THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**STORMWATER TREATMENT TECHNOLOGY**	
APPLICATION:	**SUSPENDED SOLIDS AND ROADWAY POLLUTANT TREATMENT**	
TECHNOLOGY NAME:	**THE STORMWATER MANAGEMENT STORMFILTER® USING ZPG FILTER MEDIA**	
TEST LOCATION:	**MILWAUKEE, WISCONSIN**	
COMPANY:	**STORMWATER MANAGEMENT, INC.**	
ADDRESS:	**12021-B NE Airport Way** **Portland, Oregon 97220**	PHONE: **(800) 548-4667** FAX: **(503) 240-9553**
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NSF International (NSF), in cooperation with the EPA, operates the Water Quality Protection Center (WQPC), one of six centers under ETV. The WQPC recently evaluated the performance of the Stormwater Management StormFilter® (StormFilter) using ZPG filter media manufactured by Stormwater Management, Inc. (SMI). The system was installed at the "Riverwalk" site in Milwaukee, Wisconsin. Earth Tech, Inc. and the United States Geologic Survey (USGS) performed the testing.

The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups, which consist of buyers, vendor organizations, and permitters; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

TECHNOLOGY DESCRIPTION

The following description of the StormFilter was provided by the vendor and does not represent verified information.

The StormFilter installed at the Riverwalk site consists of an inlet bay, flow spreader, cartridge bay, overflow baffle, and outlet bay, housed in a 12 foot by 6 foot pre-cast concrete vault. The inlet bay serves as a grit chamber and provides for flow transition into the cartridge bay. The flow spreader traps floatables, oil, and surface scum. This StormFilter was designed to treat stormwater with a maximum flow rate of 0.29 cubic feet per second (cfs). Flows greater than the maximum flow rate would pass the overflow baffle to the discharge pipe, bypassing the filter media.

The StormFilter contains filter cartridges filled with ZPG filter media (a mixture of zeolite, perlite, and granular activated carbon), which are designed to remove sediments, metals, and stormwater pollutants from wet weather runoff. Water in the cartridge bay infiltrates the filter media into a tube in the center of the filter cartridge. When the center tube fills, a float valve opens and a check valve on top of the filter cartridge closes, creating a siphon that draws water through the filter media. The filtered water drains into a manifold under the filter cartridges and to the outlet bay, where it exits the system through the discharge pipe. The system resets when the cartridge bay is drained and the siphon is broken.

The vendor claims that the treatment system can remove 50 to 85 percent of the suspended solids in stormwater, along with removal of total phosphorus, total and dissolved zinc, and total and dissolved copper in ranges from 20 to 60 percent.

VERIFICATION TESTING DESCRIPTION

Methods and Procedures

The test methods and procedures used during the study are described in the *Test Plan for Verification of Stormwater Management, Inc. StormFilter® Treatment System Using ZPG Media, "Riverwalk Site," Milwaukee, Wisconsin* (NSF International and Earth Tech, March 2004) (VTP). The StormFilter treats runoff collected from a 0.19-acre portion of the eastbound highway surface of Interstate 794. Milwaukee receives an average of nearly 33 inches of precipitation, approximately 31 percent of which occurs during the summer months.

Verification testing consisted of collecting data during a minimum of 15 qualified events that met the following criteria:

- The total rainfall depth for the event, measured at the site, was 0.2 inches (5 mm) or greater (snow fall and snow melt events do not qualify);
- Flow through the treatment device was successfully measured and recorded over the duration of the runoff period;
- A flow-proportional composite sample was successfully collected for both the influent and effluent over the duration of the runoff event;
- Each composite sample was comprised of a minimum of five aliquots, including at least two aliquots on the rising limb of the runoff hydrograph, at least one aliquot near the peak, and at least two aliquots on the falling limb of the runoff hydrograph; and
- There was a minimum of six hours between qualified sampling events.

Automated sample monitoring and collection devices were installed and programmed to collect composite samples from the influent, the treated effluent, and the untreated bypass during qualified flow events. In addition to the flow and analytical data, operation and maintenance (O&M) data were recorded. Samples were analyzed for the following parameters:

Sediments
- total suspended solids (TSS)
- total dissolved solids (TDS)
- suspended sediment concentration (SSC)
- particle size analysis

Metals
- total and dissolved cadmium, lead, copper and zinc

Nutrients
- total and dissolved phosphorus

Water Quality Parameters
- chemical oxygen demand (COD)
- dissolved chloride
- total calcium and magnesium

VERIFICATION OF PERFORMANCE

Verification testing of the StormFilter lasted approximately 16 months, and coincided with testing conducted by USGS and the Wisconsin Department of Natural Resources. A total of 20 storm events were sampled. Conditions during certain storm events prevented sampling for some parameters. However, samples were successfully taken and analyzed for all parameters for at least 15 of the 20 total storm events.

Test Results

The precipitation data for the 20 rain events are summarized in Table 1.

Table 1. Rainfall Data Summary

Event Number	Start Date	Start Time	Rainfall Amount (inches)	Rainfall Duration (hr:min)	Runoff Volume (ft^3)[1]	Peak Discharge Rate (gpm)[1]
1	6/21/02	6:54	0.52	0:23	420	447
2	7/8/02	21:16	1.5	2:04	1,610	651
3	8/21/02	20:08	1.7	15:59	1,620	671
4	9/2/02	5:24	1.2	3:24	1,180	164
5	9/18/02	5:25	0.37	4:54	350	136
6	9/29/02	0:49	0.74	7:54	730	70.9
7	12/18/02	1:18	0.37	3:47	300	61.0
8	4/19/03	5:39	0.55	10:00	340	96.9
9	5/4/03	21:21	0.90	11:44	540	73.2
10	5/30/03	18:55	0.54	4:06	320	83.9
11	6/8/03	3:26	0.62	11:09	450	140
12	6/27/03	17:30	0.57	13:25	460	107
13	7/4/03	7:25	0.53	40:43	550	143
14	7/8/03	9:49	0.33	3:37	260	62.8
15	9/12/03	15:33	0.22	1:55	150	21.5
16	9/14/03	5:22	0.47	6:35	340	264
17	9/22/03	2:28	0.27	2:09	270	104
18	10/14/03	1:03	0.25	2:07	220	56.5
19	10/24/03	16:46	0.71	15:07	410	75.8
20	11/4/03	16:14	0.60	2:09	560	906

[1] Runoff volume and peak discharge volume was measured at the outlet monitoring point.

The monitoring results were evaluated using event mean concentration (EMC) and sum of loads (SOL) comparisons. The EMC or efficiency ratio comparison evaluates treatment efficiency on a percentage basis by dividing the effluent concentration by the influent concentration and multiplying the quotient by 100. The efficiency ratio was calculated for each analytical parameter and each individual storm event. The SOL comparison evaluates the treatment efficiency on a percentage basis by comparing the sum of the influent and effluent loads (the product of multiplying the parameter concentration by the precipitation volume) for all 15 storm events. The calculation is made by subtracting the quotient of the total effluent load divided by the total influent load from one, and multiplying by 100. SOL results can be summarized on an overall basis since the loading calculation takes into account both the concentration and volume of runoff from each event. The analytical data ranges, EMC range, and SOL reduction values are shown in Table 2.

Table 2. Analytical Data, EMC Range, and SOL Reduction Results

Parameter[1]	Units	Inlet Range	Outlet Range	EMC Range (percent)	SOL Reduction (percent)
TSS	mg/L	29 – 780	20 – 380	-33 – 95	46
SSC	mg/L	51 – 5,600	12 – 370	3 – 99	92
TDS	mg/L	<50 – 600	<50 – 4,200[2]	-600 – 10	-170[2]
Total phosphorus	mg/L as P	0.05 – 0.63	0.03 – 0.30	0 – 70	38
Dissolved phosphorus	mg/L as P	0.01 – 0.20	0.01 – 0.19	-35 – 38	6
Total magnesium	mg/L	4.0 – 174	1.1 – 26	53 – 96	85
Total calcium	mg/L	9.4 – 430	4.0 – 68	26 – 93	79
Total copper	µg/L	15 – 440	7.0 – 140	8.3 – 96	59
Total lead	µg/L	<31 – 280	<31 – 94	33 – 91	64
Total zinc	µg/L	77 – 1,400	28 – 540	20 – 89	64
Dissolved copper	µg/L	<5 – 58	<5 – 42	-47 – 64	16
Dissolved zinc	µg/L	26 – 360	16 – 160	-86 – 56	17
COD	mg/L	18 – 320	17 – 190	-91 – 47	16
Dissolved chloride	mg/L	3.2 – 470	3.3 – 2,600[2]	-740 – 24	-242[2]

[1] Total and dissolved cadmium and dissolved lead concentrations were below method detection limits for every storm event.

[2] Dissolved chloride and TDS results were heavily influenced by a December storm event when road salt was applied to melt snow and ice.

Based on the SOL evaluation method, the TSS reductions nearly met the vendor's performance claim, while SSC reductions exceeded the vendor's performance claim of 50 to 85 percent solids reduction. The StormFilter also met or exceeded the performance claim for total and dissolved phosphorus, total copper, and total zinc. The StormFilter did not meet the performance claim for dissolved copper or dissolved zinc, both of which were 20 to 40 percent reduction, and had no performance claims for any other parameters.

The TDS and dissolved chloride values were heavily influenced by a single event (December 18, 2002), where high TDS and dissolved chloride concentrations were detected in the effluent. The event was likely influenced by application of road salt on the freeway. When this event is omitted from the SOL calculation, the SOL value is -37 percent for TDS and -31 percent for dissolved chloride.

Particle size distribution analysis was conducted on samples when adequate sample volume was collected. The analysis identified that the runoff entering the StormFilter contained a large proportion of coarse sediment. The effluent contained a larger proportion of fine sediment, which passed through the pores within the filter cartridges. For example, 20 percent of the sediment in the inlet samples was less than 62.5 µm in size, while 78 percent of the sediment in the outlet samples was less than 62.5 µm in size.

System Operation

The StormFilter was installed prior to verification testing, so verification of installation procedures on the system was not documented.

The StormFilter was cleaned and equipped with new filter cartridges prior to the start of verification. During the verification period, two inspections were conducted as recommended by the manufacturer. Based on visual observations, the inspectors concluded that a major maintenance event, consisting of cleaning the vault and replacing the filter cartridges, was not required. After the verification was complete, a major maintenance event was conducted, and approximately 570 pounds (dry weight) of sediment was removed from the StormFilter's sediment collection chamber.

Quality Assurance/Quality Control

NSF personnel completed a technical systems audit during testing to ensure that the testing was in compliance with the test plan. NSF also completed a data quality audit of at least 10 percent of the test data to ensure that the reported data represented the data generated during testing. In addition to QA/QC audits performed by NSF, EPA personnel conducted an audit of NSF's QA Management Program.

Original signed by *Lawrence W. Reiter, Ph. D. September 21, 2004*	*Original Signed by* *Gordon E. Bellen September 23, 2004*
Lawrence W. Reiter, Ph. D. Date Acting Director National Risk Management Laboratory Office of Research and Development United States Environmental Protection Agency	Gordon E. Bellen Date Vice President Research NSF International

Availability of Supporting Documents

Copies of the *ETV Verification Protocol, Stormwater Source Area Treatment Technologies Draft 4.1, March 2002,* the verification statement, and the verification report (NSF Report Number 04/17/WQPC-WWF) are available from:

ETV Water Quality Protection Center Program Manager (hard copy)
NSF International
P.O. Box 130140
Ann Arbor, Michigan 48113-0140

NSF website: http://www.nsf.org/etv (electronic copy)
EPA website: http://www.epa.gov/etv (electronic copy)
Appendices are not included in the verification report, but are available from NSF upon request.