**

Calculate the area covered by 0.5 inches of precipitation that produces a volume of 1885 gallons.

$$1885 \text{ gal} / \{7.48 \text{ gal/ft}^2 \times (0.5 \text{ in}/ (12 \text{ ft/in}))\} = 6048 \text{ ft}^2$$

Given that the STS unit is preceded by a 25% removal efficiency device and the requirement is 80%, calculate the required STS removal efficiency to reduce the 75% remaining to 55% (the difference between 80% and 25%).

Take the ratio of 55%/75% = 0.733 removal efficiency

Multiply this factor by the area treated in the study 6050 ft^2. This is the area that can be treated with the STS unit and catch basin, achieving 80%

8080 ft2 area/unit